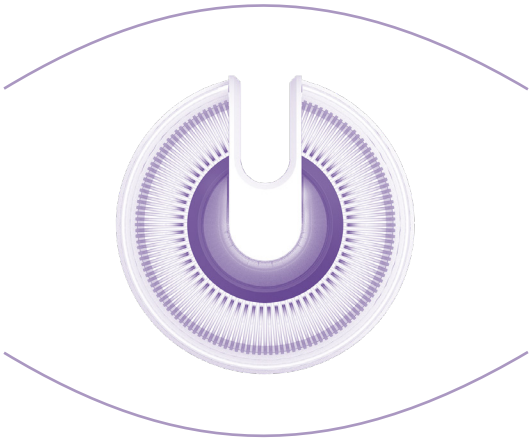

A DIPLOMA IN INDUSTRIAL DESIGN

Speculative Solar

Towards long term futures and sustainability

JOMY JOSEPH

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THE OSLO SCHOOL OF ARCHITECTURE AND DESIGN

A Diploma thesis by Jomy Joseph

Supervised by:

Håkan Edeholt, Linda Blaasvær and Synne Christiansen

Diploma Partner:

designBRICS

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All for better futures.

abstract

With the onset of cataclysmic climate change and the sixth mass extinction, organised human life is presented with a bleak future. Even in our collective imagination we are forced to comprehend the self-reinforcing loops of dystopian thinking. This project proposes an exploration in speculative industrial design through both process and artefact-making for the purposes of creating a more resilient, hopeful narrative of the future and subsequently provide alternatives to our current predicament. The specific speculation focuses on the context of solar energy but the project could just as well be applied in diverse ways to a number of inquiries of the future(s). From an interdisciplinary lens, this project has attempted to trigger a discourse through industrial design, ways in which we can think about a long term future that is sustainable for future generations in the age of the Anthropocene. In so far as it enables for visualising scenarios and as a tool for collaboration, a speculative future fiction in VR was also explored as a means to 'time-travel' where the designed artefact from the future could be interacted with and brought back to the present. As a manifestation of that future transposed back to the present, an artefact, a 3D printed optical solar cell was proposed as a potential alternative to existing solar cells. The designed artefact here draws on existing technology as means of agency, enabled by industrial design to create a framework of climate action that this project proposes is critical to long term futures thinking and sustainability. The exploration of the process also poses the question "what if" to the ways in which industrial design can serve society today and how it could strive towards visions of better, more thriving paradigms as we head into an uncertain future.

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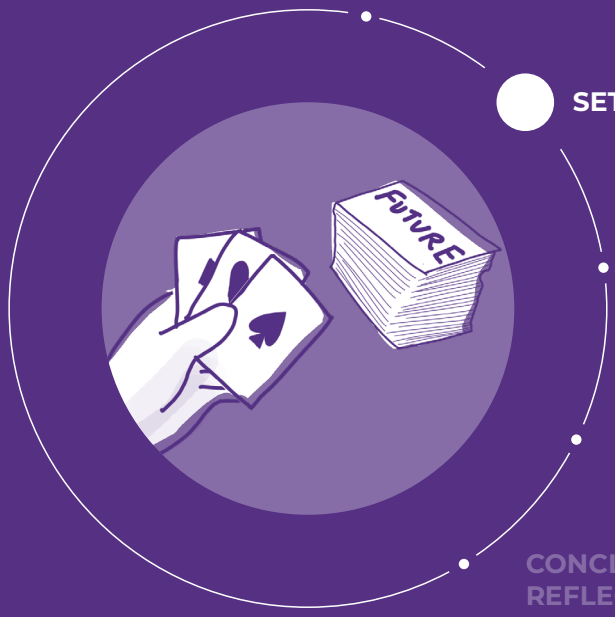


SETTING THE CONTEXT

IMAGINING ALTERNATIVE FUTURES

SPECULATIVE INDUSTRIAL DESIGN

CONCLUSIONS AND REFLECTIONS

1. Setting the Context

Introduction

The age of the Anthropocene and climate change brings with it an uncertain future while we continually plunder our life sustaining biosphere in the pursuit of mass consumption, enabled by design. With the need for immediate climate action there seems to be a crisis of imagination in seeing a future beyond business as usual, particularly when it comes to industrial design practise. This diploma is an attempt at showing how industrial design can allow for envisioning radically sustainable, long term futures in the context of solar energy.

Foreseeing radically different futures depends on being able to visualise a future that doesn't yet exist. Designing for such a future context depends on the credible foresight gained by designers through their craft to create a vision both desirable and feasible. This project also argues for using VR as a versatile tool for futures thinking in the context of long term sustainability and climate action through industrial design in the context of solar energy. The texture of these designed futures is interpreted through a speculative exploration of design fiction, virtual reality and industrial design. The introduction of VR tools as a tool for future foresight in combination with other tools such as design fiction, design sketching, CAD, film sketching and animation leads a richer space for approaching the holistic complexity of climate change.

This Diploma engages in a broader scope of speculation for long term futures but in that respect also aims to create a bridge to that future by pointing to an industrial design solution for today and thereby offer a viable alternative towards long term futures. Being an industrial design diploma, the project's outcome has been focussed on a tangible solution, however, in the course of the exploration it was quite evident that the methodology held potential for a wide range of design disciplines and also within a broader, interdisciplinary framework. In that spirit, this diploma also aims to create an interdisciplinary space to engage with a better imagination of the future and the actions we can take today to potentially head to that future. This project therefore being part of a larger discourse on long term futures and sustainability showcases only a small piece of a much larger puzzle. In this regard, the diploma was an attempt at discovering ways in which Industrial Design could bring about technology and research that already exists today to create speculative imaginings, that by virtue of a designed tangible artefact, points towards more radical futures. In the absence of a perfect world with perfect solutions, this diploma looks towards opening an alternative space in taking action towards long term futures and sustainability decoupled from the dystopian visions of business as usual.

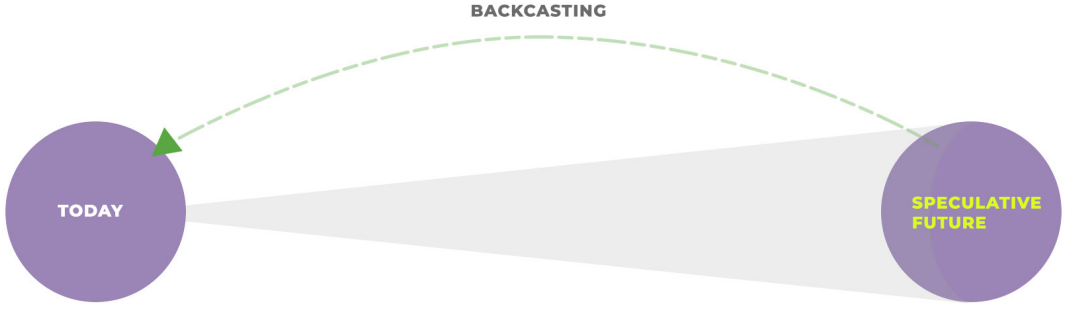


Fig 1: The challenge for this diploma: to imagine alternative speculations of the future(s) and bring it back to be engaged with today.

Why Radical Futures:

Hoping for linear, incremental change in the face of an exponential, existential threat is slowly becoming an untenable position to maintain. Much like a deer staring into the headlights, our collective institutional inertias seem to have somehow frozen us in time and space. It is time for a flight response to get to a place where our life sustaining ecosystem has a chance to nurture future generations. So how do we decide on what a “more hopeful” future looks like? What are the possibilities that allow for discovering a radical yet inspiring future?

Over the course of the project I looked at a few of the following values that I could call important in exploring the texture of a future worth having:

- Shows possibilities of abundance both social and economic rather than mere scarcity and competition.
- Inspirational through the radical nature of the future itself.
- Does not prefer utopia over dystopia, doesnt propose a perfect universe with perfect solutions.
- Provokes discussion and critical reasoning to understand and challenge conventions.

As a speculative exploration of the methodology itself this diploma holds promise in creating a space for engaging with other disciplines towards creating a shared space of rigorous imaginings of the future. The outcome of these alternative visions, allows for different disciplines to pull different threads from it. This report is an attempt at documenting just one thread, a manifestation of the speculative future i.e. through industrial design, one thread within a multitude of possible threads as shown below. One could just as easily choose to pursue another thread if one so chooses, which is however outside the scope of this project.

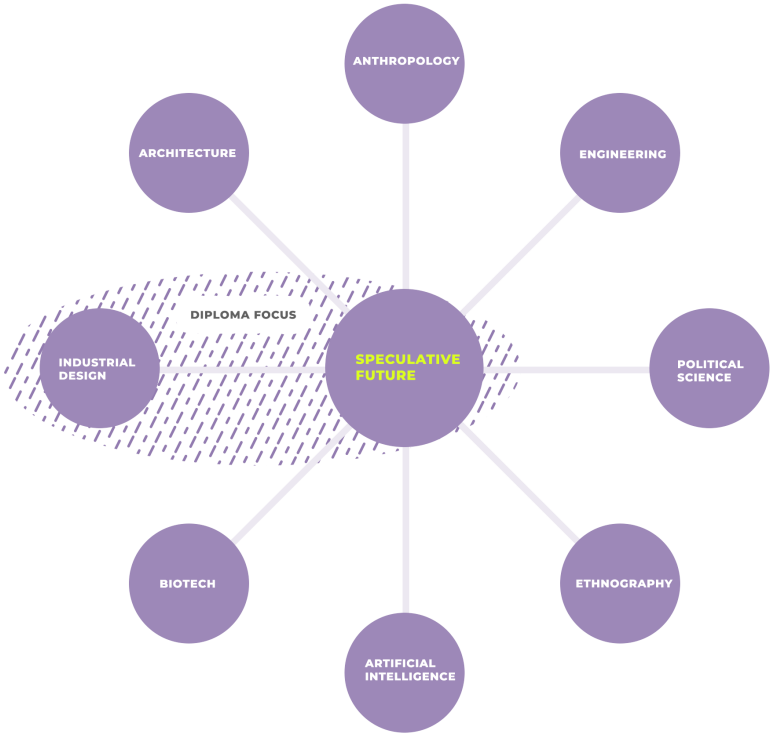


Fig 2: A rich speculative future and the Industrial Designers role in the imaginings of the future which is also the focus of this diploma.

1.1. Background

We have reached a point where global average temperatures 0.8°C above normal is already a reality and we are looking at 2°C above normal [(1)] in the best case; and that is ***if*** we manage to reduce our carbon emissions and start sequestering it. 2°C is still a disaster when we realise that the sixth mass extinction [(2)] is also underway due to human activity. At such a juncture then, all our assumptions about growth and prosperity are called into question. This means that we are now required to reevaluate the role of design as an agent of this crisis and the choices that made these cataclysmic patterns possible, to rethink the existing paradigms of modern life that depend on the relentless extraction and exploitation of resources and the commons for the short term.

We have been living on borrowed time. What we have today with the modern marvels of the industrial world is a highly bloated mirage of infinite growth to maintain in a finite world. We see ecology as a quantifiable, replaceable commodity that through the design, mass manufacture, logistics and planned obsolescence of which the engine of our economy runs. For a lack of a better vision, these signs make for a very grim story. Perhaps what we really need is less things and better visions of thriving new paradigms. We must move on from cultivating mono-cultures in design, of selling trinkets of desires at the expense of ecology and society.

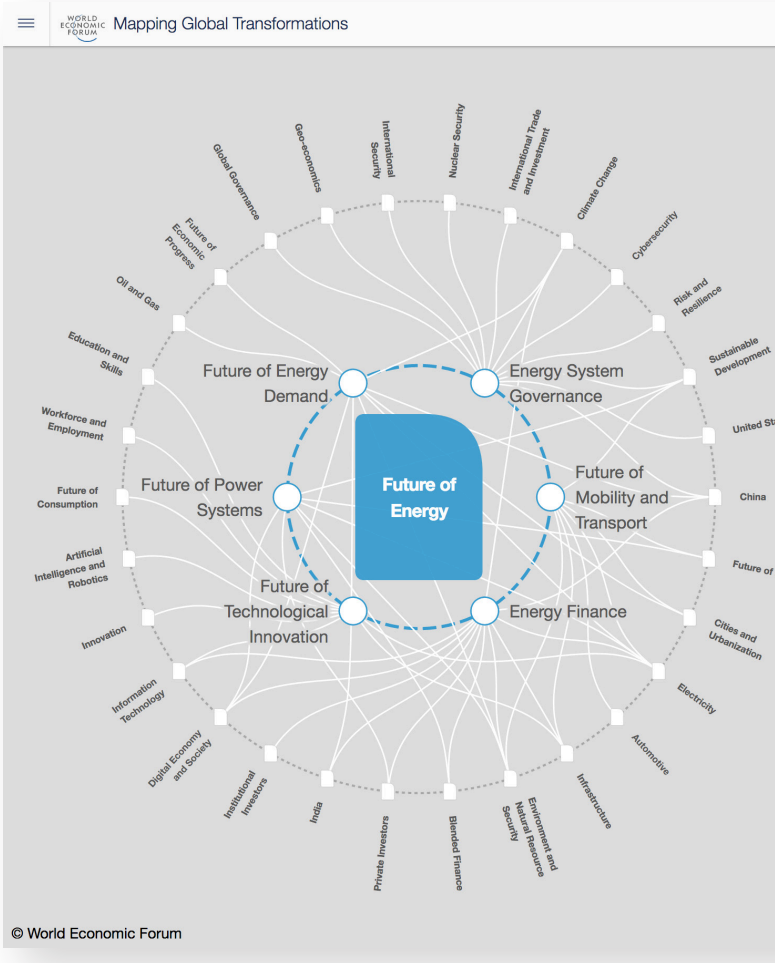
(1) "World Is Locked into About 1.5°C Warming & Risks Are Rising, New Climate Report Finds." Text/HTML. World Bank. Accessed Janurary 9, 2018. http://www.worldbank.org/en/news/feature/2014/11/23/climate-report-finds-temperature-rise-locked-in-risks-rising.

(2) Ceballos, Gerardo, Paul R. Ehrlich, and Rodolfo Dirzo. "Biological Annihilation via the Ongoing Sixth Mass Extinction Signaled by Vertebrate Population Losses and Declines." Proceedings of the National Academy of Sciences 114, no. 30 (July 25, 2017): E6089–96. https://doi.org/10.1073/pnas.1704949114.

Figure 3: Conflict Coal mine in India:
Who is this progress for? Most of the gains from Business as Usual deny the very people who create the gains even the basic means to enjoy those gains.

The climate narrative and the scope for better futures

We are at a point now that all our assumptions about growth and prosperity are called into question. If 'progress' means the decimation of organised human life, perhaps it may not really be progress as no generation before the anthropocene had to deal with the collective responsibility of "biological annihilation". Climate change as a 'hyperobject', as coined by Timothy Morton[(3)], is staring us in the face. If one were to ask, "How did we get here?", the answer could arguably be, by design. If one looks carefully at the way the modern world, it is organised around mass consumption, where every metric is focussed on maximising gains at the cost of an ***externality***. This externatily, is namely the life sustaining biosphere and ironically crucial to the very gains the aforementioned metrics depend upon. So here we see a conundrum wider and larger than individual action shows up. Just as we designed the systems in place to give rise to the sixth mass extinction event, it stands to reason that as designers we are now required to reevaluate our role in creating the world before us. We created this redundant cycle of dystopias by design. So perhaps we can try designing a conscious way out of this. This project however, is not about pining for a pre-industrial era, or reverting back to primitivism. As a first step to understanding our place in the future is to be able to direct introspection inward to the way we design and in doing so perhaps discover the possible tools that could help envision a better future and the challenges we will face in getting there.



Wicked Problems

The challenge for this diploma is to create new paradigms that point to alternative solutions facilitating the transition to a renewable energy surplus. This means breaking conventional assumptions when it comes to avoiding the traps of our present mono-cultures of design solutions. To design a thriving, ecologically symbiotic world we would need to derive inspiration

(3) "What Is Dark Ecology?" Changing Weathers. Accessed November 6, 2017. http://www.changingweathers.net/en/episodes/48/what-is-dark-ecology.

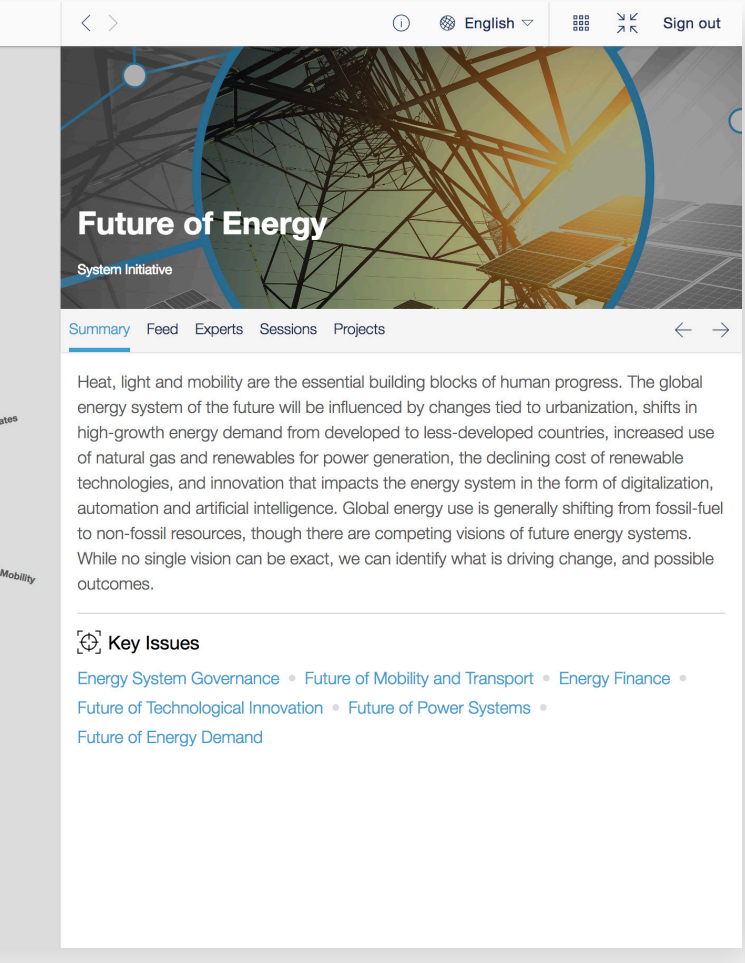


Figure 4: Business a bit more than Usual: World Economic Forum Transformations Map

See Appendix 1

from holistic self awareness rather than an insular point of view. Yet, in so far as we still live in this "real" world, we are still bound by this wicked problem of ecology vs economy. Ecology which is interconnected and communicating all the time [(4)], while in the economy every action and interaction is measured as a zero sum game, fueled by competition. If we are to find ourselves in a future worth having it may be sound to drop the notion of man vs nature, instead look at our place in ecology as that of a symbiotic species in a complex web of layered, complex relationships.

In so far as economic policies are concerned, it was important to see what was being done to prepare for the post climate future. As part of my foray into understanding what the future of the world was when it came to business as usual, the World Economic Forum had created a systemic map [(5)] of the changes they expected to take place. I studied and analysed these 'Transformation Maps' in order to get a clearer understanding of what the world leaders were looking at when it came to sustainable development or the future of energy among others. On the face of it, it would seem that the economic system eventually realised the existential threat to itself. I analysed some of the major trends from those maps directly linked to solar energy and industrial design hoping to gain an insight as to what economic policies were set in place to influence the future.

Unwrapping the research showed a trend of growth and more growth, green or otherwise. There was a clear struggle between the new 'renewables' profit versus the dirty old fossil profit. A development agenda that pointed to a 'sustainable' growth but much of the same modes of resource extraction. In short, and quite unsurprisingly, business a bit ***more than usual***. These visions for the future as business sees it, unsurprisingly enough leave very little room for radical shifts, which is exactly what the modes of climate action need to be. Understanding how economics drives the policies for future building, gives an insight into where the answers are ***not*** going to come from. It might just turn out that when our worship of the economy yields half baked answers, we can perhaps pick the pieces of whatever remains of our ecology.

(4) Fleming, Nic. "Plants Talk to Each Other Using an Internet of Fungus." Accessed January 28, 2018. http://www.bbc.com/earth/story/20141111-plants-have-a-hidden-internet.

(5) "Explore Insights | TOPLINK." Accessed January 17, 2018. https://toplink.weforum.org/knowledge/explore/all.

1.2. Contemporary Standpoints on Climate Change

In such a bleak scenario, as it so often happens, it is easy to get trapped in trying to "predict the future" by mapping projected trends much like the exercise of the World Economic Forum, leaving hardly any room for other more "rigorous' imaginings" [(6)]. Such a practise might give predictable interventions but might just steer clear of addressing real systemic ailments that might have lead to radical changes and solutions. Much like trying to change a flat tyre from the inside of a moving car while travelling at a hundred miles an hour towards a cliff. Perhaps such 'rigorous' imaginings is exactly what the doctor ordered. It could be argued, and this diploma does argue for, is that by it's very nature, a radical future vision would make the trend-mapped future obsolete, as it nudges the oncoming future towards a different trajectory. These changes can be analysed to learn lessons from and map onto the present the ways in which we could set into motion a radical shift. Facing the threat of species extinction within the century, we need to scour our collective creative abilities to carve out a future that looks more hopeful and much more sustainable in the long term.

Planned Degrowth and Circular Economy

All the progress on sustainable methods means nothing if growth for growth sake is the prime directive of sustainability. The fallacy of "green" growth is one such phenomenon[(7)]. The Technosphere i.e. a geological entity accounting for all the objects mankind has made to survive including homes, refrigerators, plastic cups etc. account for 30 trillions tons [(8)] of resources hollowed out from the natural habitat, most of which will never return to the natural systems. For all the talk of becoming an interplanetary species, we sure have created a massive redundancy that is counterintuitive to any form of life on earth. Infinite growth on a finite planet sounds like a paradox of paradoxes. We can not talk of long term sustainability or indeed any future without collectively moving towards a saner direction of decoupling growth from progress. The emperor called 'growth' wears no clothes and is finally being called out across the world [(9)]. While we contemplate heading to Mars it would be wise to really get to grips to the synergies of our finite world. So whatever we choose to do from here on will need to be within the purview of de-growth and circular thinking. It is a bitter pill to swallow for business as usual because it means a radical change in a system that is riddled with massive inertia and a paralysis of imagination. Planned degrowth and circular economy might just be a pressure valve among many that we need, to safely transition as we head into uncertain times.

(6) Miller, Riel. "Futures Literacy: A Hybrid Strategic Scenario Method." Futures 39, no. 4 (May 2007): 341–62. https://doi.org/10.1016/j.futures.2006.12.001.

(7) Ladha, Alnoor. "From '"Green Growth"' to Post-Growth." Truthout. Accessed April 22, 2018. http://www.truth-out.org/opinion/item/44111-from-green-growth-to-post-growth.

(8) "Earth's 'technosphere' Now Weighs 30 Trillion Tons, Research Finds." Accessed April 22, 2018. https://phys.org/news/2016-11-earth-technosphere-trillion-tons.html.

(9) Clendaniel, Morgan, Morgan Clendaniel, and Morgan Clendaniel. "To Save The Economy, We Have To Break Its One Sacred Rule." Fast Company, March 15, 2016. https://www.fastcompany.com/3057801/to-save-the-economy-we-have-to-break-its-one-sacred-rule.

Figure 5: Harnessing Naturally grown Material Technology, Ecovative Fibreboard

Role of Existing Technology

With the rise of technological shifts such as automation, blockchain, mycotechnology, material sciences and biotech to name a few, we can see a better way of thinking about a long term future. As this project will show later, by working with existing technology and research there might be a way to create the space for design to act as a bridge towards shaping better visions of the future and which might even establish new collaborations between research and design. While solar cell technology has been in the labs for many decades now, it wasn't until a couple of years ago and within the economies of scale that a mainstream shift to renewables could happen that would allow for it to enter into economic consciousness. Once again showing how on pure scale and growth terms alone, the dictates of the marketplace do not give a fair voice to the imperative needs of climate action or even to better solutions that ***already*** exist. By the time "market" forces embrace such a technological leap, it may to be too obsolete or far removed from its potential, far too centered on unsustainable economies of scale and short term gains.

Dogmas of Making

The role of legacy technology in software is well known. Like a precarious house of cards, it makes for very unstable conditions. If we consider the delicate balance in the inherent scales of operations in resource extraction, manufacturing, distribution, consumption and eventual disposal into landfill, we can argue that the fruits of industrial production we depend on, surely shouldn't be so expendable. Change in such systems is antithetical to short term gains and yet, paradoxically, adapting to change is the key to resilience and long term sustainability. It might be noted that as it stands today, making our stuff requires an astounding amount of raw materials, materials based on destructive methods of extraction. Our obsessive gadgeteering has only enormously sped up such practises. Mass scale industrial manufacturing sucks up resources and energy; resources extracted from the global south, often leading to the oppression of indigenous people, using energy from fossil fuels to run industrial operations round the clock to stockpile inventories that reach our stores and end up in the trash in less than a year. An 8-ounce phone requires over 165 pounds of raw material that nature took millions of years to form[(10)]. Modern gadgets consume far more embodied energy to make than we are lead to believe [(11)], questioning the very merits of such a practice. Yet we are always told to admire its precision and 'efficiency' in it's functioning. Climate change is still an externality to such a system. The things we make comes with baggage that we are not aware of or wilfully ignore because it becomes someone else's problem down the supply chain.

(10) Smil, Vaclav. "Your Phone Costs Energy—Even Before You Turn It On." IEEE Spectrum: Technology, Engineering, and Science News, April 26, 2016. https://spectrum.ieee.org/energy/environment/your-phone-costs-energyeven-before-you-turn-it-on.

(11) Madrigal, Alexis C. 2014. "The Energy in Things." The Atlantic, October 17, 2014. https://www.theatlantic.com/technology/archive/2014/10/the-energy-in-things/381557/.

Figure 6: The Traces of our stuff

Biomimicry

Nature on the other hand nurtures the elements in conditions conducive to life [12], nothing is wasted in a closed system. The challenge is to facilitate industrial design in such a way that can be ***nurtured*** into existence and help us thrive in our habitats. In many ways then the anthropocene can be argued as a strong argument for transitioning human society to a new regenerative paradigm. As a case in point, the advent of mycotechnology [13] i.e. products made from mycelium, are being explored as a means to grow products such as packaging material[14], high performance leather[15], bioremediation, antibiotics [16] and batteries [17] among others showing that there is far more possibilities for interventions by design. We can look at these shifts as a means of not just replacing our current products but also design new and seemingly impossible technology and tools that would never exist in a mass produced industrial economy. In the quest of long term sustainability, it would be disingenuous to ignore the ecological synergies and symbiotic relationships all lifeforms have within the environment that sustains it. In this perspective, this project argues for a move beyond simply mimicking biology. Maybe we need to create the way nature creates, constantly self correcting and evolving. Naturally the science needed for that is perhaps too advanced for us, but then again, so was landing on the moon. Even so, if that is too complex for us to work on, we might try and create conditions for the natural world to do what it does, regenerate life. One such method is mycoremediation i.e. bioremediation using mushroom mycelium.

Together with mycoremediation, there are firms already making things from regenerative biological materials such as Ecovative, which sells fibreboards that are basically grown and not glued. Another firm, Mycoworks is growing victimless, biological leather from mycelium at room temperature that is far stronger than animal leather. It is important to note how in these cases the assumptions that the major roadblock to these methods are technological is not always true, most often than not these filters are quite porous, that is to say, the technology we need more often than not exists in the here and now, not just in the future.

Dark Solar

Climate change it turns out is a symptom of a rather complex systemic problem. In that complex web of intersectionality it is understandably arduous to come up with a narrow framework of solutions that would mitigate climate change. In order to look for a focal point where I could delve into for the purpose of this diploma I looked to the usual suspects of Climate Change with a rather simple intention: to explore a mode of climate action assumed to be so obvious such that the designed solution must inadvertently challenge the assumptions, I hope that this friction might lead to opening up space for radical solutions.

What better climate action strategy than solar cells: the star child in the renewables narrative for its role in helping the global transition away from fossil fuels. It is generally looked at as a sensible solution to the climate crisis; it doesn't get cleaner than solar. Yet, it is still tied to the systemic baggage that it is trying to mitigate [18]; mining and toxic refinement processes which only make economic sense at scale with a high throughput. The long term benefits of silicon solar panels, or in fact any such technology is arguable and in fact look unsustainable if we look at what it takes to mine and chemical processing of the quartz sand, gallium, indium, tellurium and cadmium used in the production of different kinds of solar cells. These processes more often than not are carried out in the global south countries leading to habitat destruction, with direct costs being borne by the indigenous population and on a long enough timeline, the global population.

Here we must also consider that the terms 'costs' includes measures beyond the narrow economic rationale too, such as environmental degradation, toxicity, embedded energies and human well-being throughout the supply chain. If we effectively assume the total costs of such renewable energy systems i.e. the 'real' costs of energy we soon realise that these too have challenges to overcome. Even lifetime costs from land use for solar farms, lithium battery packs for power storage [19] all pose a real threat. It may not be as bad as fracking for fossil fuels but if solar energy is the proverbial 'silver bullet', we can surely do better.

(12) Benyus, Janine. Biomimicry in Action. Accessed January 28, 2018. https://www.ted.com/talks/janine_benyus_biomimicry_in_action.

(13) Haneef, Muhammad, Luca Ceseracciu, Claudio Canale, Ilker S. Bayer, José A. Heredia-Guerrero, and Athanassia Athanassiou. "Advanced Materials From Fungal Mycelium: Fabrication and Tuning of Physical Properties." Scientific Reports 7 (January 24, 2017): 41292.

(14) https://www.ecovativedesign.com

(15) "MycoWorks: Redefining Leather." http://www.mycoworks.com/.

(16) Bierend, Doug. "How Mushrooms Could Hold the Key to Our Long-Term Survival as a Species," March 30, 2015. https://motherboard.vice.com/en_us/article/wnjyxb/how-mushrooms-could-hold-the-key-to-our-long-term-survival.

(17) https://www.engineering.com/IOT/ArticleID/11863/Better-Batteries-Might-Be-Made-of-Mushrooms.aspx

(18) Mulvaney, Dustin. "Solar Energy Isn't Always as Green as You Think." IEEE Spectrum: Technology, Engineering, and Science News, November 13, 2014. https://spectrum.ieee.org/green-tech/solar/solar-energy-isnt-always-as-green-as-you-think.

(19) "This Is Where Your Smartphone Battery Begins." Washington Post. Accessed Februray 9, 2018. https://www.washingtonpost.com/graphics/business/batteries/congo-cobalt-mining-for-lithium-ion-battery/.

Figure 7: Something amiss about Solar: The dark side of the push for solar is not a redeeming factor. Photo credits: Tesla Energy

1.3. Contemporary approaches to Industrial Design

Speculative Futures and Industrial Design

In the usual humdrum of trying to quantify the future by predicting, forecasting, trend analysis and extrapolating existing norms and practises are actually contributing to a form of policy paralysis [(20)] , much to our dismay. In the wake of the recent exponential spikes in extreme climate events [(21)], these kinds of predictions have been proven wrong, again and again. By posing "what if" questions, there is chance for opening up alternative future visions. As far as things go with design practise in the act of imagining possible futures, speculative design or critical design, as coined by Anthony Dunne and Fiona Raby [(22)], is perhaps the most influential in understanding as to how we can imagine these possible futures. Speculative design can function as a tool for engaging with futures that may or may not be desirable. As an open discourse, the speculations are not limited to design alone and as shown in this diploma, there is a potential for spaces to open up for collaborative imaginings where disciplines can interplay, drawing from their own fields and yet inspiring other disciplines through a collective imagining. As it stands, speculative design seems to draw from art, design, architecture, cinema, and photography. Pulling threads from other fields such as futurology, political theory, social anthropology, the philosophy of technology, synthetic biology, computational science and literary fiction. The intersectionality of such ideas in a free space enabled by speculative design provides a rich mosaic and could ultimately create a path to a more desirable future and a break from the self-fulfilling dystopian death spirals we have today.

On the flipside however, contemporary approach to speculative design is riddled with a stinging question: Is awareness and discourse the only redeeming quality for such an imaginative direction? Most speculative design we see today, hovers around between art and fiction and perhaps for good reason. As a potent agent for awareness, it does what it is supposed to do. Although with the urgency of climate action, I see speculative design that might have more potential for envisioning radical shifts in existing paradigms ***today*** that might give rise to a new and invigorating path towards long term sustainability and futures.

(20) Schwartz, John. "Paris Climate Deal Is Too Weak to Meet Goals, Report Finds." The New York Times, January 20, 2018, sec. Science. https://www.nytimes.com/2016/11/17/science/paris-accord-global-warming-iea.html.

(21) Resnick, Brian. "We're Witnessing the Fastest Decline in Arctic Sea Ice in at Least 1,500 Years." Vox, December 12, 2017. https://www.vox.com/energy-and-environment/2017/12/12/16767152/arctic-sea-ice-extent-chart.

(22) Dunne, Anthony, and Fiona Raby. Speculative Everything: Design, Fiction, and Social Dreaming. MIT press, 2013.

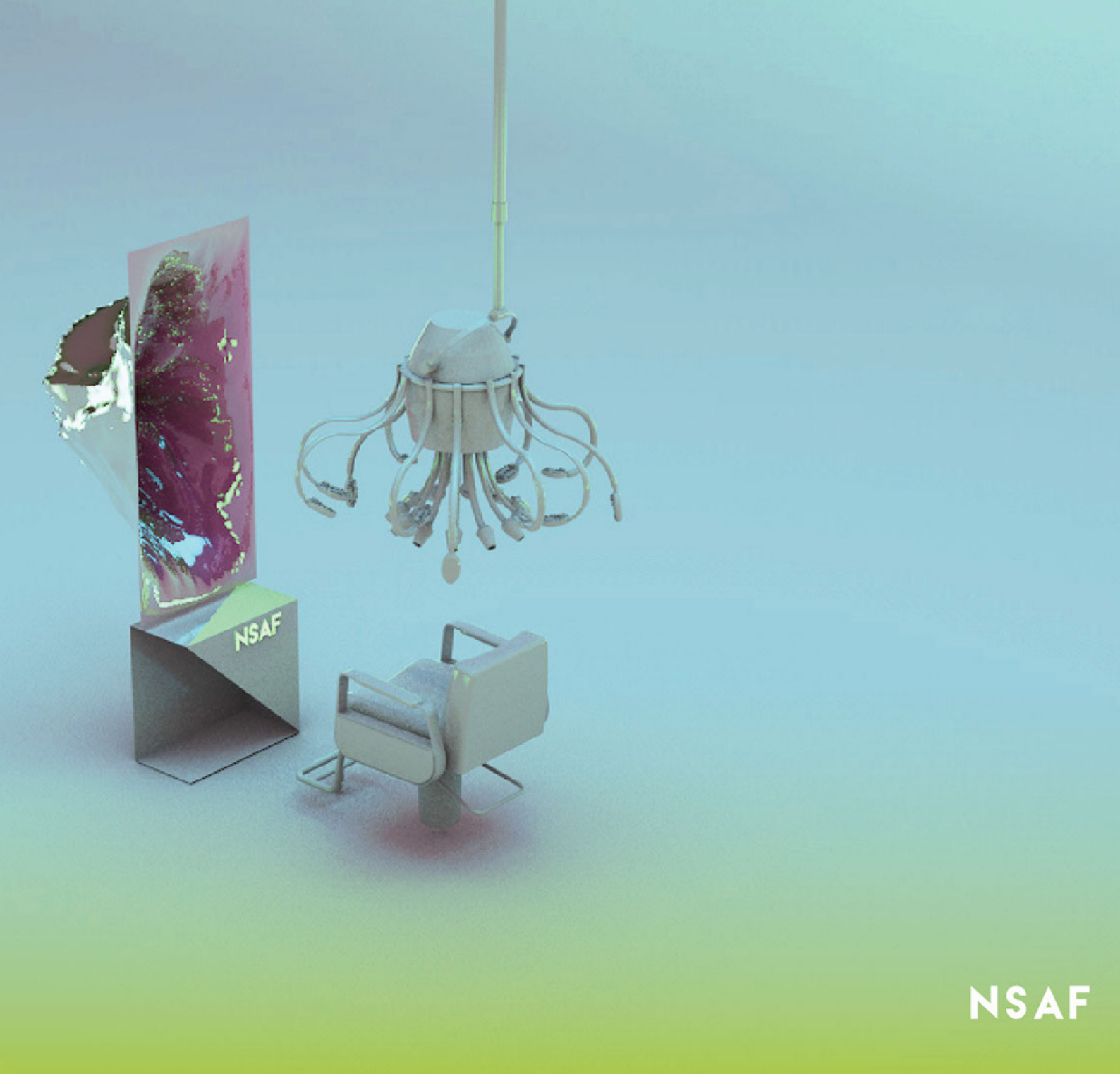


Figure 8: Neuro-Speculative Afro Feminism[23]

(23) Robertson, Adi. "Building the Afro-Feminist Future at Sundance, One Cyberpunk Beauty Salon at a Time." The Verge, January 26, 2017. https://www.theverge.com/2017/1/26/14377214/neurospeculative-afrofeminism-vr-science-fiction-sundance-interview-2017.

Apologetics, Reverse Archeology, concept visions, Tangibility of futures.

Speculative Fiction as a form of storytelling, follows the general principles of dramatics. This means it also follows conventions of good storytelling and possible interpretations of the fiction in order for an audience to engage with a story. In the scope of imagining the future, the role of industrial designers then becomes that of archeologists of the future through the narratives they create about the future. As such the aim of ***Reverse Archaeology*** [(24)] is to make an artefact from the future and much like archaeologists who deduce a picture of the vanished past using fragments of objects left behind, speculative industrial design allows for designers to use a future scenario to construct a fragment from a world yet to be. In that respect the designed artefact allows for a form of inter-dimensional time travel that puts audiences and the designers themselves into a context that is far removed from the way things are and into the world of the future; a complex unknown. Good storytelling in the context of such a future allows for the suspension of disbelief whereby the audience can follow the diegetic logic [(25)] of that future.

'Apologetics' [(26)] is a way of rationally apologising for logical inconsistencies that might crop in an explorative project such as this. Such defences of the logical inconsistencies within that future may be used as another creative tool to further strengthen the logic of how those seemingly anomalous inconsistencies could be justified or 'apologised' for. In the book ***Make it So***, the authors found themselves using the method in the cases where they looked at an interface that couldn't work the way it was shown and "apologised" for it by thinking of ways that the interface could work the way it was depicted. Thus, in telling a compelling narrative of a radically different future, an experiential encounter might not need to provide a heavy burden of proof to begin with and sometimes conflict may lead to a speculation of its own.

In such a practice where strategic foresight meets design, these future scenarios are pulled into and manifested in the here and the now. The aim here is to help the project develop a capacity for strategic foresight that might create threads in possible ways of reimagining different layers of the future.

Figure 9: Still from 2001: A Space Odyssey

(24) Candy, Stuart. 2013. "Time Machine / Reverse Archaeology." In , 28–30.

(25) Raven, Paul Graham, and Shirin Elahi. 2015. "The New Narrative: Applying Narratology to the Shaping of Futures Outputs." Futures 74 (November): 49–61. https://doi.org/10.1016/j.futures.2015.09.003.

(26) Shedroff, Nathan, and Christopher Noessel. 2012. Make It so: Interaction Design Lessons from Science Fiction. Brooklyn, N.Y., USA: Rosenfeld Media.

Example 1: Apologetics in 2001: A Space Odyssey.
The authors in Make it So, go on to show how Apologetics in Science Fiction could justify apparent failings in logical consistencies in the scene: *"From an Earthorbiting space station, Dr. Floyd has a videophone conversation with his daughter back on Earth. During the scene, we see the young girl's hands mash on the keypad of the phone, but the call isn't interrupted. Although this may have been an oversight on the director's part, it is nonetheless the way the system should work. If the system knows that a child is using it and the button mashing is likely unintentional, it should disregard these inputs and not interrupt the call. Although this presumes sophisticated technology and an interface idea even the film's producers probably didn't think about, we can still use this principle even as we work with our real-world technology today."*

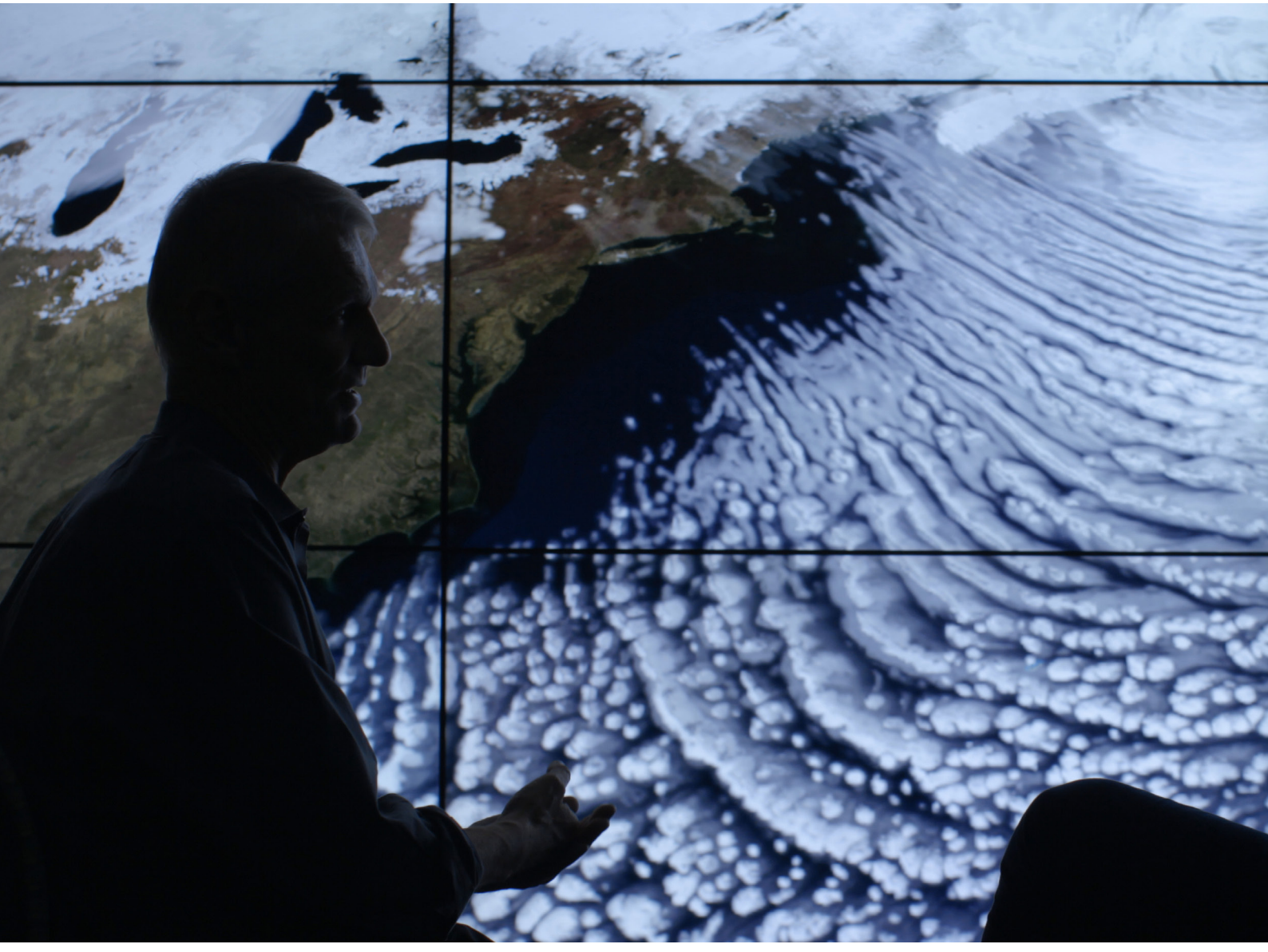


Figure 10: Still from: Before the Flood, National Geographic

Why am I suggesting a New Approach:

The future is inevitable, yet it is not predetermined. This project calls for taking responsibility for our actions from here on out, leading up to a new kind of future. In order to design for that vision, we must start with trying to imagine a world that doesn't yet exist. This diploma thus proposes a probable method to engage with these futures in a more open, explorative manner, one that uses designerly skills and tools towards creating rich visions of long term futures. Designers have been trained in the very skills that make it possible to craft these visions. A new approach to the design methods I explore here is an attempt at cross pollinating across the silos of professional boundaries and terminologies, thereby make the case for a transformative approach to Industrial Design. All for long term futures and equally long term sustainability. This approach, as has been explored in the diploma has given rise to a vibrant spectrum of futures instead of one singular future, making for a resilient ensemble of ideas and understanding that might help overcome the paralysis of imagination when it comes to getting through to the other side of the Anthropocene.

In order to adapt to the complexity of the challenge at hand, I decided to engage with a systems thinking approach more as a means to explore a rich solution space through these future scenarios and in order to trigger a discourse that might help ask the question "what if" to open it up to even further imagination and discourse, which hopefully builds alternative designed interventions that possibly might facilitate climate action.

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SETTING THE CONTEXT

IMAGINING ALTERNATIVE FUTURES

SPECULATIVE INDUSTRIAL DESIGN

CONCLUSIONS AND REFLECTIONS

2. Imagining Alternative Futures

Methods and Tools for Radical Futures through Industrial Design

In exploring possible methods that might help create a better picture of what it means to envision a more hopeful future, the challenge was to come up with a plan of action that would help navigate the project through systemic complexity of the dystopian inertias and one that would point to, in the case of this diploma, an industrial design solution. The method I suggest here, could just as well be relevant for other design solutions too. In that it can potentially function as a creative and an evaluative tool upon further iterations. In this case virtual reality becomes a strategic tool for gaining future foresight for the industrial design solution that would potentially point towards steps we could take today towards long term sustainability in an unsustainable world. This method was explorative and so in that spirit they serve as guides to get to a point where the picture of the future becomes gradually clearer through the different design tools that I use in this project.

Product Solution

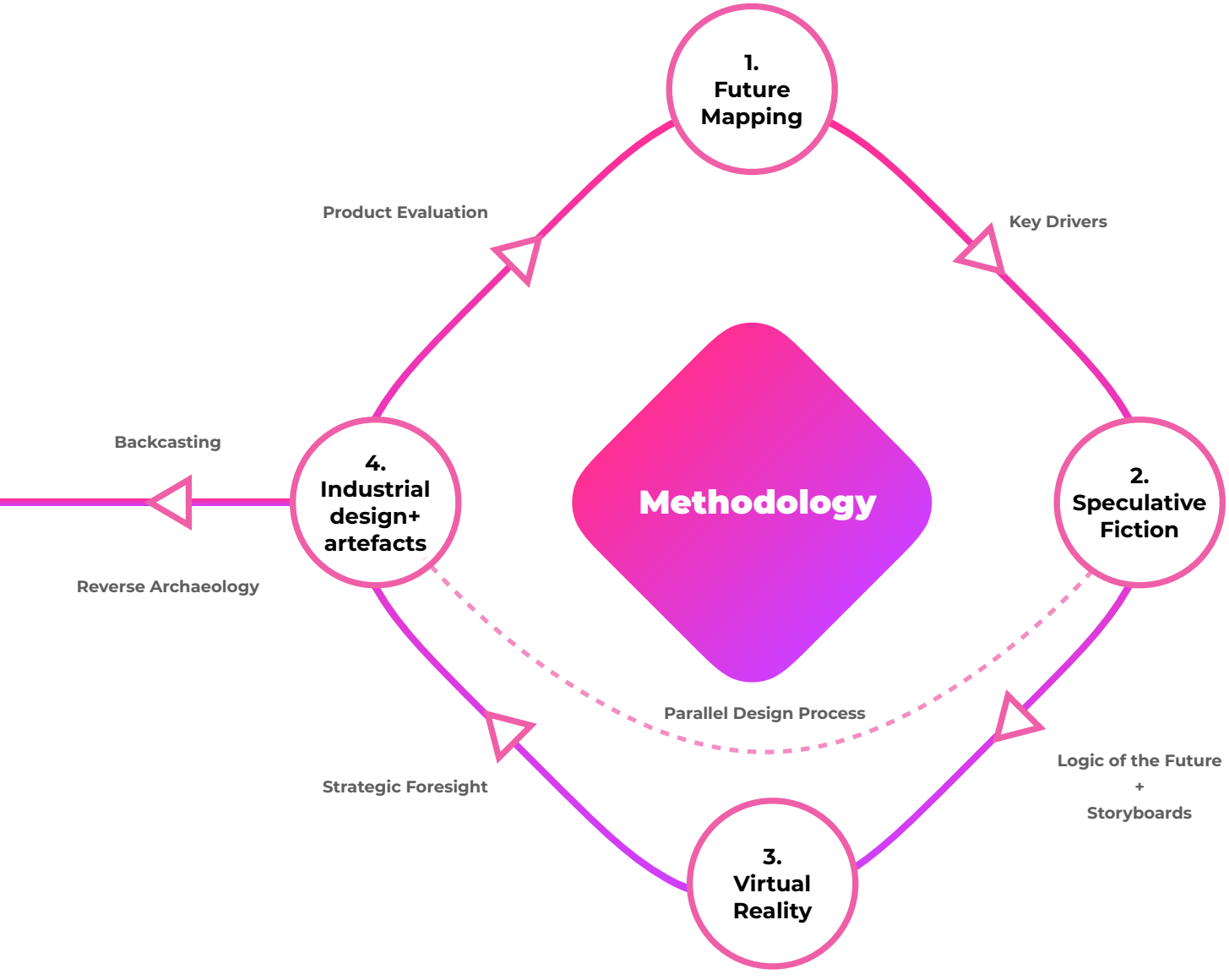


Figure 11: Illustraition of an Explorative Method for Diploma

2.1. Mapping the Unknown Future

Expert Interviews:

In exploring the tendencies of the future to grapple with, I decided to cast a wide net and interview some experts in fields that might offer insights in understanding the predicament and complexities of the zeitgeist. In this journey I met with two experts in the field of human geography and social anthropology.

Karen O'Brien is a professor in the Department of Sociology and Human Geography at the University of Oslo. She has participated in four IPCC reports and shared the Nobel Peace prize that was awarded to the IPCC in 2007. She is on the Science Committee for Future Earth, a 10-year global change research initiative. She is also the co-founder of cCHANGE.no, a website that provides perspectives on transformation in a changing climate. In the short exchange I learned that the challenges for transformation of modern society lies in engaging with better visions of understanding of global change from the point of view of synergies and ecosystems.

Hanne Cecilie Geibo is a researcher at Research Group for Design of Information Systems at the University of Oslo. Her research has been engaged in the anthropology of technology and infrastructure with a key area of interest in solar electricity systems for rural and urban environments. She has worked and written about the development of a solar electricity mini-grid in a village in Bangladesh as part of her PhD thesis.

See Appendix 2 for Audio links to the Interviews

So about future scenarios, the idea that "oh its so utopian or something like ", all we do is we create a **dystopia by creating path dependency** *by saying we can't do it. Changes were never made based on evidence. There was* **always an idea** *and then it came into play. I am looking very much at the* **collaborative power.** *So your design goes out and creates fractals among other things.*

Karen O'Brien

Professor of Human Geography and Adaptations Researcher - Department of Sociology and Human Geography

Bangladesh is all about **fluctuating landscapes,** *flooding and so on and we didn't really take that landscape into account. We were building a Pukka* electricity grid for a kuchha landscape. Not just in places like Bangladesh, but all over we need to challenge this assumption because the* **environment is more kutcha****. We need to build more kutcha things.* **Infrastructure needs to be flexible** *but flexibility can be durable as well.*

Hanne Cecilie Geirbo

Researcher - Research Group for Design of Information Systems

** Pukka: stable, strong, certain in Hindi*
kutcha: raw, temporary, makeshift in Hindi

Drivers of the Future

In trying to create a picture of the future, I tried to analyse and identify the possible agents of change, their interplay and relevance in creating the texture of the future, whatever it may be. As an exercise, it gave me insights into the bigger role, the various themes of engagement the future could provide for. For the sake of clarity, I categorised these future themes into the following 7 broad categories:

1. technology,

2. ecology,

3. economy,

4. Society

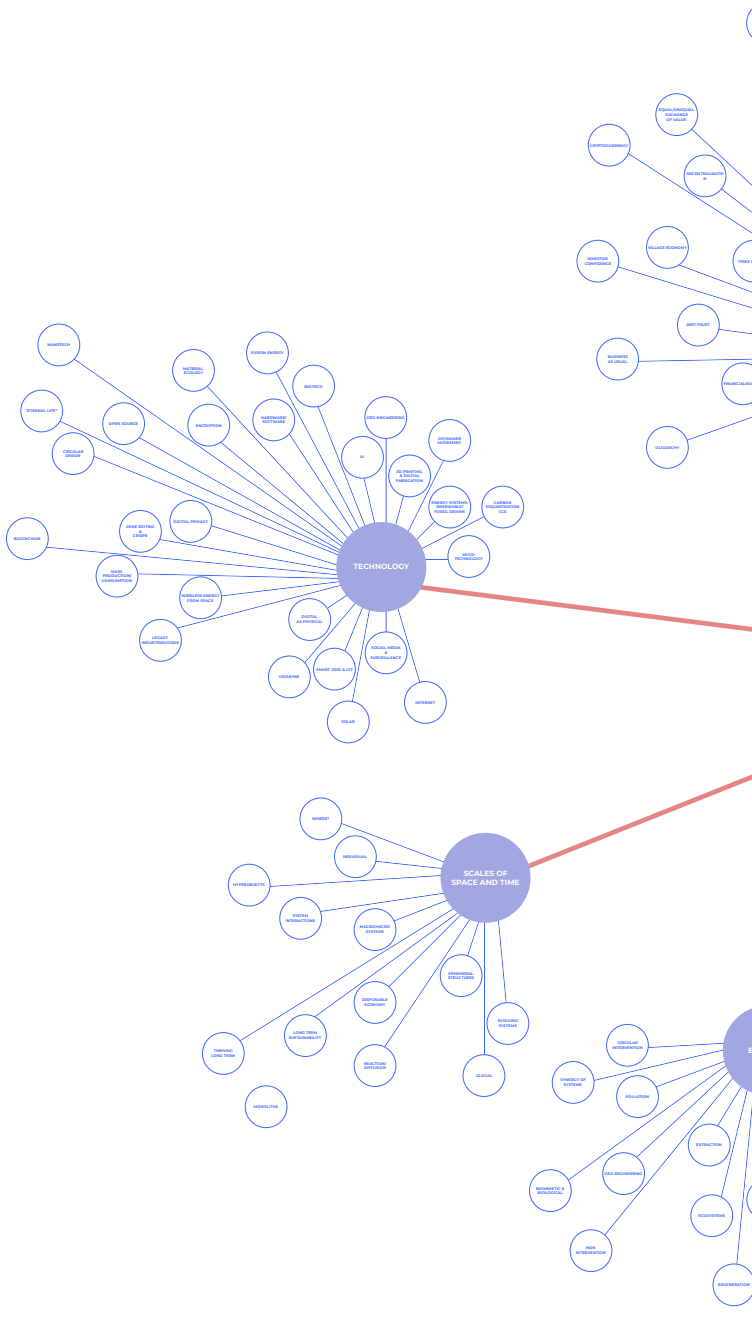
5. Impacts and influences on a human level (Individual)

6. Climate Change

7. How it all plays out in the Scale of Space and Time

These themes, influenced by the values of the designer, bring forth a picture of the future and subsequently point to the nature of agency within the interaction of these drivers. This analysis, already shows divergence in the nature of future studies that were to be embarked from here on out. I found, this early on in the project, a healthy point cloud of themes had emerged from the analysis. When dealing with the uncertain future, it made sense to let loose the ideas, that may seem absurd from a business as usual perspective. In that regard, having made this analysis showed how these drivers reflect the values of the design team, therefore a larger team might build this into a far richer list of drivers.

See Appendix 3 for full scale chart



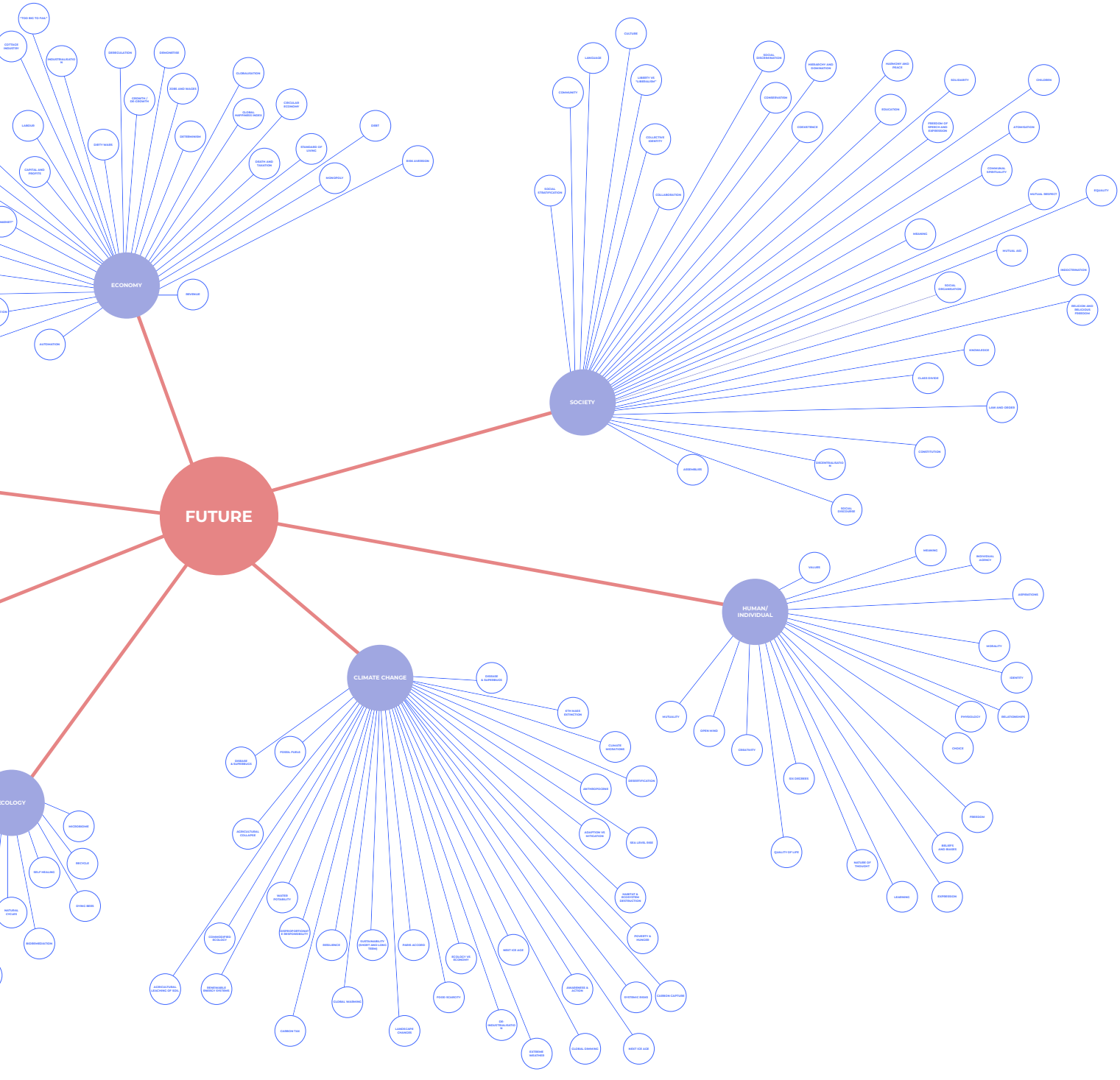
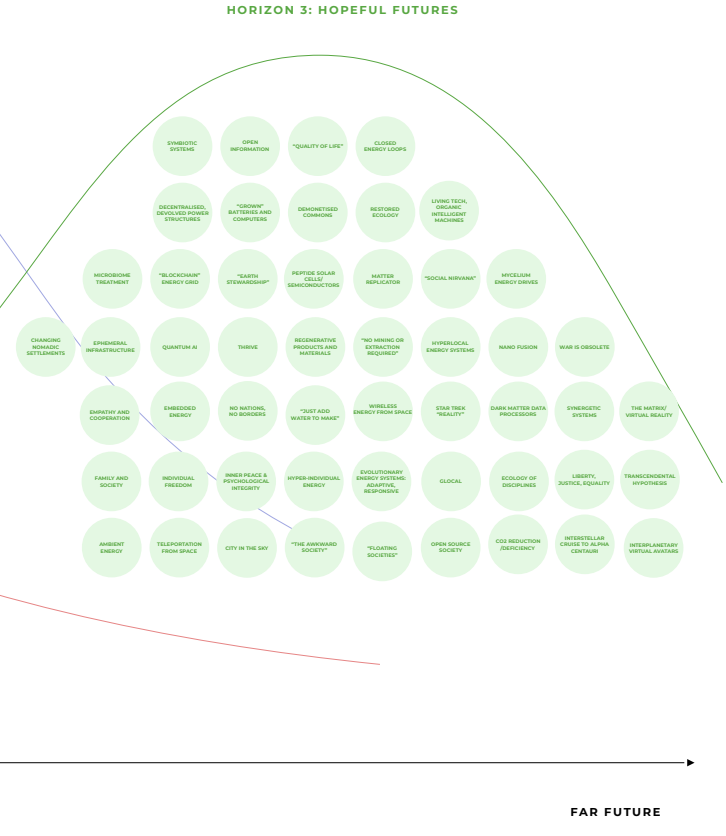


Figure 12: Analysing Drivers of the Future

Figure 13: Mapping the Symptoms of a hopeful future



The Future in Three Horizons

Three Horizons Method is a systems tool for grappling with the future where the present and the future are part of shifting horizons [27]. The tool helps identify dominant patterns or symptoms of the present and set course for a vision of the futures that might emerge over the next horizon. The whole task of creating better alternative visions of the future requires a foray into a giant, intricate web of complexities. In order to tackle such complexities, I had to engage with a systems thinking framework to grapple with the machinations of the anthropocene and its entrapment of the popular imagination.

I planned to weave different future scenarios around the position of "what if". The future I intended to gain insight from/about was one that was to be radical, not how things are but how they "could be" and thus paint a picture of a future where the design intervention facilitates climate action. The Three horizons framework [28] used in this project offers a way of making sense of this very complex interplay of civilisation, climate change and the future it has held to ransom, in a way that is comprehensible which perhaps might lead to potential strategies to get there. Here the values of the future that were identified earlier with the future drivers were now mapped onto an exploration of the inner values of my role as a designer with the patterns or "symptoms" of the future the project was aiming to change. The method helps explore the prevalence and contribution of the "future drivers" that were mapped to represent the symptoms of possibilities that the future(s) might contain. It is important to note that a lot of the technological and socio-economic drivers that were symptomatic of these futures were also existing research areas being pursued today.

What would make for a better future? These were the values that I brought to the project as a designer and also things that came up from my analysis and as such the future you see in this report is an expression of those values.

See Appendix 4 for full scale chart

(27) Curry, Andrew, and Anthony Hodgson. 2008. "Seeing in Multiple Horizons: Connecting Futures to Strategy." Journal of Futures Studies 13 (1): 1–20.

(28) "Three Horizon Mapping Guide - H3Uni Resource Library." n.d. Accessed January 15, 2018. http://www.h3uni.org/resource_library/index.php?title=Three_Horizon_Mapping_Guide.

Figure 14: Building Speculative Future scenarios through gameplay, **See Appendix 6 for video**

Basic Gameplay:

See Appendix 5 for all cards and their descriptions

Insights:

- The game eventually showed up more possibilities for Creative collaboration as opposed to competition itself.
- Provoking creative narratives
- Common team goals lead to better stories
- Hard to combine some values if they are not co-created
- Quick and easy tool for scenario building for 1 - 7 players
- Biases crop up

2.2 Futures Poker: From Mapping to Speculation

When it came to the practise of rigorous imaginings of the future, I turned to speculative storytelling and gameplay as a means to break perceived notions of the future. With the Three Horizons as the backdrop, I tailor-made a futures poker game, that would help me force combinations of the symptoms of the future, that would undercut, amplify or interplay with each other.

The card game was inspired by ***Futures Poker***, a game [(29)] created by Strange Telemetry, a London based studio. It was tailor made to suit the symptoms of this very particular project and directed towards creating distinct and rich speculative fictions that could point to radically different futures.

While the game may not be perfect for the purposes of entertainment, it can be perceived to be a creative tool for future scenario building. Each of the future drivers point to a symptom of a future. In the act of playful storytelling, forced combinations and gameplay engages the players to come up with possible future narratives in a playful and open manner. Although I designed these cards to help me quickly build future scenarios, I was struck by the relative ease with which I could readily see a creative engagement in the rich and diverse futures that kept cropping up while testing the game on my own. To see if this specific game would work for a larger team I did a short test run with the ProtoHype studio course at AHO which showed some promise. This creative engagement in future scenario building lead me to an understanding of the possible role of co-creation that this game might have for other designers who might want to engage in this theme.

The game consists of three sets of cards:

1. Year of the future: 4 cards.

2. Location of the Future: 15 cities.

3. 43 Future Drivers (Social, tech, ecological, economic, political, climate change from the horizon mapped future drivers)

Each player has four minutes to come up with a story that combines the future drivers within the year and place chosen by the dealer. These themes of the future may undercut, amplify or interact with each depending on how the player interprets these themes. The player can use any medium to note down the story through sketch, writing or even improvised storytelling. The most creative and exciting story as decided by the group story 'wins' the round.

(29) "Projects." n.d. Strange Telemetry. Accessed January 19, 2018. http://www.strangetelemetry.com/projects/.

2.3 Speculative Design Fiction

Although speculative design is a relatively new field, fiction writing, specifically science fiction is an established art form. Speculative Design draws relies heavily on good speculative fiction, although in the choice between creating awareness and pointing to an actionable solution, speculative design, in my opinion has long delved on the former. In the sense of urgency concocted by climate change, creating the means to a possible action today was a driving force in this project for me. Thus, in order to further flesh out the speculative scenarios of the future, I used a design criteria map to choose between futures that sort of pointed to an intriguing industrial design solution. So when I tried the card game myself, I had twelve distinct future scenarios in three, one hour sessions, all of which pointed to a product solution in varying levels of detail. The speed at which these scenarios get built do allow for a high number of possible speculations, however, for the sake of this diploma I decided to settle on twelve scenarios in so far as they inspired alternative futures through an industrial design solution.

Upon further narrowing down these scenarios, I found three distinct futures that allowed for a unique speculation of solar futures. These scenarios were then followed up by written pieces of fiction accompanied by a sketch, as a screenshot of that future. The sketches, as seen here, were inspired by the work of French comic book artist Moebius (Jean Giraud), who's style was greatly influenced by the tumultuous time of social upheaval of the sixties and seventies. One could argue that now, as it was then, the nature of the crises we are in as a society calls for such an inspired imagining. In particular the sketches you see in this chapter are in fact a reimagining of how his signature characters might look like in these future fictions. The intention of such a cross fertilisation is to see how an expression of upheaval and spirituality can find its way into a albeit different vision of the future.

See Appendix 7 for twelve future scenarios

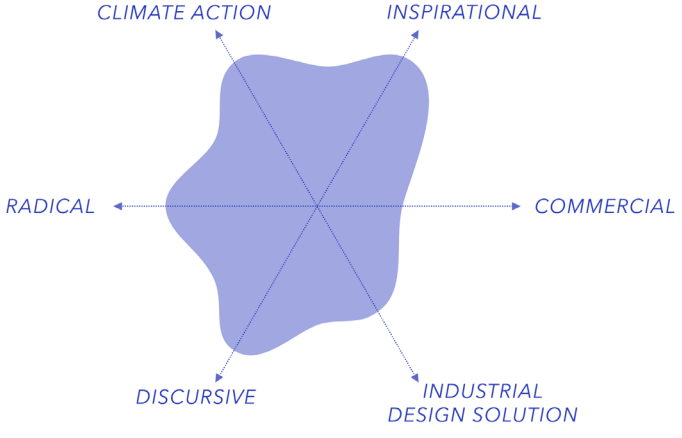
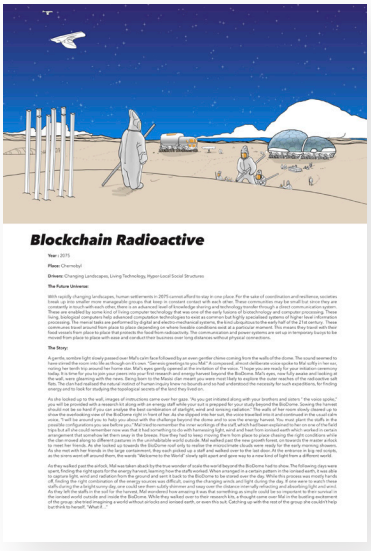
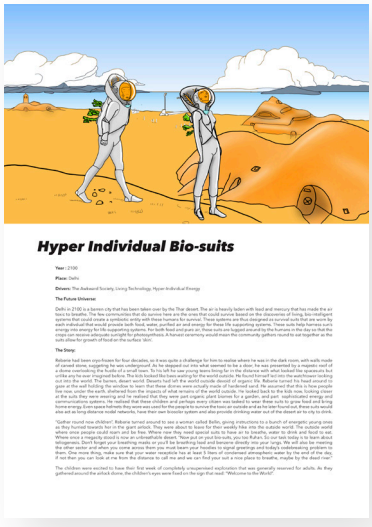
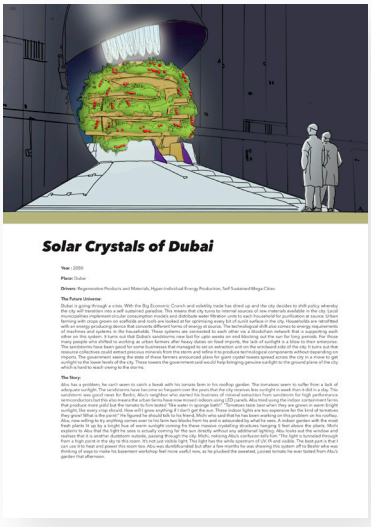


Figure 15: Design Criteria for decision making







See Appendix 8 for three final future fictions

Figure 16: Speculative Fictions and snapshots of the future, with artwork inspired by Moebius

Final Design Fictions

1.Blockchain Radioactive

A post nuclear dead zone in Chernobyl in the year 2075, where a solar staff is used to perform an energy ritual. The staff uses combined Solar, radioactive black fungus [(30)], and a graphene wind 'hinge' to harvest energy.

2. Hyper Individual bio Suits:

A desertified Delhi in 2100 where the population lives in underground caverns and harvest energy individually like a beehive, with a biological suit that both grows food on their backs but also produces energy from biological, peptide solar cells [(31)] that are grown.

3. Solar Crystals of Dubai

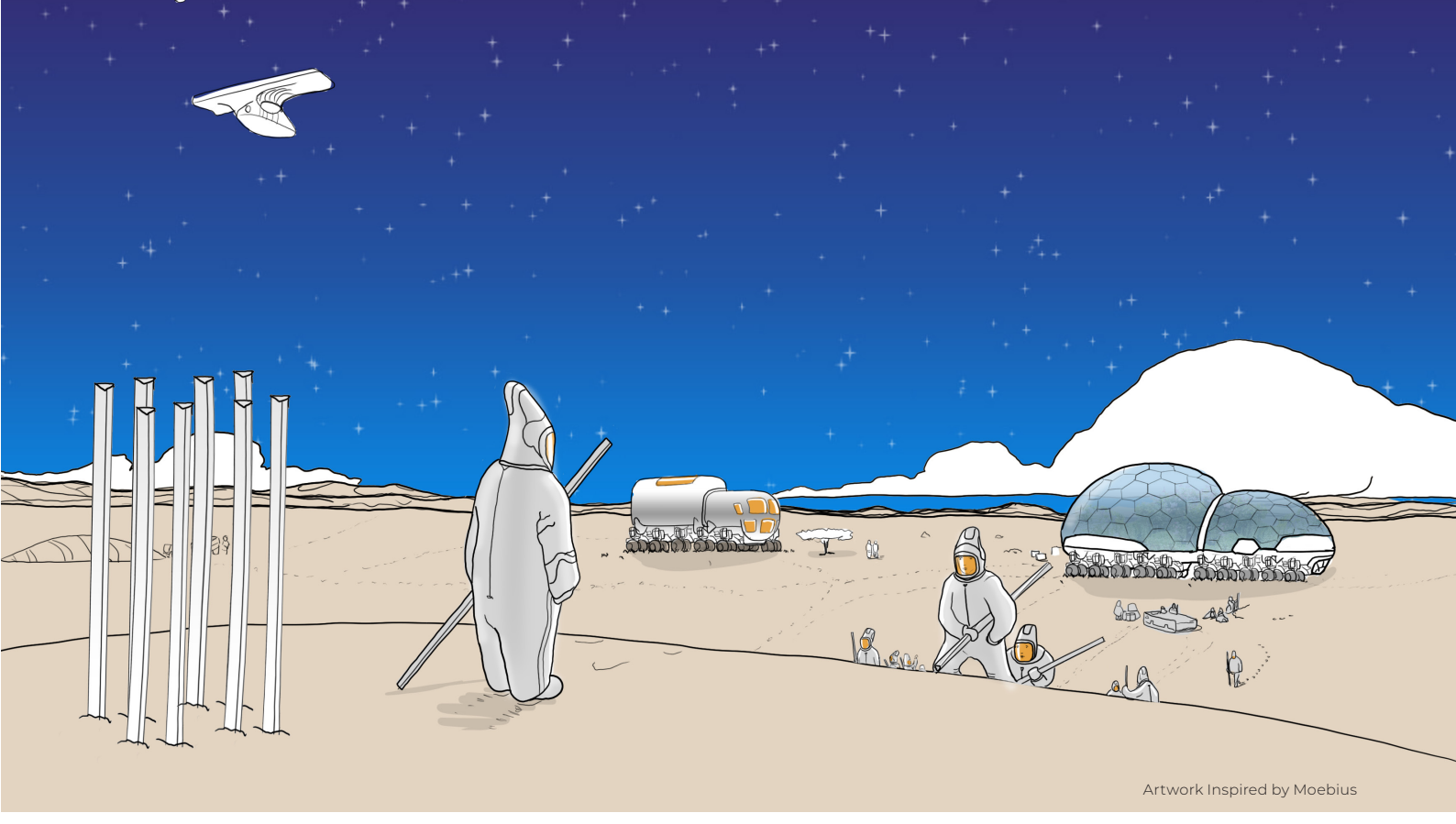
A modern megacity of Dubai which faces sandstorms that block sunlight for weeks on end where food has to be grown using hydroponics and artifical lights. Hot solar cells [(32)] and light transmitting crystals allow for a new ways of transmitting light down to the dark indoor farms that can now grow fresh food.

I chose the speculative story titled "Blockchain Radioactive" as the key future for my project that fit the design criteria the most for me. The design fiction and the sketch of the story helps shed light on the inner workings of that scenario. Much like "Blockchain Radioactive", each future is tied to a possible solution that is indicated in the image itself and furthermore, each story points to a solution that is based on the existing technology and research being carried out today. The point of this was to show that speculations can also be part of the contemporary zeitgeist but interpreted in more ways than one. As the intention of this project isn't to point to a magic box solution, it was important to ground these fictions in sound technological research and rather speculate on the context.

(30) Duncan, David Ewing. n.d. "Eating Radiation: A New Form of Energy?" MIT Technology Review. Accessed February 25, 2018. https://www.technologyreview.com/s/407974/eating-radiation-a-new-form-of-energy/.

(31) Caruso, Mario, Emanuela Gatto, Antonio Palleschi, Piero Morales, Manuela Scarselli, Simone Casaluci, Alessia Quatela, Aldo Di Carlo, and Mariano Venanzi. 2017. "A Bioinspired Dye Sensitized Solar Cell Based on a Rhodamine-Functionalized Peptide Immobilized on Nanocrystalline TiO2." Journal of Photochemistry and Photobiology A: Chemistry 347 (Supplement C): 227–34. https://doi.org/10.1016/j.jphotochem.2017.07.027.

(32) Temple, James. n.d. "This Device Could Be a Big Boost for Making Solar Power Much Cheaper." MIT Technology Review. Accessed January 30, 2018. https://www.technologyreview.com/s/603497/10-breakthrough-technologies-2017-hot-solar-cells/.



Artwork Inspired by Moebius

BLOCKCHAIN RADIOACTIVE

Year : 2075

Place: Chernobyl

Drivers: Changing Landscapes, Living Technology, Hyper-Local Social Structures

The Future Universe:

With rapidly changing landscapes, human settlements in 2075 cannot afford to stay in one place. For the sake of coordination and resilience, societies break up into smaller more manageable groups that keep in constant contact with each other. These communities may be small but since they are constantly in touch with each other, there is an advanced level of knowledge sharing and technology transfer through a direct communication system. These are enabled by some kind of living computer technology that was one of the early fusions of biotechnology and computer processing. These living, biological computers help advanced computation technologies to exist as common but highly specialised systems of higher level information processing. The menial tasks are performed by digital and electro-mechanical systems, the kind ubiquitous to the early half of the 21st century. These communes travel around from place to place depending on where liveable conditions exist at a particular moment. This means they travel with their food vessels from place to place that protects the food from radioactivity. The communication and power systems are set up in temporary buoys to be moved from place to place with ease and conduct their business over long distances without physical connections.

The Story:

A gentle, sombre light slowly passed over Mal's calm face followed by an even gentler chime coming from the walls of the dome. The sound seemed to have stirred the room into life as though on it's own. "Genesis greetings to you Mal." A composed, almost deliberate voice spoke to Mal softly in her ear, noting her tenth trip around her home star. Mal's eyes gently opened at the invitation of the voice. "I hope you are ready for your initiation ceremony today. It is time for you to join your peers into your first research and energy harvest beyond the BioDome." Mal's eyes, now fully awake and looking at the wall, were gleaming with the news. Being born to the Masisi clan meant you were most likely to explore the outer reaches of the radioactive salt flats. The clan had realised the natural instinct of human inquiry knew no bounds and so had understood the necessity for such expeditions, for finding energy and to look for studying the topological secrets of the land they lived on.

As she looked up to the wall, images of instructions came over her gaze. "As you get initiated along with your brothers and sisters " the voice spoke," you will be provided with a research kit along with an energy staff while your suit is prepped for your study beyond the BioDome. Sowing the harvest should not be so hard if you can analyse the best combination of starlight, wind and ionising radiation." The walls of her room slowly cleared up to show the overlooking view of the BioDome right in front of her. As she slipped into her suit, the voice travelled into it and continued in the usual calm voice, "I will be around you to help you about with the challenge beyond the dome and to sow the energy harvest. You must plant the staffs in the possible configurations you see before you." Mal tried to remember the inner workings of the staff, which had been explained to her on one of the field trips but all she could remember now was that it had something to do with harnessing light, wind and heat from ionised earth which worked in certain arrangement that somehow let them sway in the breeze. How they had to keep moving them from place to place chasing the right conditions while the clan moved along to different pastures in the uninhabitable world outside. Mal walked past the new growth forest, on towards the master airlock to meet her friends. As she looked up towards the BioDome roof only to realise the microclimate clouds were ready for the early morning showers. As she met with her friends in the large containment, they each picked up a staff and walked over to the last door. At the entrance in big red scripts, as the sirens went off around them, the words "Welcome to the World" slowly split apart and gave way to a new kind of light from a different world.

As they walked past the airlock, Mal was taken aback by the true wonder of scale the world beyond the BioDome had to show. The following days were spent, finding the right spots for the energy harvest, learning how the staffs worked. When arranged in a certain pattern in the ionised earth, it was able to capture light, wind and radiation from the ground and sent it back to the BioDome to be stored over the day. While this process was mostly hands off, finding the right combination of the energy sources was difficult, owing the changing winds and light during the day. If one were to watch these staffs during the a bright sunny day, one could see them subtly shimmer and sway over the distance internally refracting and absorbing light and wind. As they left the staffs in the soil for the harvest, Mal wondered how amazing it was that something as simple could be so important to their survival in the ionised world outside and inside the BioDome. While they walked over to their research kits, a thought came over Mal in the bustling excitement of the group: she tried imagining a world without airlocks and ionised earth, or even this suit. Catching up with the rest of the group she couldn't help but think to herself, "What if…"

2.4 VR for future Foresight

As a fork in the road, one could simply use any of the three design fictions to start with a traditional industrial design process for sketching out solutions and developing a product and we would find a very distinct outcome from that end. In order to comprehend the texture and granularity of the future in Blockchain Radioactive, the story had to live in a world beyond text and single image. The challenge in overcoming such a unidimensional aspect of future studies should not be limited by shoddy fiction writing on part of the designer. I decided to pursue the tools of virtual reality in order for the fiction to become a world richer unto itself, enabled by the vision of the speculation. In so far as VR was a tool for building on my existing skills of CAD and video sketching, creating the future scenario in it was the logical step in creating a more richer, non-insular point of view that I hoped might create a space for collaboration too.

In creating a virtual fiction as an immersive experience, the goal was to obtain meaningful insight about the future. The difference between a two dimensional film and VR is feedback, a sense of engagement and a break from present reality. The foresight for such a future will be gained when those virtual interactions transfer valuable cues as to what the diegetic logic of the universe might be. I was hoping for two things, break the existing reality of the “Now”, which VR is good at no matter how unrealistic the virtual experience is as I found in the process, and it also provides different points of view which a film doesn’t provide. Although I had never worked with VR before, the tools over the years have now become available and versatile enough for anyone not experienced in VR to take it up. So with a novice approach, I set about trying to design the future ficiton in VR.

Creating a Story in VR

How could I go about designing in VR when I have never worked in VR? I had a good reference point to start working on this trajectory, the speculative fiction allowed for mapping out elements from the story of exactly what was needed to be built for the VR world. I dissected the important bits of the fiction to categorise them as descriptors of product, environmental and secondary technology.

- Product Solution Descriptors: Pointing to product solution
- Secondary Technology Descriptors: Pointing to peripheral technology, like Artificia Intelligence etc.
- Environment Descriptors: Providing clues for designing the VR space

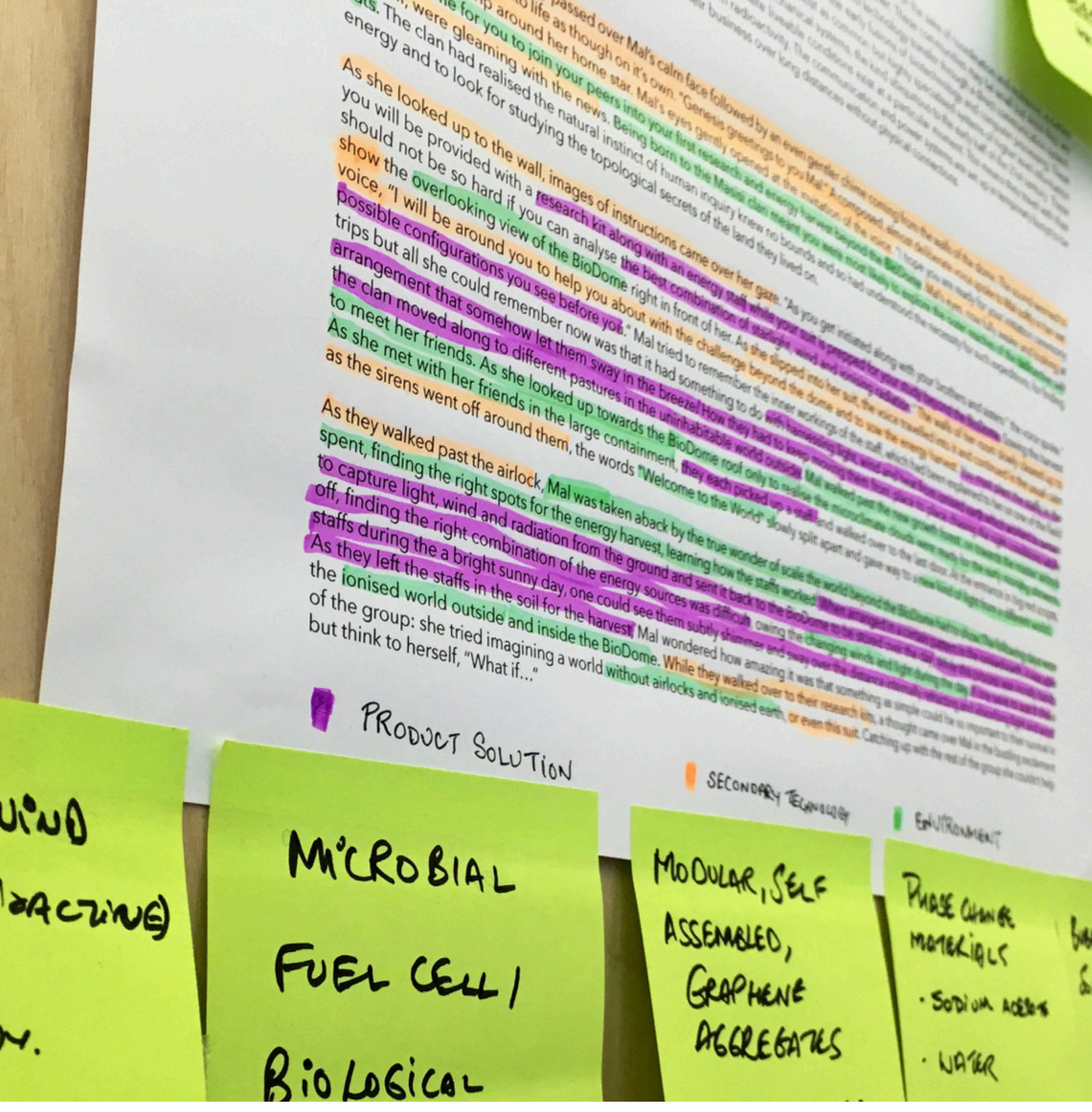
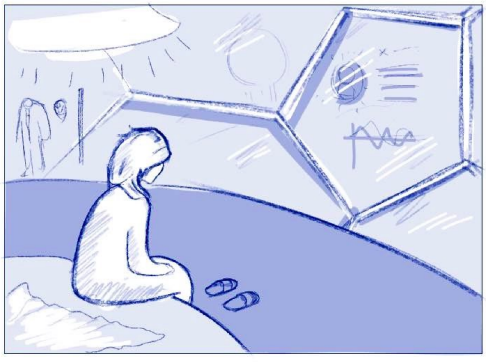


Figure 17: Creating a VR space from written Fiction

Storyboarding

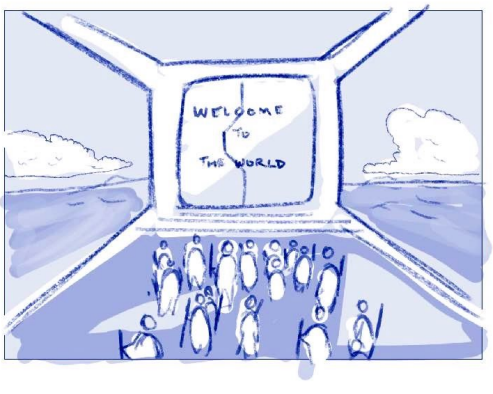
From here on, I sketched out a simple storyboard, directly sourced from the fiction which gave me a sense of the space and environment that needed to be designed.

The story follows a girl, Mal who is a member of the Masisi clan which is a technologically advanced nomadic settlement. The children of that community follow a ritual around energy harvesting.

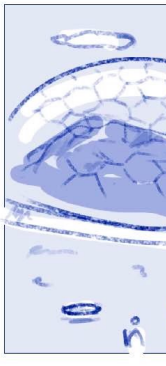


1. WAKING UP

2. VIEW

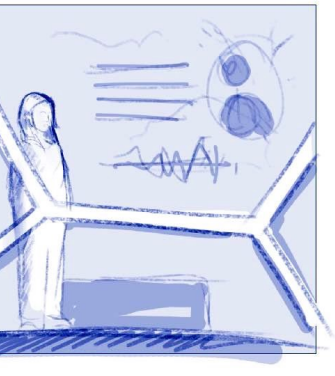


5. INSIDE THE AIRLOCK

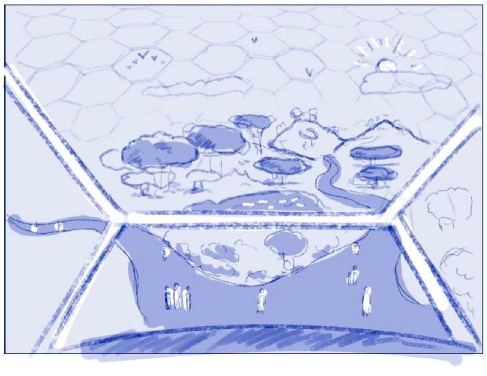


6. OUT

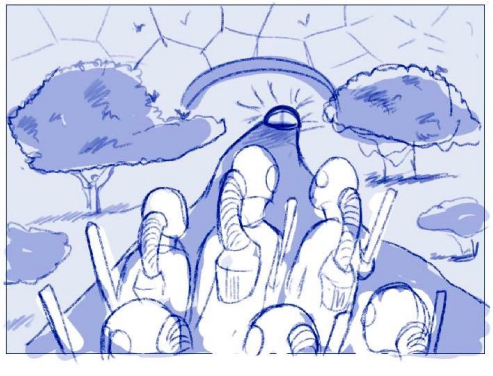
STORYBOARD: BLOCKCHAIN RADIOACTIVE



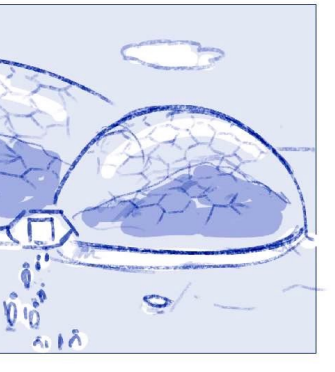
V FROM THE ROOM



3. OVERLOOKING THE BIODOME

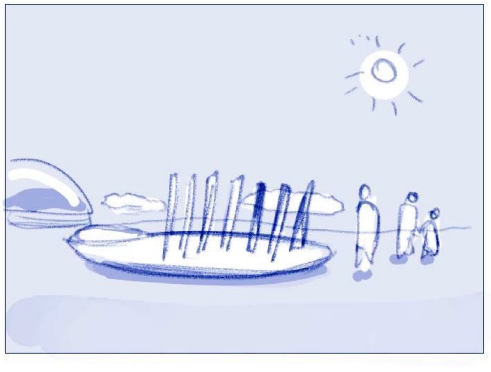


4. WALKING TO THE AIRLOCK



TSIDE THE BIODOME

7. SETTING UP THE ENERGY STAFFS, ENERGY DRONE



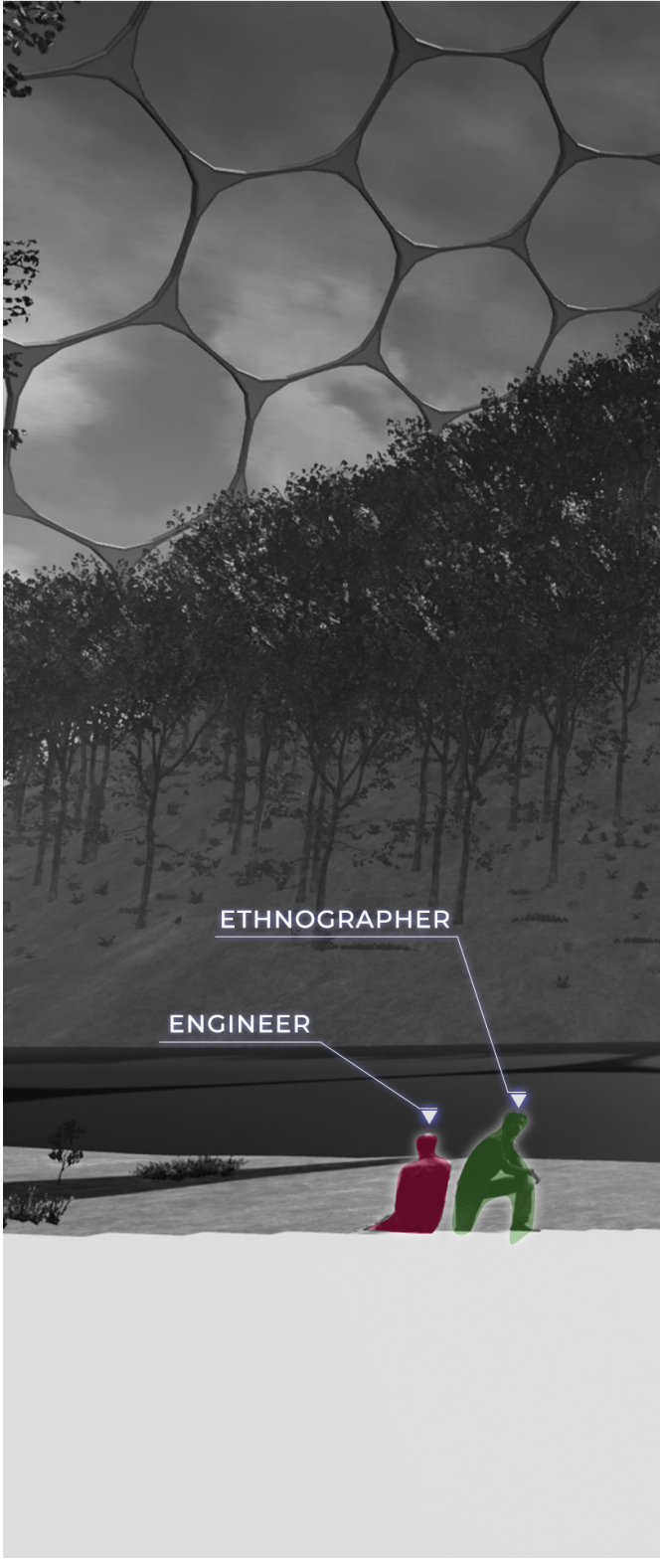
8. HARVESTING RADIOACTIVE MUSHROOMS AND ENERGY STAFF

Figure 18: The Storyboard: a blueprint for designing the VR space

Collaborative Futures in VR:

In so far as it allows for a common experiential space to open up, VR tools could ideally create a space for collective imagining and collaboration where the future can be engaged with. As a potential thread beyond this project it could also be adopted in a non educational setting. It just might be that designers could use this VR space with other collaborators like biologists, ethnographers, citizens, anthropologists, researchers, etc while being committed to a common discourse of building better futures. With its instant break from reality and an instantaneous sense of scale it could possibly lead to engagement with a diverse understanding of the future context, although this thread could be pursued futher, perhaps as another project altogether.

I also see possibilities in combining morphogenetic design methods along with computational simulations that could be directly integrated into this space and could potentially lead to designed solutions in the real world now through additive manufacturing but through a creative exchange of ideas in these virtual futures.



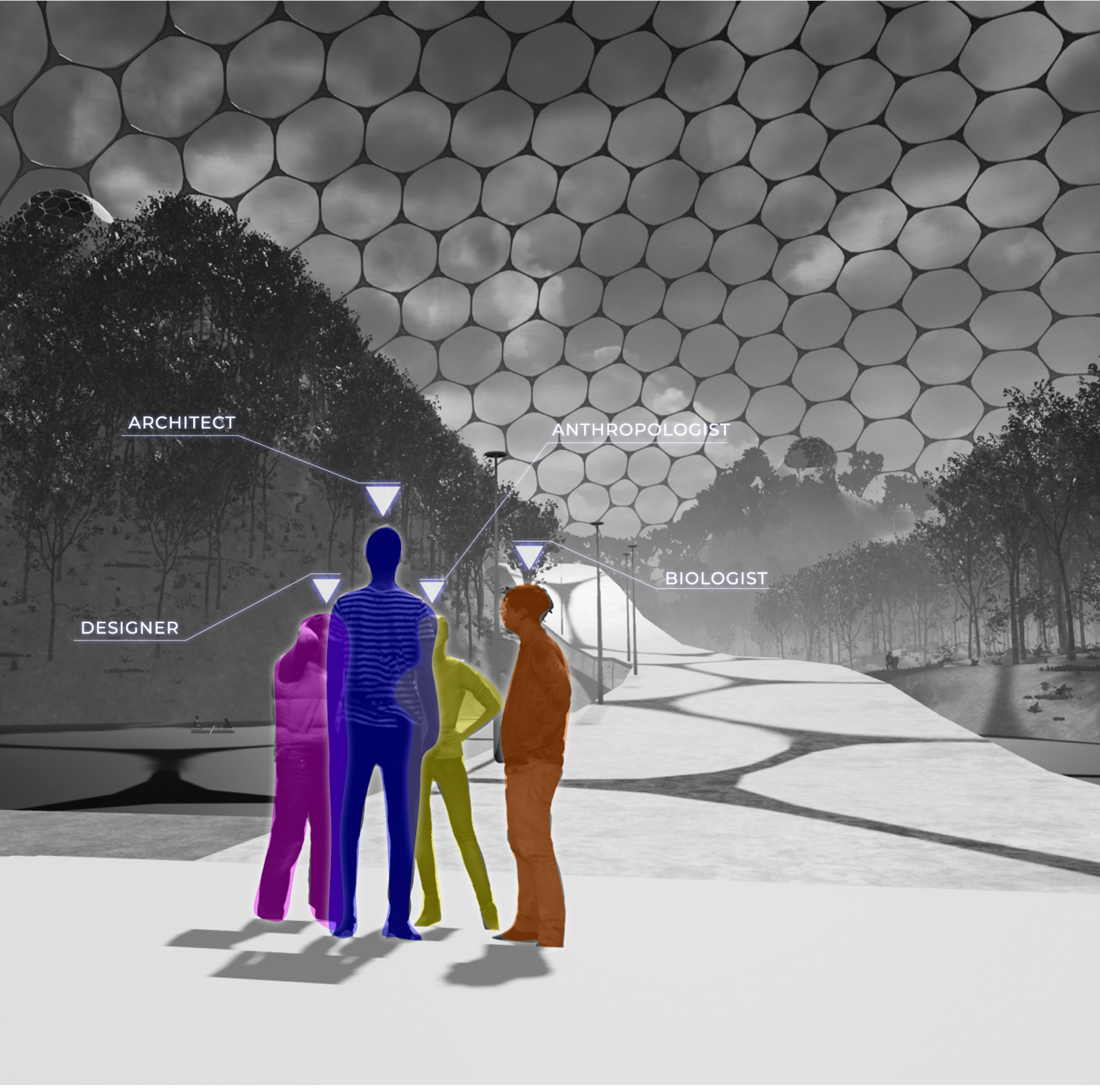


Figure 19: Finding Collaborative, interdisciplinary virtual spaces for collective imagining

CONTENTS

SETTING THE CONTEXT

IMAGINING ALTERNATIVE FUTURES

SPECULATIVE INDUSTRIAL DESIGN

CONCLUSIONS AND REFLECTIONS

3. Speculative Industrial Design

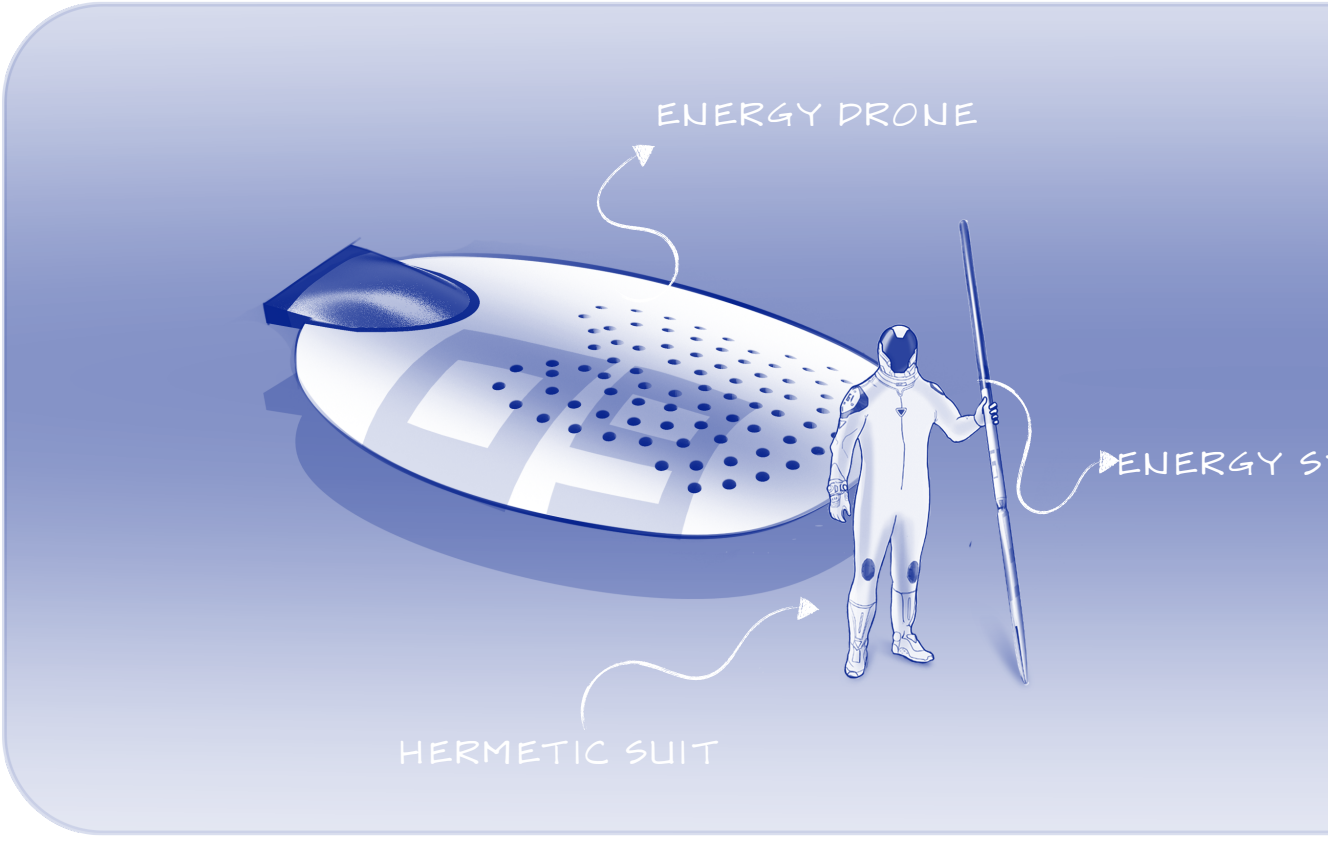
Design Concepts

While working on the intended solutions for the diploma, it dawned on me that the questions that the design interventions needed to answer were quite unique and challenging. Not just from the standpoint of climate change but especially when we pit it against the dark and blurry visions of how we understand the world. If we ask ourselves about how we get here, terms like scarcity and growth were often used as opposed to abundance and synergies. So in order to project a solution that would focus on the latter, some aspects of the solution were key to understanding its impact.

Radical futures may just as well point back to reasonable and obvious directions that may or may not deserve merit in the present discourse of business as usual. Therefore the concepts presented here are more to be looked at as a representation of the methods and the processes I explored in the project rather than the particulars of the solution per se.

Intentions of the Concepts:
For the sake of a clear picture of the industrial design solution, stemming from an unconventional method I had to clear up some intentions on my part as a designer, one that would showcase the solution as it is, not more than what it could be:

- Simple, easy to comprehend and use but a step or two away from magic
- Combine existing technology in a unique way
- Encompass Regenerative potential
- Can evolve over time
- Adapt to changing conditions
- Be locally attuned and responsive
- Use life friendly chemistry
- Resource efficient/multifunctional
- Provides for collaboration and cooperation over competition.



3.1 Far Future Concept

The Ritual:

According to the narrative in Blockchain Radioactive, the children of the Masisi, a clan that is the descendants a research community that survived the post nuclear wasteland of Chernobyl are tasked with the “energy harvest”. The story here suggests that the clan is actually a community that enjoys a progressive level of technological expertise and social cohesion. It draws similarities with the research communities in Svalbard and Antarctica and imagines how a highly educated, egalitarian community would organise itself in such a world. These young teenagers walk around and explore the world around them all the while helping with energy ‘harvests’. This ritual is part of a coming of age ceremony that they do with these energy staffs.

The ceremony involves the use of an “energy drone” that for all intents and purposes represents the advancements in automation which makes this ritual more of an explorative quest than an arduous task. The purpose of this ritual is to have the children of that community be lively and explore to the fullest their habitat. The energy drones support this expedition by providing the logistical arrangements such as reconnaissance of the best combinations for the combinations of sunlight, wind and radioactivity. The drone transfers this harvested energy via wireless microwave radiation back to the BioDome. The drone also functions as a soil excavator and provides the slots for the staffs to be placed into. This partnership of the drone with the children is intended to combine a critical survival method to a method of learning that values exploration. Of all the aspects of the speculation to choose from, the energy staff described in the fiction was in line with the theme of the project and taken forward.

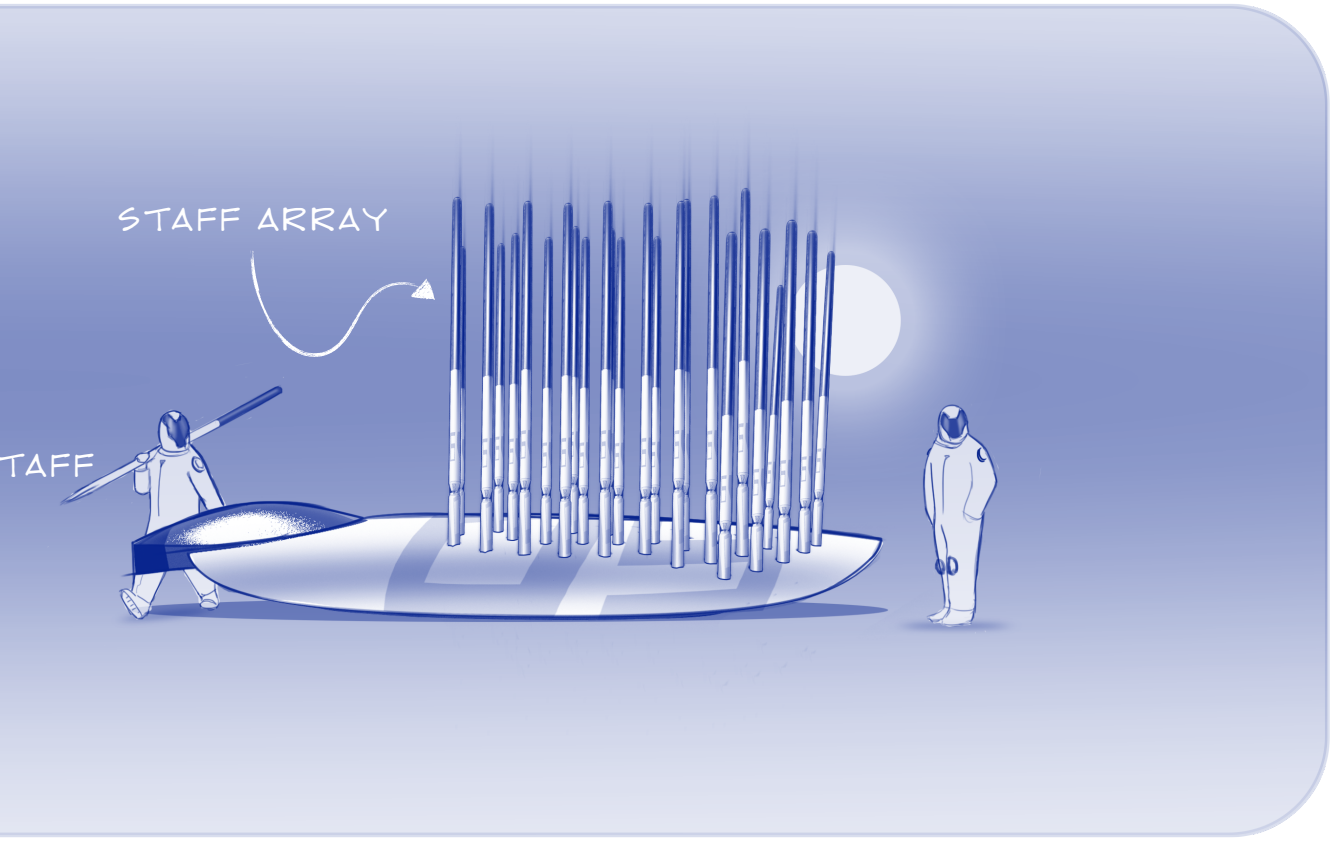
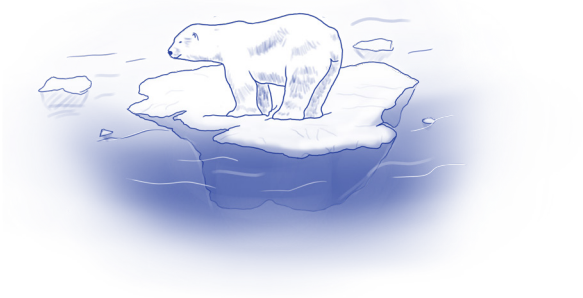


Figure 20: The Ritual of the Energy Harvest



Biomimetics:

The arrangement of these energy staffs was inspired by the properties of the polar bear hair. The hair we see on a polar bear is actually transparent. It appears white to the naked eye due to the structural properties of the hair that cause internal reflection and refraction of light [(33)]. Due to this internal scattering of light, a polar bear can absorb the maximum amount of incident sunlight which in the arctic is a valuable resource. Using the same principle, the energy drone arranges the positions of the energy staff in certain configurations that offer a template to the Masisi children to position their staffs in.

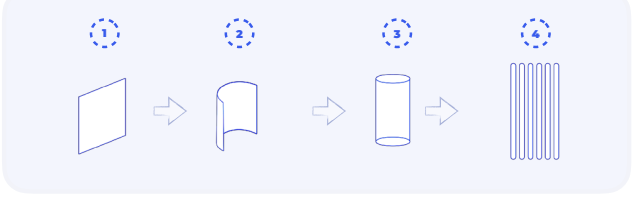


Figure 21: **"Do Solar Panels Have to be flat?."**Biomimetic structures inspired by the polar bears hair.

(33) Stegmaier, Thomas, Michael Linke, and Heinrich Planck. 2009. "Bionics in Textiles: Flexible and Translucent Thermal Insulations for Solar Thermal Applications." Philosophical Transactions of the Royal Society of London A: Mathematical, Physical and Engineering Sciences 367 (1894): 1749–58. https://doi.org/10.1098/rsta.2009.0019.

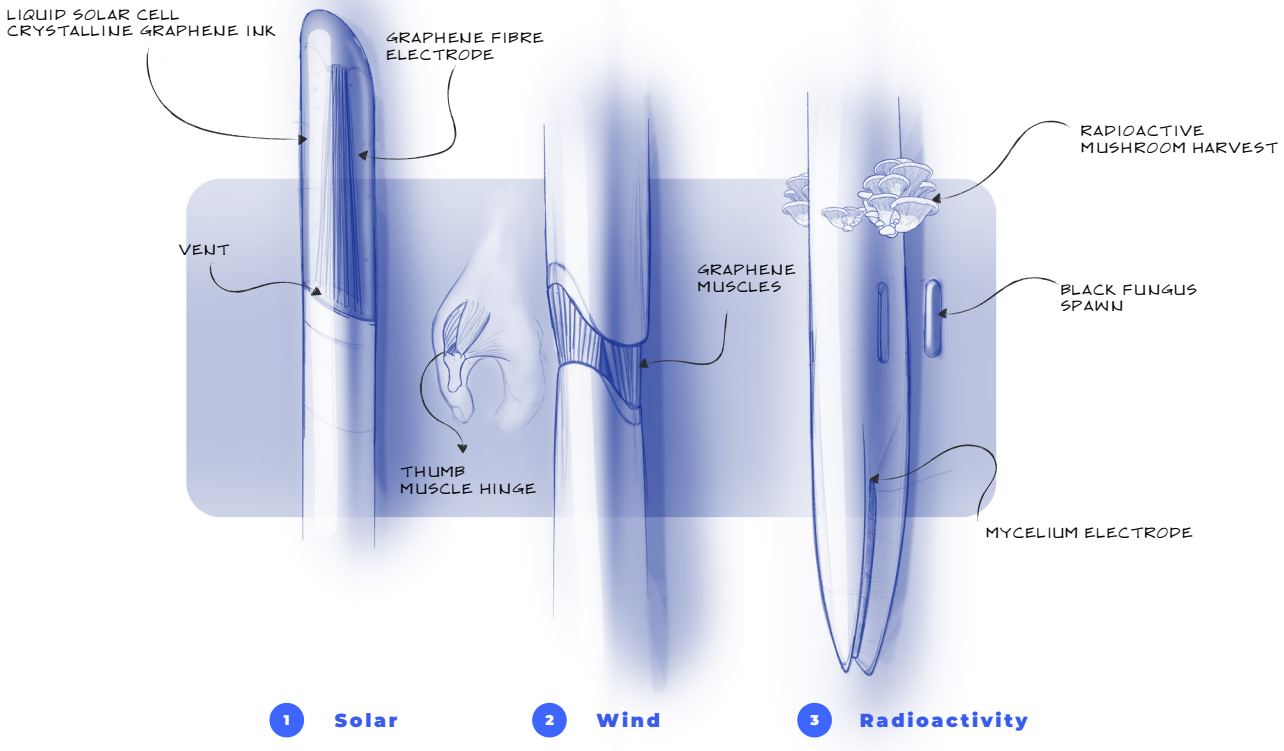


Figure 22: The multifunctional Energy staff

The Energy Staff:

The energy staff that the children use is made of three functions, namely Solar, Wind and Radioactive Energy Harvesting. With a transparent solar ink [34] canister with graphene electrodes [35] at the top, a carbon nanotube muscle 'wind hinge' [36] that bends in the wind in the middle and a mycelium (fungal) electrode that feeds on radioactive soil as the driving head. The energy staff combines all three functions in a single unit.

After planting the staffs, the black fungus feeds on the radioactive soild and gestates for the next four to five weeks. This growth releases energy which is captured by the electrodes and combined with energy from the sun and wind, the drone transmits it back to the BioDome. When it is time to harvest they pluck the mushrooms and move out to other areas in effect remediating the radioactive soil too.

NOTE: Interestingly an outcome of this speculation showed a new direction for research to look into whether this black fungus could be used to harvest energy.

(34) "Organisms Capture Radiation :" n.d. AskNature (blog). Accessed March 5, 2018. https://asknature.org/strategy/organisms-capture-radiation/.

(35) "Electrons Flowing like Liquid in Graphene Start a New Wave of Physics." n.d. Accessed March 11, 2018. https://phys.org/news/2017-08-electrons-liquid-graphene-physics.html.

(36) Johnson, Dexter. 2015. "Graphene Overcomes Achilles' Heel of Artificial Muscles." IEEE Spectrum: Technology, Engineering, and Science News. May 22, 2015. https://spectrum.ieee.org/nanoclast/semiconductors/materials/graphene-overcomes-achilles-heel-of-artificial-muscles.

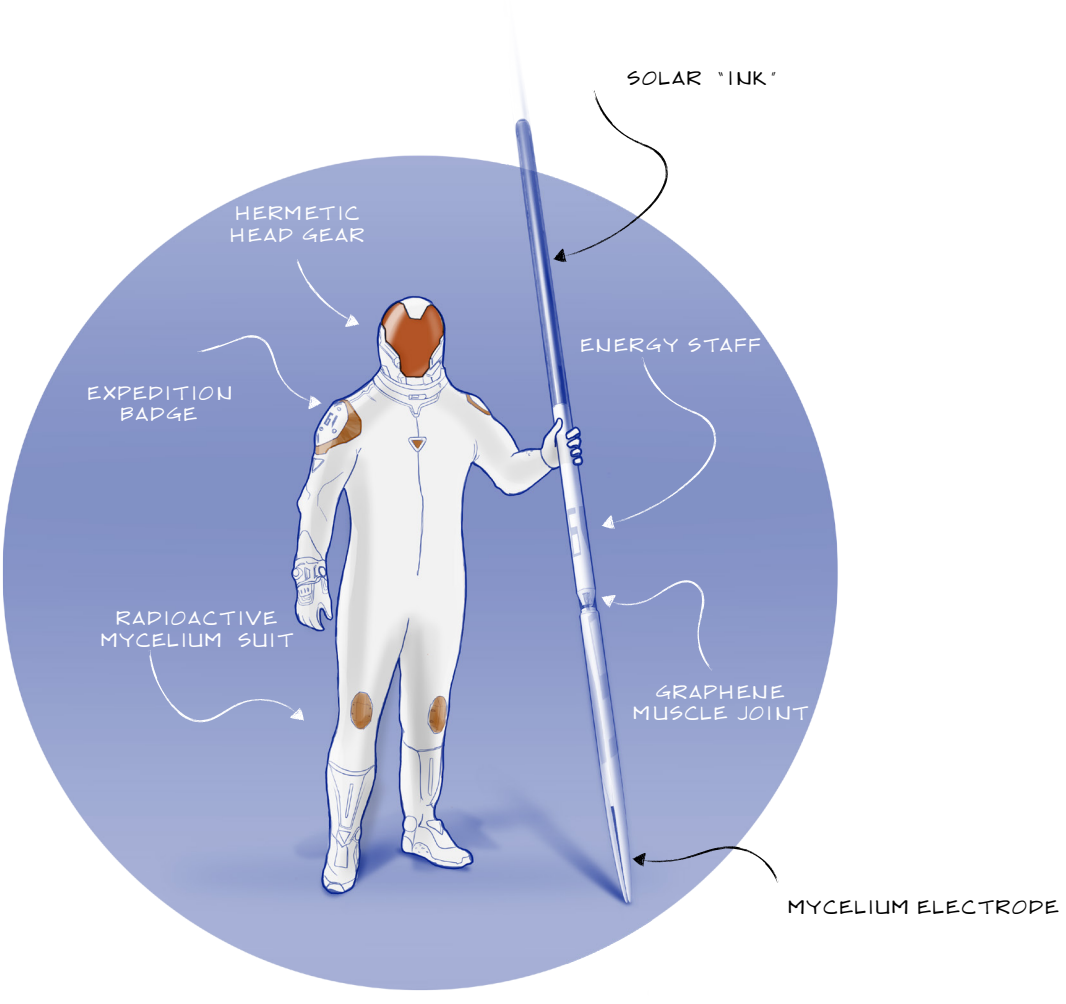


Figure 23: The outdoor suits for Mal, the hero of the future fiction.

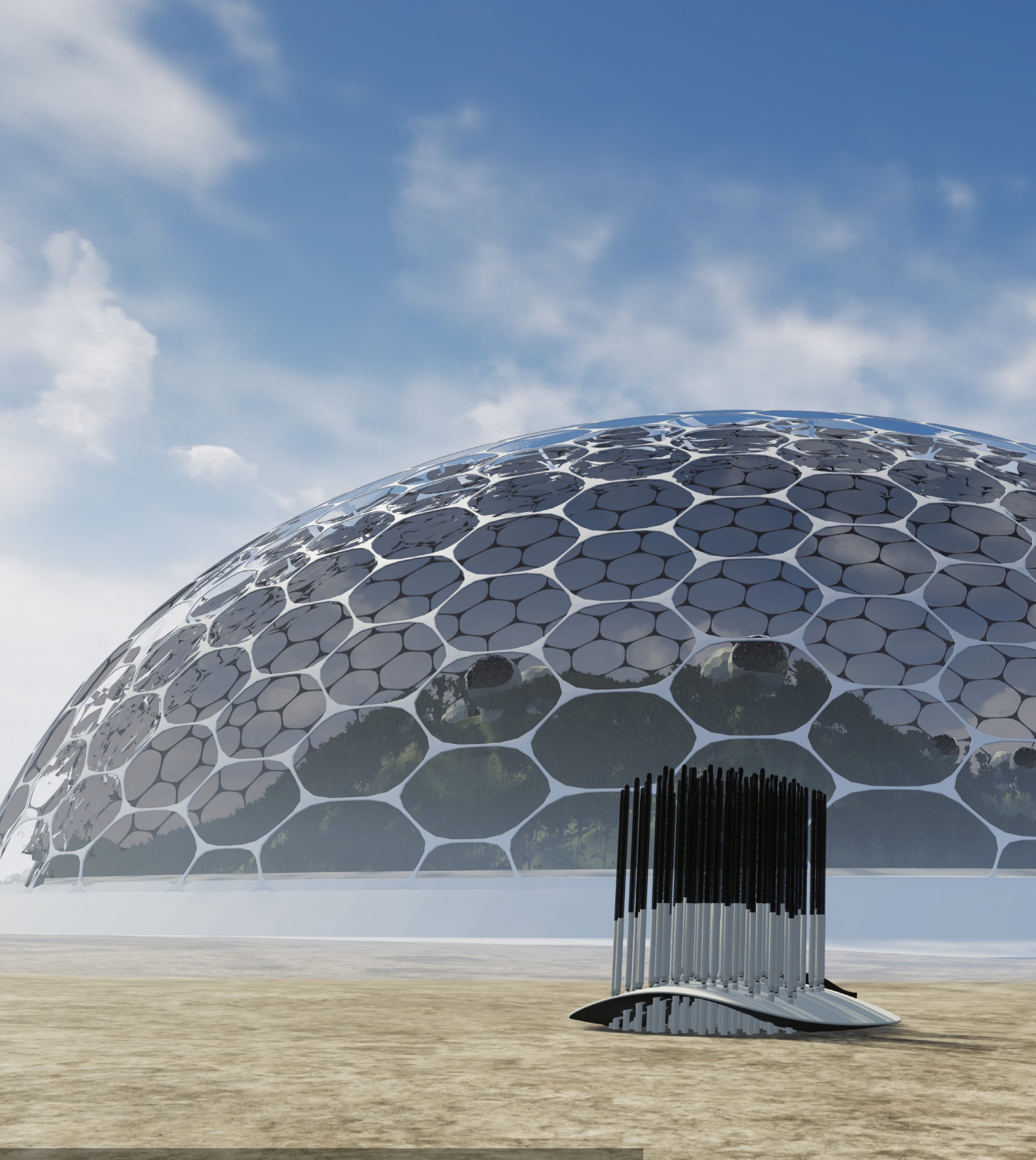
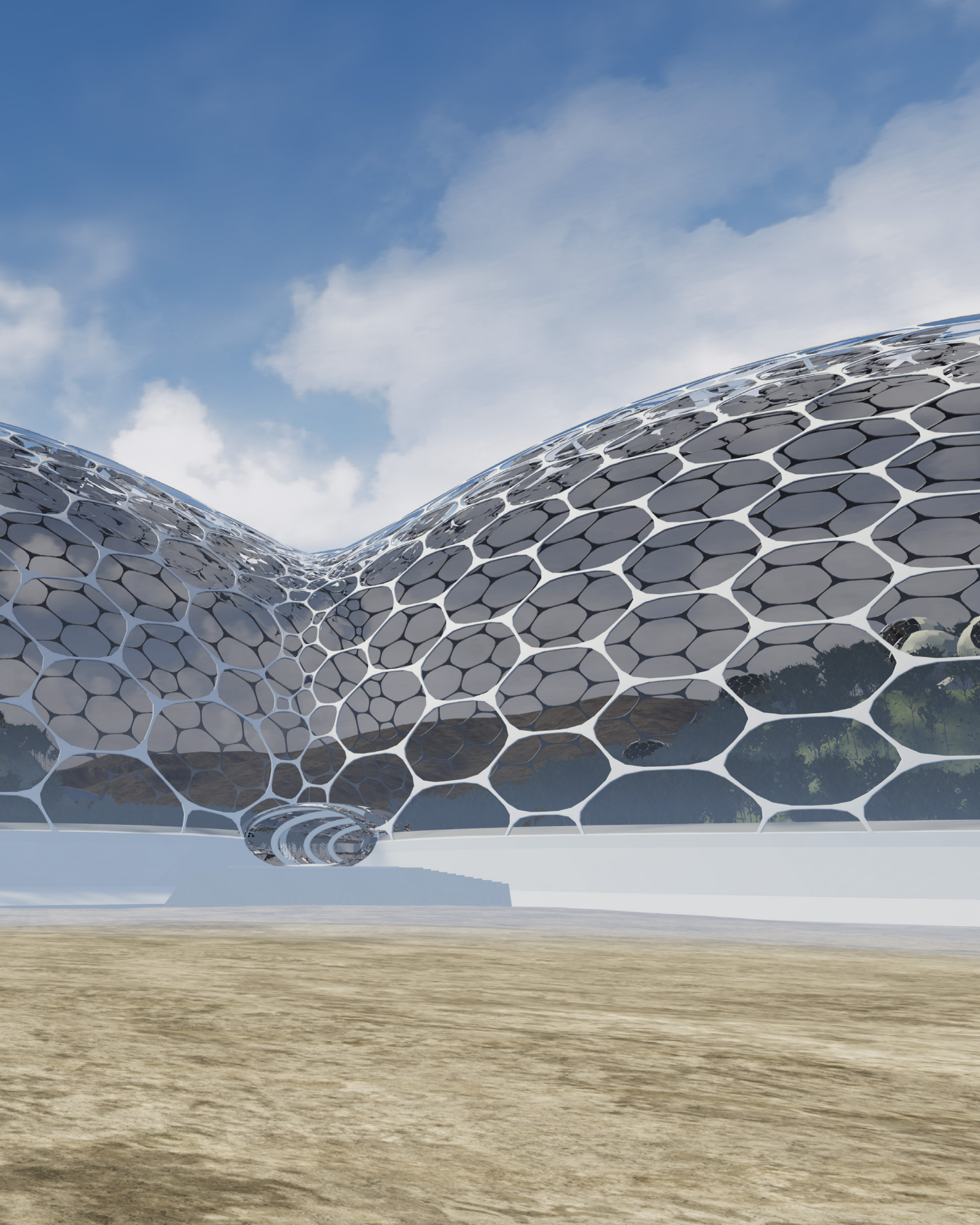


Figure 24: Placing The Energy Drone and Staff back into VR

See Appendix 9 to watch the film showcasing the VR experience based on the speculative fiction of Blockchain Radioactive



3.2 Possible short term outputs, consequences and opportunities (pragmatic backcasting)

Usually, at this stage, a Speculative Design project would tend to hover about the future and build it up further in detail and create a stunningly immersive picture of that future. This project however, intends to be a voyeur in that future such that through this project and in the limitations of the time frame, I intended to pursue a backcasting approach to the solutions of the future.

How would we gain insight from the future that could lead to action today? What kind of insight does this future provide?

Future Foresight:

> *Can a kutcha (temporary) energy solution be made for the kutcha (temporary/ nomadic) communities of the future?*

Figure 25: The case can be made that technology of the future already exists today.

Technology:

In keeping with the spirit of using existing understanding of technology, I decided to look into various research papers into what kind of alternatives were being explored when it came to solar cells. I found a paper suggesting making solar cells out of fibre optics [37] by coating the fibre optic surfaces with solar ink. In another study [38] I also found that graphene could potentially serve as an excellent solar cell being able to capture a large spectrum of visible and infrared solar energy vastly increasing both efficiency and safety of a solar cell all the while reducing the toxic logistics of conventional solar cells.

Hierarchical Biomimetics:

I decided to explore biomimicry and look at how light capturing structures are grown in nature [39] and in that process I found the glass sponge found at the bottom of the ocean which grows flexible yet strong optical structures at room temperature. These organisms produce fibres far superior to any fibre optics today that is composed of hierarchical structures grown of basic building blocks called spicules. These allow for scalability and resilience at all scales starting from the nanoscale to the macro-scale.

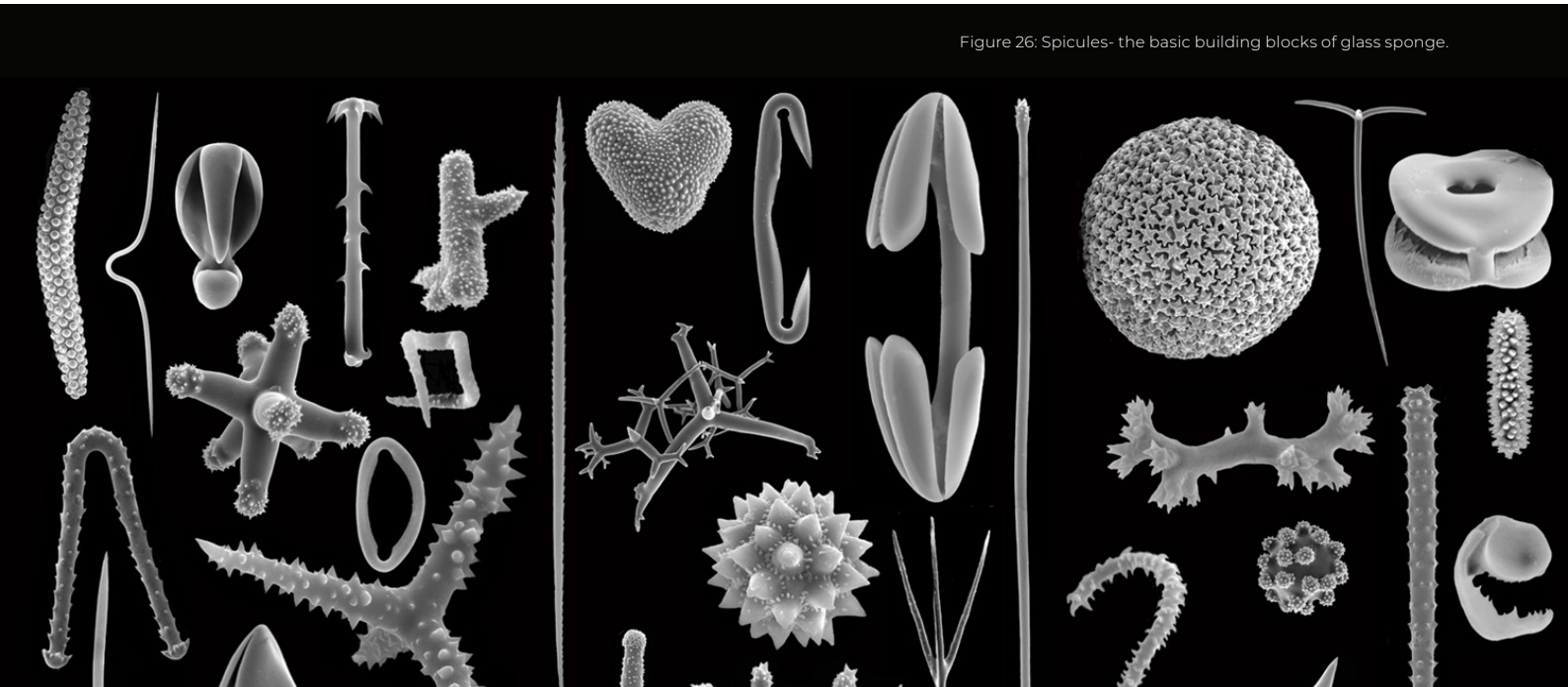
So the backcasted concept tries to mimic the same principle of a basic building block for the future of solar cells.

(37) Bourzac, Katherine. n.d. "Wrapping Solar Cells around an Optical Fiber." MIT Technology Review. Accessed March 14, 2018. https://www.technologyreview.com/s/416052/wrapping-solar-cells-around-an-optical-fiber/.

(38) "Proof: Graphene Can Convert Sunlight to Electricity." n.d. Sciencenordic.Com. Accessed March 6, 2018. http://sciencenordic.com/proof-graphene-can-convert-sunlight-electricity.

(39) "Light-Transmitting Fibers : Venus's Flower Basket." n.d. AskNature (blog). Accessed March 5, 2018. https://asknature.org/strategy/light-transmitting-fibers/.

Figure 26: Spicules- the basic building blocks of glass sponge.



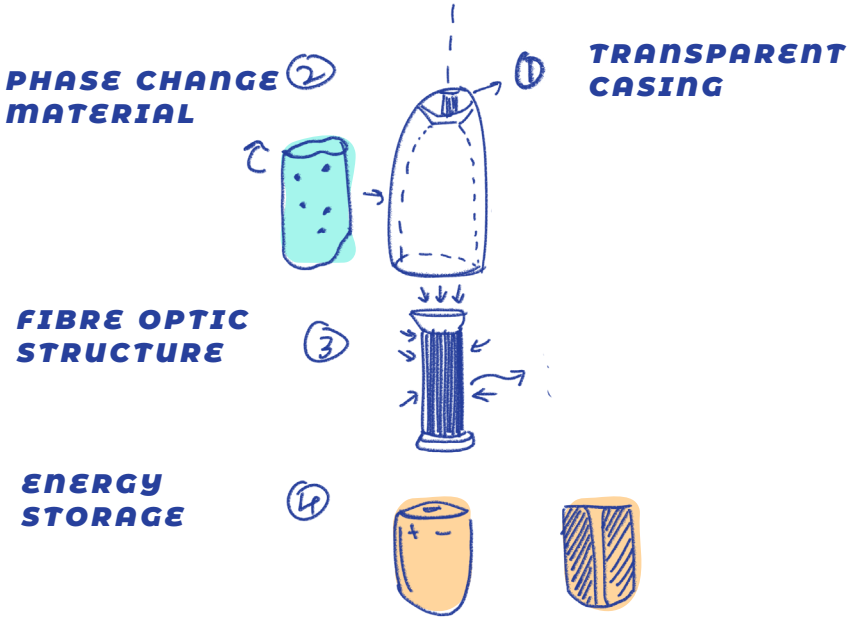
The Concept:

The combination of existing technology and hiearchical biomimetics along with processes such as Digital Fabrication and harvesting graphene from the atmosphere using carbon sequestration, allow for the potential fabrication of a three dimensional solar cell in which 3D printed optical structures are etched/coated with graphene nanotubes. These solar cells could also be combined with a wide range of solar technologies that exist today such as dye sensitised solar inks or perovskite solar solutions [(40)]. In order to compensate for the loss of sunlight at night, the cell also consists of a phase change material [(41)] that is a material which changes phase such as from solid to liquid and releases large amounts of heat due to crystallisation. This material depends on a physical property of crystal formation and can be reset infinite number of times while extending the energy produced by the cell through the night.

Since this concept is unbiased to where the sun is at any given point in the sky, it doesn't need complicated sun tracking

(40) "Printable Solar Cells Just Got a Little Closer: Research Removes a Key Barrier to Large-Scale Manufacture of Low-Cost, Printable Perovskite Solar Cells." n.d. ScienceDaily. Accessed January 2, 2018. https://www.sciencedaily.com/releases/2017/02/170216142800.htm.

(41) Yang, Jie, Guo-Qiang Qi, Yang Liu, Rui-Ying Bao, Zheng-Ying Liu, Wei Yang, Bang-hu Xie, and Ming-Bo Yang. 2016. "Hybrid Graphene Aerogels/Phase Change Material Composites: Thermal Conductivity, Shape-Stabilization and Light-to-Thermal Energy Storage." Carbon 100 (April): 693–702. https://doi.org/10.1016/j.carbon.2016.01.063.



systems. Moreover, due to it's small footprint, it could also be used to convert existing vertical urban spaces into solar collectors where usually rooftops were the only option.

Features

The 3D solar cell is composed of

1. 3D printed fibre optic structure

2. Coating of Solar Ink made of Graphene.

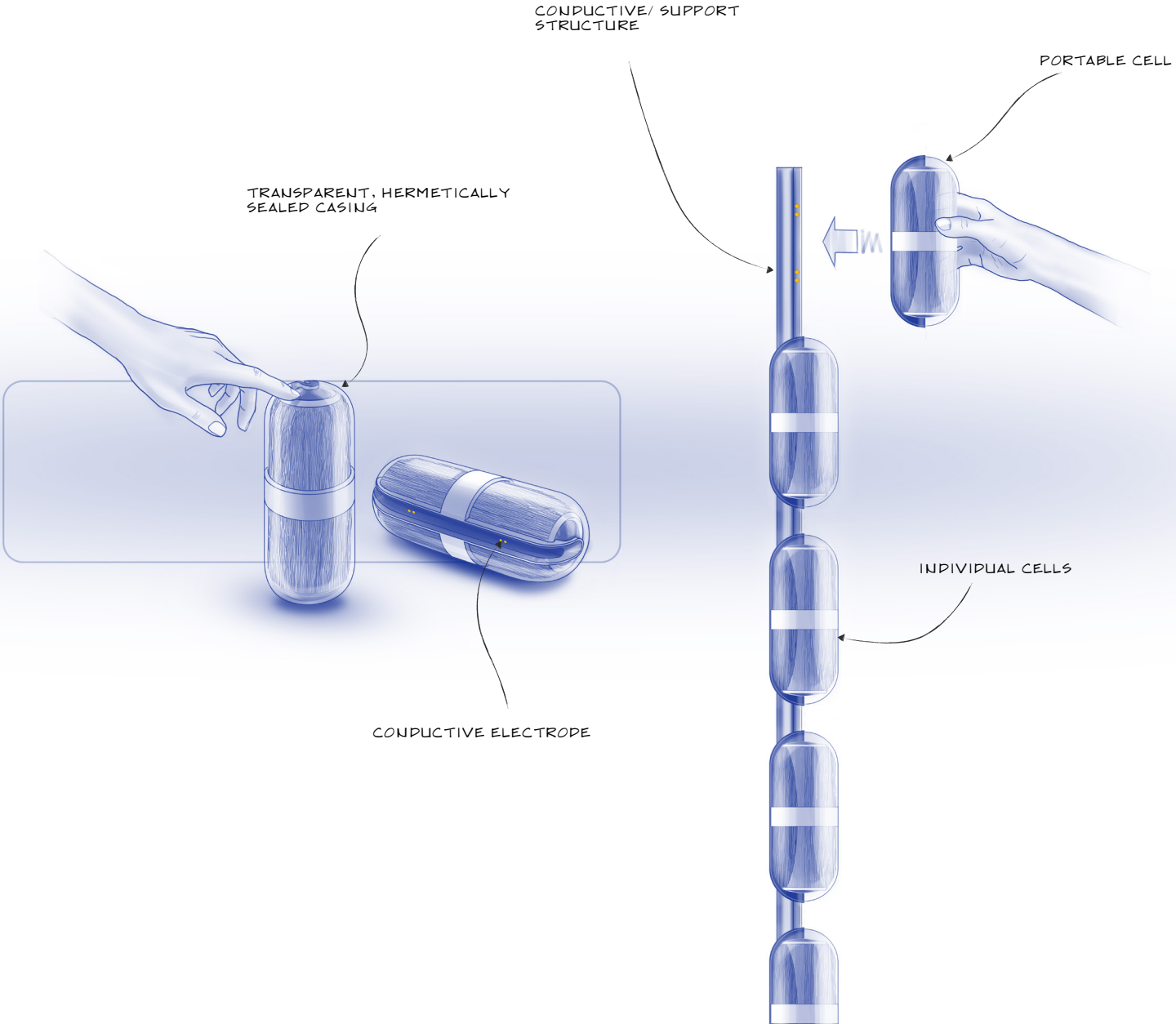
3. Transparent Phase change material for storing heat

4. In-built energy storage such as batteries or ultracapacitors

The concept tries to point to an infinitely scalable, modular solar cell that can be deployed in complex and varied combinations to create resilience when it comes to a "kutcha" or temporary solar solution. It is basically a self contained solar module that could be at ease in an infinitely scalable solar farm or even be used as a single unit.

3D Solar

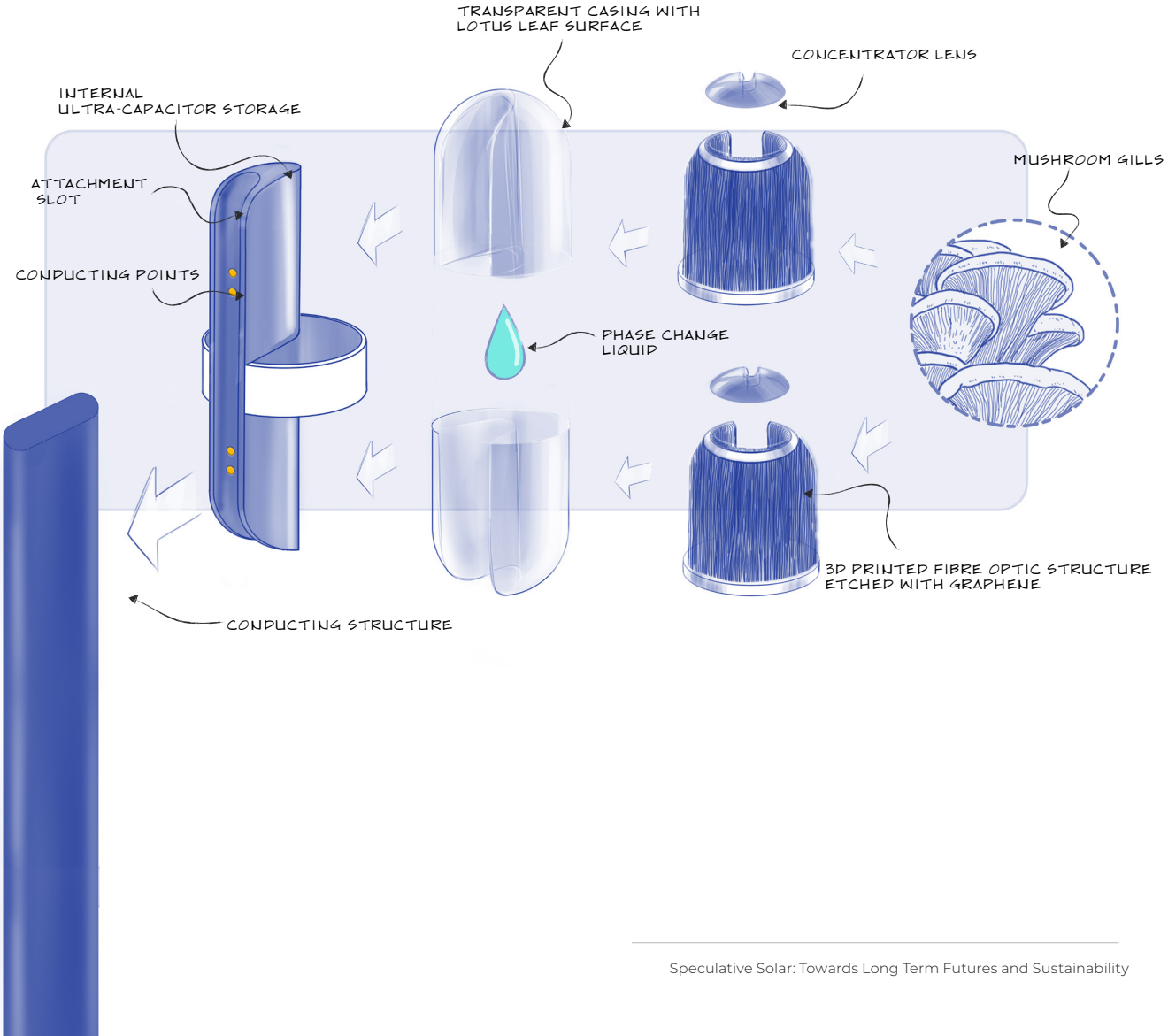
A modular, self contained solar cell that is independent of line of sight with the sun and can be readily manufactured using additive manufacturing methods on demand. Each individual cell produces some energy but also just as the energy staffs of the future, the key is to work together to use them as a group, hopefully leading to collaborative potential. It follows a structural arrangement of the cells to be able to harvest reflected solar radiation which in turn alludes to the concept of hierarchical biomimetics in the glass sponge.

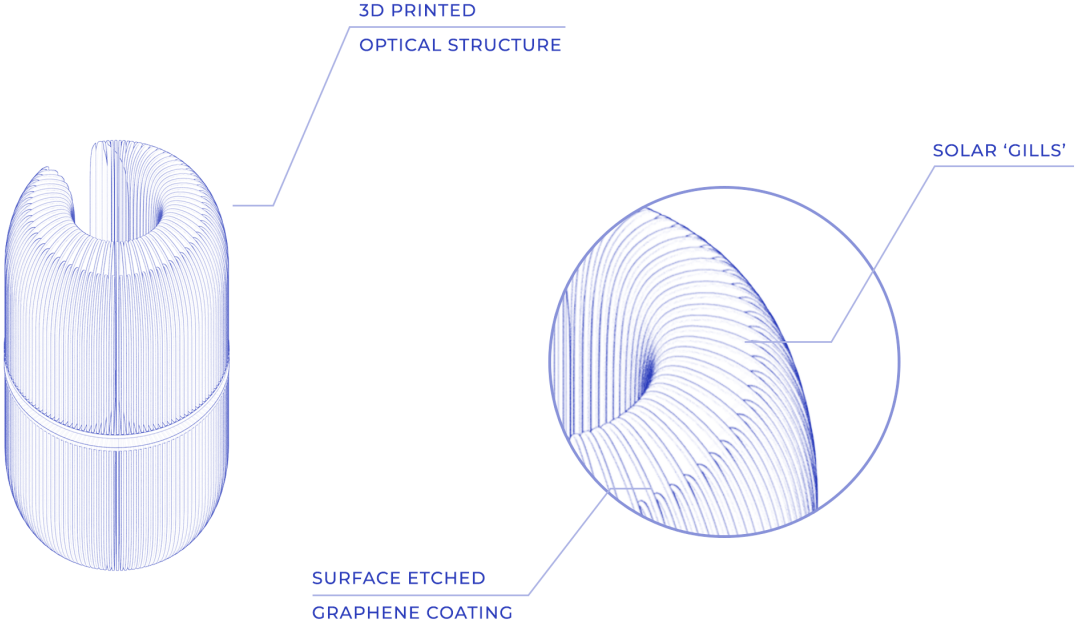



TESLA

Concept Details

For the most part, the cell was designed to keep a low profile. To keep it as bare bones as possible such that each part was absolutely necessary to work. The optical structure of the cell was designed keeping the form of the mushroom gills in mind to facilitate a larger surface area for solar energy absorption but also make further internal reflections of light possible. Most if not all of the parts you see here are possible to 3d print today, including the transparent parts.

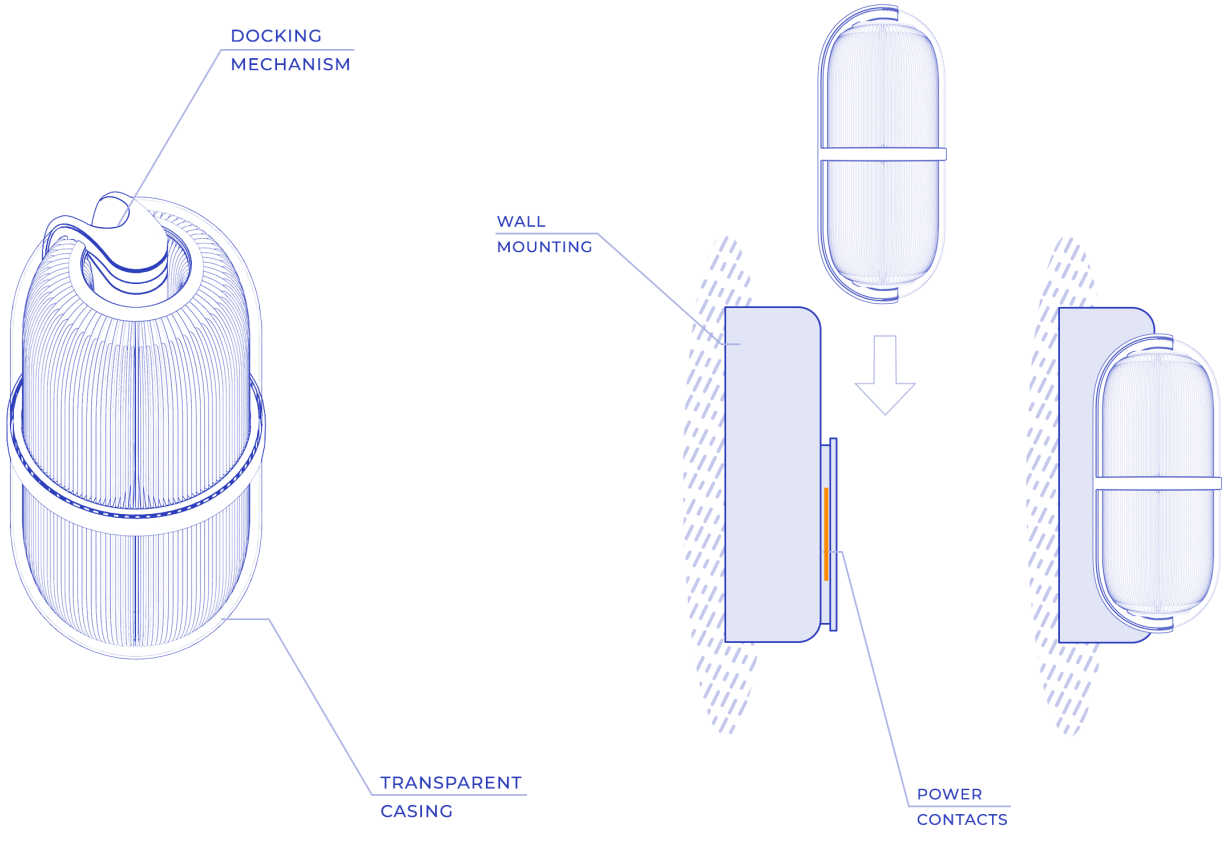




Broad Spectrum Solar

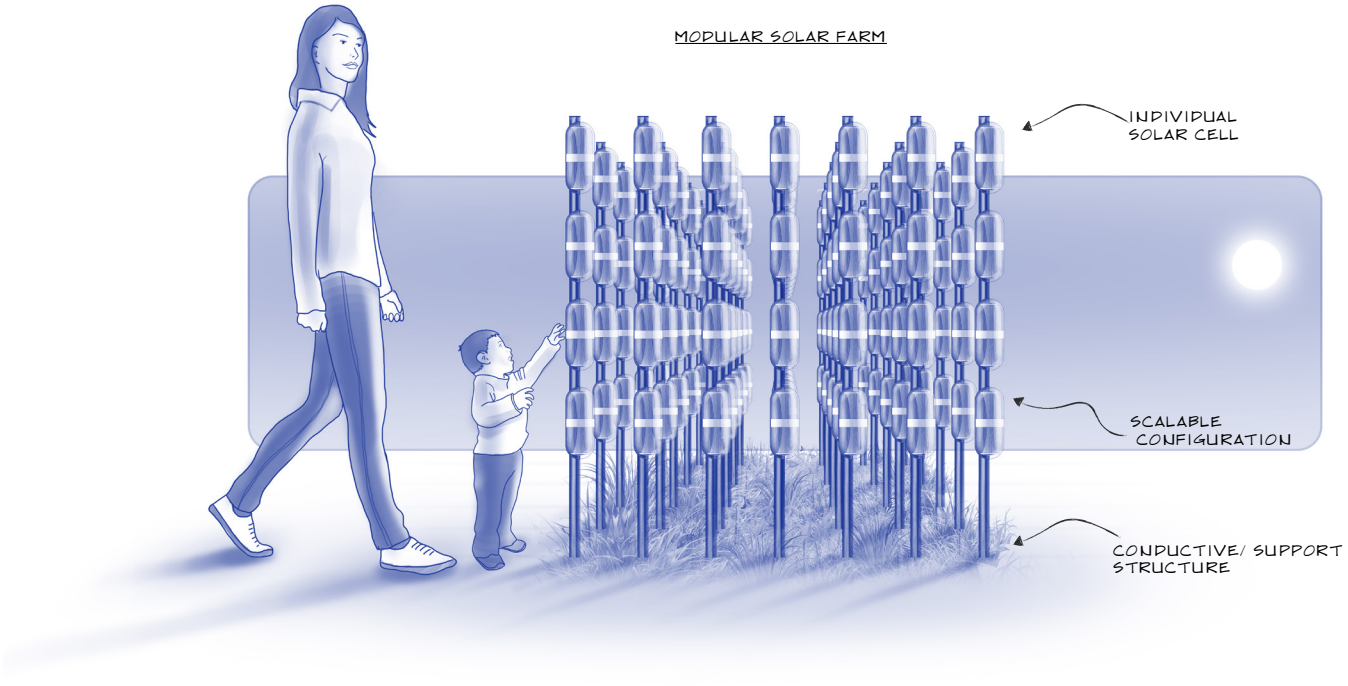
The cells are etched with a graphene solar ink which makes the transition of a solar cell to harvest even the infrared spectrum of solar radiation, making it a broad spectrum solar cell. By combining the properties of graphene to convert both visible spectrum and infrared we can make solar cells that produce energy more with less.

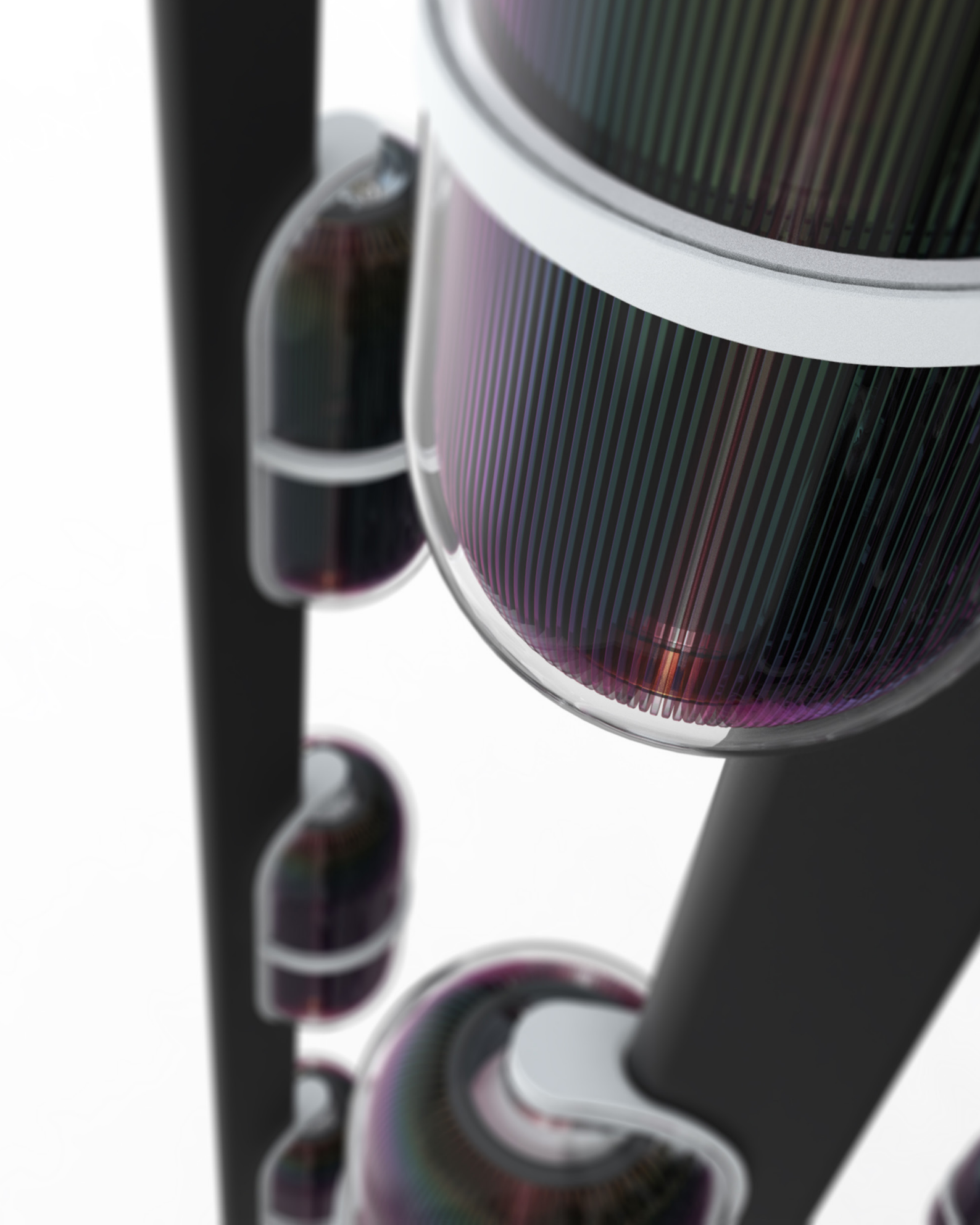
These cells can be 'docked' onto conductive supports that makes for ease of repair possible.

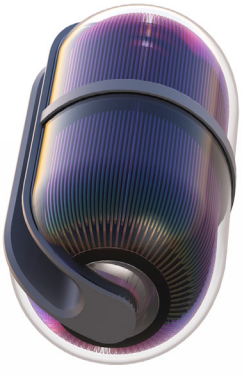

DOCKING
MECHANISM
TRANSPARENT
CASING
WALL
MOUNTING
POWER
CONTACTS

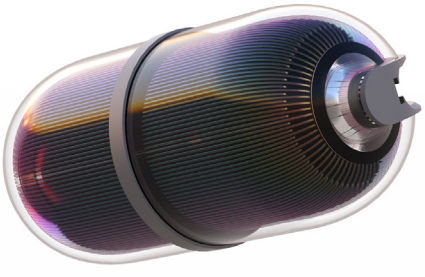
Solar “Crop” Farms

Much like the Energy staffs, the concept could also play with various possible arrangements that enable a high level scale of use where an individual cell maintains its autonomy but also contributes to the whole system.



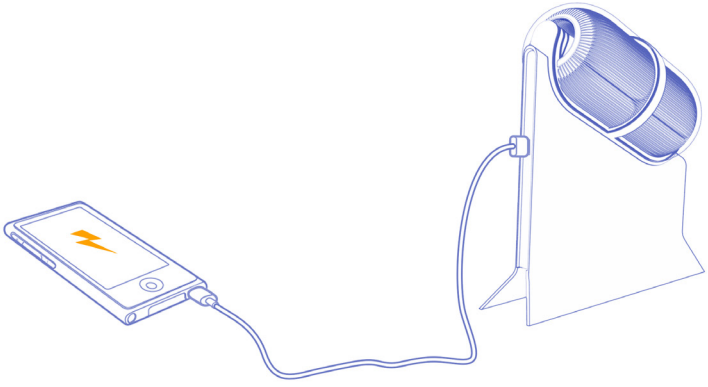






360° Solar

The cells can capture light from a wide range of spectral ranges and from any angle of sunlight while today's cells need to have direct sunlight for a normal operations. They do away with the need for complicated mechanisms of solar tracking and energy management systems.



Case 1: Micro Scale

An individual cell or at least a version of it could possibly be used as a portable power supply for charging phones or providing lighting in energy scarce regions of the world. This however is something that should be looked into as a mode of transition, not as an end unto itself. These individual cells would be a starting point to transition to more organised form of energy independence. A single cell could provide some energy to some people...

Case 2: Macro Scale

...but a large scale arrangement of these cells could hopefully lead to a more complex understanding of energy. The elements of organising that the speculative future talked about earlier. The arrangement of the cells could possibly allow for a resilient structure that captures all useful spectrums of solar radiation while also allowing for internal reflections and refractions of light much like the polar bears hair. This scalability and modularity proposes a form of grid level infrastructure that can be flexible in use and resilient to the nature of its use.

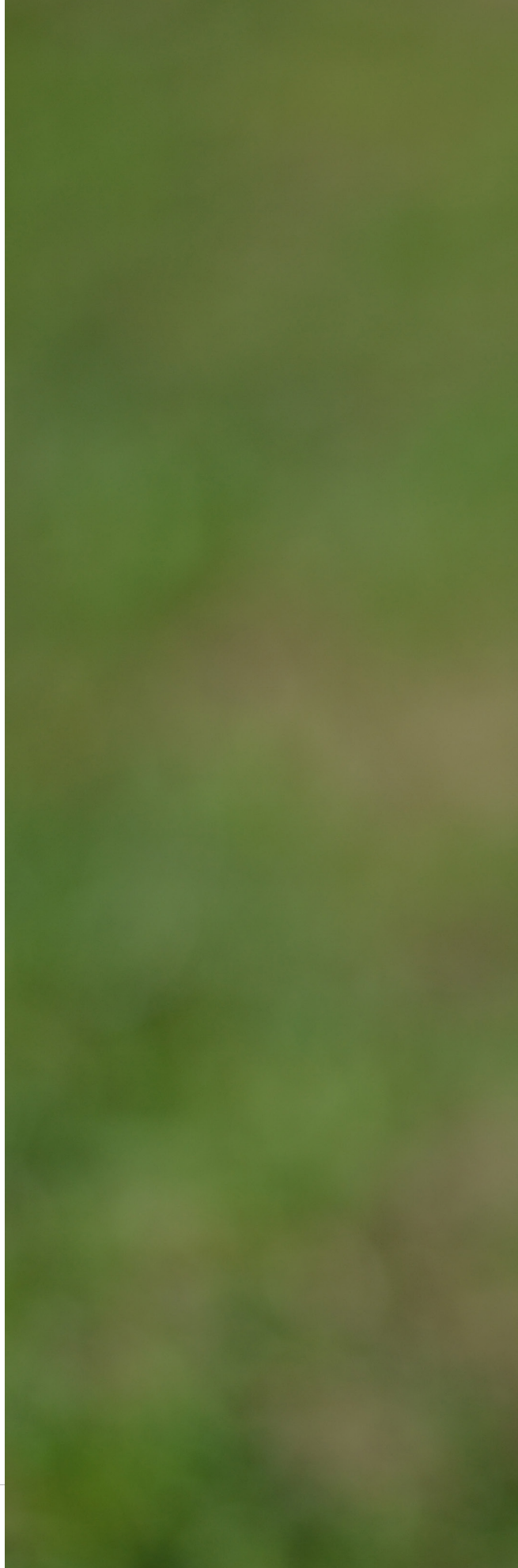
Case 3: Solar Metamorphosis

What if we could turn our existing cities into solar power plants, without the need for massive infrastructure overhaul? If we stretch the modularity of the concept further, we can imagine applications such as mounting them on the vertical surfaces of existing structures Most often than not these get overlooked due to the rooftop approach to solar.

These cells could be mounted on existing facades and also integrated in new ones thereby transforming urban high rises into net generators of energy instead of consumers. When mounted vertically on dense urban skyscrapers, the cells could also additionally capture the reflections and scattered incident sunlight off of other buildings in addition to direct sunlight. At night, the urban heating effect also becomes another possible source of infrared radiation that the graphene inks could capture thereby greatly enhancing the efficiency of these cells. As a means of taking action today, this could be an approach to a large scale application of these cells.

Artefact-making

The final step was to create an artefact from the future and bring it into the now. The model pictured here is a representation of just how mature the additive manufacturing process can be, which makes it possible to 3d print optically transparent structures just as easily as any other material.



3D printed Optics

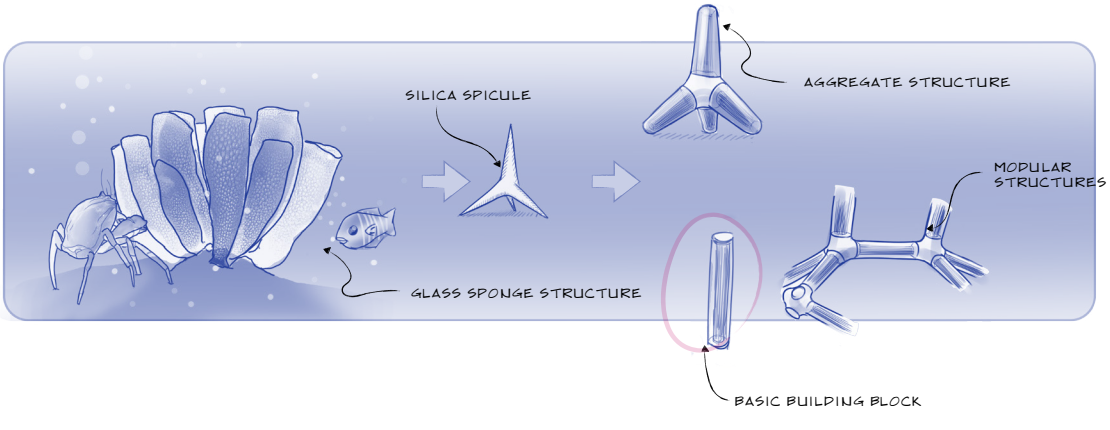
These layers are 100 microns in size and are made using existing SLA printers with clear resin, without any surface treatment. The choice to 3D print these structures was to also showcase the capabilities that already exist today that we could leverage for better solutions.

3.3. Desired mid-term outcomes: Forecasting Alternative Product concepts

This project helped me discover a further segway into a forecasted solution as a form of a quick trip back to the future. If we were to stretch the backcasted solution back into the future, we could speculate as to how infrastructure and energy would also follow a same ephemeral pattern of temporary conditions.

For the sake of time I did not explore this direction further than it needed to but rather to show how this process can actually be very iterative leading to possibilities that would otherwise be lost to complexity. In this regards I looked to the glass sponge again and noticed how the spicules were an aggregate, a sort of building block of the structure. Could there be such a DNA of the possible future of solar cells?

I discovered that there were such inquiries in the field of architecture where we could see the field of Aggregate architecture being developed. I tried to imagine a speculative scenario where the backcasted solution could become a part of these temporary structures. What if a solar cell was part of such a temporary structure or settlement?



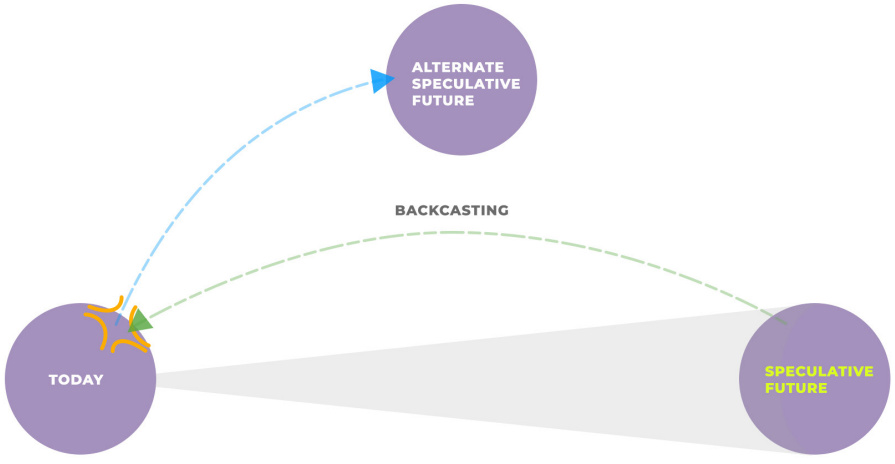
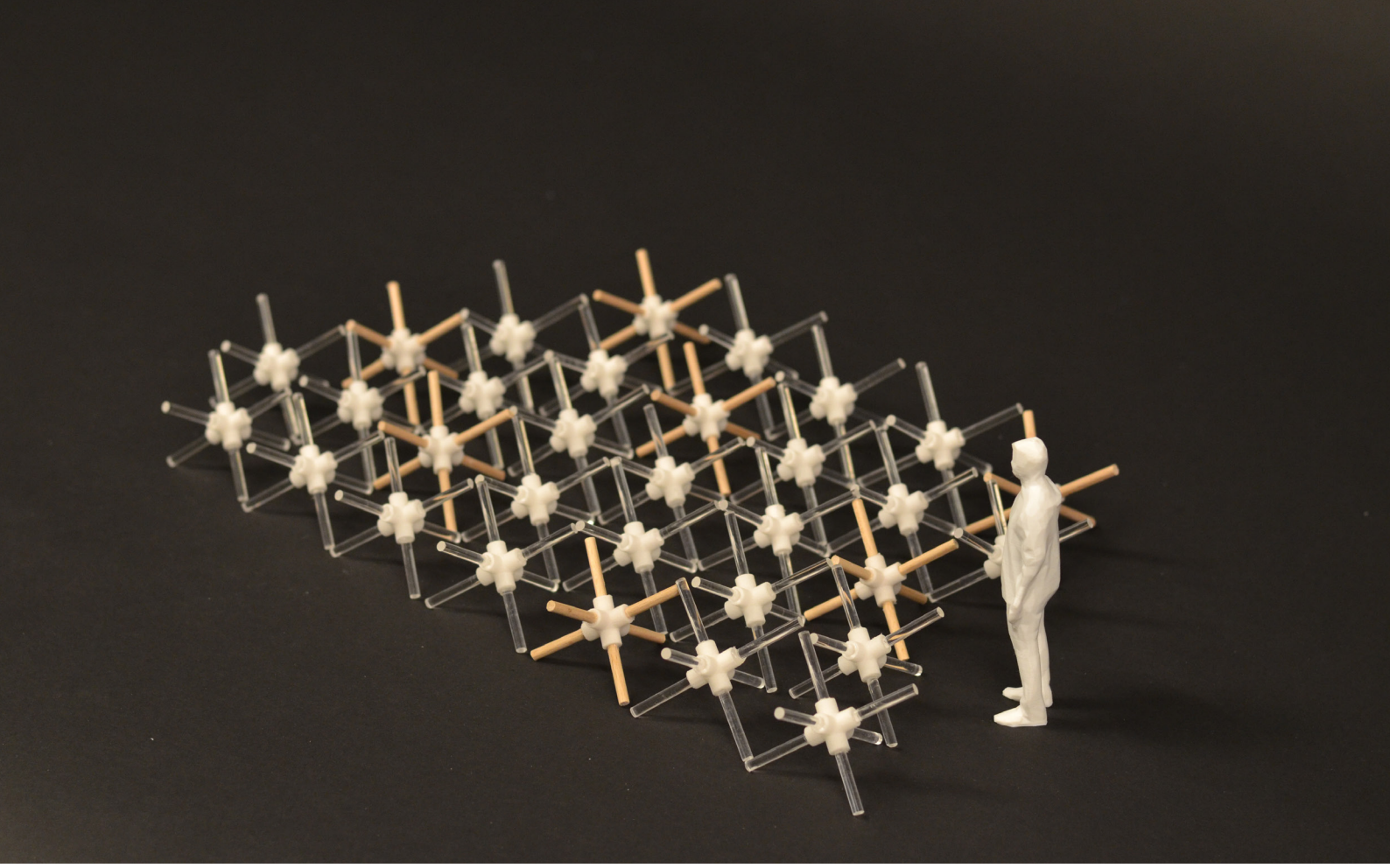


Figure 26: Forecasting the backcasted solution back into an alternate future



Aggregate Solar Structures

Aggregates like sand are held together by basic building blocks similar to that of the spicules of the glass sponge. These strucures could offer possible temporary solar structures that might be relevant to the needs of changing landscapes and uncertain climate conditions.

3.4 Futures Discourse

As part of a final stage in the diploma, I decided to hold a casual discussion titled “Futures Discourse”. To see what the speculations and the VR could lead to. I was hoping to get experts from various fields like architecture, design, anthropology, and tech researchers etc. to be involved in this conversation where I planned to present a brief journey of the project which would serve as a starting point to a more richer discourse on preferred futures.

It was an attempt at tying up the diploma by creating a space for collective imaginings and perhaps possible interpretations of the speculative future scenarios that I set out to explore in this project and the role industrial design can play in supporting other disciplines as a means to climate action.

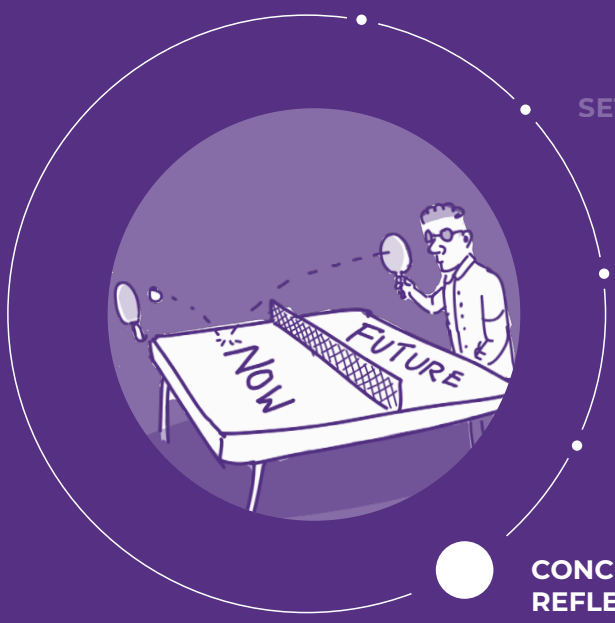
I think it would work, because stories are good to think with, as anthropologist Claude Levi Straus who talked about that some things are better for human beings to think with than others... I think it's a good starting point for various groups to come together be able to discuss and explore. It should be something that is easy to imagine for people, like this scenario for example. You don't need special competence to understand this story.

This is really interesting... As the backcasting comes in here (the method) and you develop the future, you could sophisticate the process to play on the integration between the future, the speculative fiction and combine the backcasting and future mapping. You could also have a more spiral approach, you could imagine small (process) spirals in the big spiral. I think here resistance is quite important, because it can trigger something at the same time, so you can build more and more resistance and conflict.

The product in itself is a trigger for speculation and a way of meeting cross disciplines and bringing different perspectives on speculation... from this to that to that...

This is fun.

CONTENTS



SETTING THE CONTEXT

IMAGINING ALTERNATIVE FUTURES

SPECULATIVE INDUSTRIAL DESIGN

CONCLUSIONS AND REFLECTIONS

Conclusions and Reflections

4. Contributions

This project, is part of a bigger piece in the giant maze of long term future thinking and climate action. In trying to design for the future, the product becomes comprehensible and obvious. Those choices inform the future which this project has used to inspire our present, while not just creating a space for discourse and providing an explorative framework but also pointing to a possible solution that could be used today. I think the project contributes to the field in the following ways:

- Exploring ways and suggesting new methods in which Industrial Design can create discursive spaces to strive toward better visions for the future and long term sustainability.
- Posing the question ***"what if"*** for which directions today's research can take in the relevant disciplines, such as SINTEF or other such research institutes.
- Imagining possible alternative visions to existing solutions.

Photo by: Gard Hagen

5. Reflections

This project for me is a culmination of all the design skills and tools I have learned over the past couple of years. While one can never deny the scope for improvement and I do sincerely hope there are ways these methods can be improved upon, I believe that this project represents the best of what I have learned at AHO. The project in its relation to the vast complexity and nature of the problem at hand called for an approach to industrial design that I see today as far removed from what we need to be doing. Industrial design that caters to the bottom line alone has shown us the door to a collective isolation within our silos. In such a world of hyperspecialisation, I believer we can still equally celebrate diverse and broad range of skills and practises that need for a project such as this to exist. The need for perfect solutions would make sense in a perfect world. Ironically the burden of proof for alternative solutions is also that much higher than the systems we have today, the conventional wisdom it turns out is so much easier to accept. This project I believe was all about showing that it may be far more exciting to dream again, and in doing so create and even better solution that what we have now and that which helps bridge the future through the act of artefact making.

This project was by no means an easy task. It was deliberate in its endeavor to create an exciting space for collective dreaming. Thus in the same sense it also doesn't intend to impose a singular point of view. Every aspect of this future-making is up for further improvement or disruption. If one were so inclined, one could build on this further to create a more meaningful action for not just sustainability as a practise but for a long term future that any thriving species could instinctly organise around.

Photo by: Farid Sayar

6. References

The entire diploma has been anchored by existing technology and research carried out today.

The following is a list of references that anchor the project.

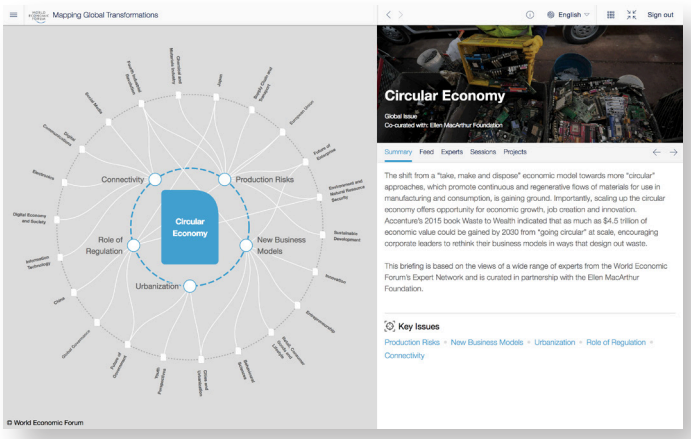
- *"World Is Locked into About 1.5°C Warming & Risks Are Rising, New Climate Report Finds." Text/HTML. World Bank. Accessed Janurary 9, 2018. http://www.worldbank.org/en/news/feature/2014/11/23/climate-report-finds-temperature-rise-locked-in-risks-rising.*
- *Ceballos, Gerardo, Paul R. Ehrlich, and Rodolfo Dirzo. "Biological Annihilation via the Ongoing Sixth Mass Extinction Signaled by Vertebrate Population Losses and Declines." Proceedings of the National Academy of Sciences 114, no. 30 (July 25, 2017): E6089–96. https://doi.org/10.1073/pnas.1704949114.*
- *"What Is Dark Ecology?" Changing Weathers. Accessed November 6, 2017. http://www.changingweathers.net/en/episodes/48/what-is-dark-ecology.*
- *Fleming, Nic. "Plants Talk to Each Other Using an Internet of Fungus." Accessed January 28, 2018. http://www.bbc.com/earth/story/20141111-plants-have-a-hidden-internet.*
- *"Explore Insights | TOPLINK." Accessed January 17, 2018. https://toplink.weforum.org/knowledge/explore/all.*
- *Miller, Riel. "Futures Literacy: A Hybrid Strategic Scenario Method." Futures 39, no. 4 (May 2007): 341–62. https://doi.org/10.1016/j.futures.2006.12.001.*
- *Ladha, Alnoor. "From '"Green Growth"' to Post-Growth." Truthout. Accessed April 22, 2018. http://www.truth-out.org/opinion/item/44111-from-green-growth-to-post-growth.*
- *"Earth's 'technosphere' Now Weighs 30 Trillion Tons, Research Finds." Accessed April 22, 2018. https://phys.org/news/2016-11-earth-technosphere-trillion-tons.html.*
- *Clendaniel, Morgan, Morgan Clendaniel, and Morgan Clendaniel. "To Save The Economy, We Have To Break Its One Sacred Rule." Fast Company, March 15, 2016. https://www.fastcompany.com/3057801/to-save-the-economy-we-have-to-break-its-one-sacred-rule.*
- *Smil, Vaclav. "Your Phone Costs Energy—Even Before You Turn It On." IEEE Spectrum: Technology, Engineering, and Science News, April 26, 2016. https://spectrum.ieee.org/energy/environment/your-phone-costs-energyeven-before-you-turn-it-on.*
- *Madrigal, Alexis C. 2014. "The Energy in Things." The Atlantic, October 17, 2014. https://www.theatlantic.com/technology/archive/2014/10/the-energy-in-things/381557/.*
- *Benyus, Janine. Biomimicry in Action. Accessed January 28, 2018. https://www.ted.com/talks/janine_benyus_biomimicry_in_action.*
- *Haneef, Muhammad, Luca Ceseracciu, Claudio Canale, Ilker S. Bayer, José A. Heredia-Guerrero, and Athanassia Athanassiou. "Advanced Materials From Fungal Mycelium: Fabrication and Tuning of Physical Properties." Scientific Reports 7 (January 24, 2017): 41292.*
- *https://www.ecovativedesign.com*
- *"MycoWorks: Redefining Leather." http://www.mycoworks.com/.*
- *Bierend, Doug. "How Mushrooms Could Hold the Key to Our Long-Term Survival as a Species," March 30, 2015. https://motherboard.vice.com/en_us/article/wnjyxb/how-mushrooms-could-hold-the-key-to-our-long-term-survival.*
- *https://www.engineering.com/IOT/ArticleID/11863/Better-Batteries-Might-Be-Made-of-Mushrooms.aspx*
- *Mulvaney, Dustin. "Solar Energy Isn't Always as Green as You Think." IEEE Spectrum: Technology, Engineering, and Science News, November 13, 2014. https://spectrum.ieee.org/green-tech/solar/solar-energy-isnt-always-as-green-as-you-think.*
- *"This Is Where Your Smartphone Battery Begins." Washington Post. Accessed Februray 9, 2018. https://www.washingtonpost.com/graphics/business/batteries/congo-cobalt-mining-for-lithium-ion-battery/.*
- *Schwartz, John. "Paris Climate Deal Is Too Weak to Meet Goals, Report Finds." The New York Times, January 20, 2018, sec. Science. https://www.nytimes.com/2016/11/17/science/paris-accord-global-warming-iea.html.*
- *Resnick, Brian. "We're Witnessing the Fastest Decline in Arctic Sea Ice in at Least 1,500 Years." Vox, December 12, 2017. https://www.vox.com/energy-and-environment/2017/12/12/16767152/arctic-sea-ice-extent-chart.*
- *Dunne, Anthony, and Fiona Raby. Speculative Everything: Design, Fiction, and Social Dreaming. MIT press, 2013.*
- *Robertson, Adi. "Building the Afro-Feminist Future at Sundance, One Cyberpunk Beauty Salon at a Time." The Verge, January 26, 2017. https://www.theverge.com/2017/1/26/14377214/neurospeculative-afrofeminism-vr-science-fiction-sundance-interview-2017.*
- *Candy, Stuart. 2013. "Time Machine / Reverse Archaeology." In , 28–30.*
- *Raven, Paul Graham, and Shirin Elahi. 2015. "The New Narrative: Applying Narratology to the Shaping of Futures Outputs."*

Futures 74 (November): 49–61. https://doi.org/10.1016/j.futures.2015.09.003.

- *Shedroff, Nathan, and Christopher Noessel. 2012. Make It so: Interaction Design Lessons from Science Fiction. Brooklyn, N.Y., USA: Rosenfeld Media.*
- *Curry, Andrew, and Anthony Hodgson. 2008. "Seeing in Multiple Horizons: Connecting Futures to Strategy." Journal of Futures Studies 13 (1): 1–20.*
- *"Three Horizon Mapping Guide - H3Uni Resource Library." n.d. Accessed January 15, 2018. http://www.h3uni.org/resource_library/index.php?title=Three_Horizon_Mapping_Guide.*
- *"Projects." n.d. Strange Telemetry. Accessed January 19, 2018. http://www.strangetelemetry.com/projects/.*
- *Duncan, David Ewing. n.d. "Eating Radiation: A New Form of Energy?" MIT Technology Review. Accessed February 25, 2018. https://www.technologyreview.com/s/407974/eating-radiation-a-new-form-of-energy/.*
- *Caruso, Mario, Emanuela Gatto, Antonio Palleschi, Piero Morales, Manuela Scarselli, Simone Casaluci, Alessia Quatela, Aldo Di Carlo, and Mariano Venanzi. 2017. "A Bioinspired Dye Sensitized Solar Cell Based on a Rhodamine-Functionalized Peptide Immobilized on Nanocrystalline TiO2." Journal of Photochemistry and Photobiology A: Chemistry 347 (Supplement C): 227–34. https://doi.org/10.1016/j.jphotochem.2017.07.027.*
- *Temple, James. n.d. "This Device Could Be a Big Boost for Making Solar Power Much Cheaper." MIT Technology Review. Accessed January 30, 2018. https://www.technologyreview.com/s/603497/10-breakthrough-technologies-2017-hot-solar-cells/.*
- *Stegmaier, Thomas, Michael Linke, and Heinrich Planck. 2009. "Bionics in Textiles: Flexible and Translucent Thermal Insulations for Solar Thermal Applications." Philosophical Transactions of the Royal Society of London A: Mathematical, Physical and Engineering Sciences 367 (1894): 1749–58. https://doi.org/10.1098/rsta.2009.0019.*
- *"Organisms Capture Radiation :" n.d. AskNature (blog). Accessed March 5, 2018. https://asknature.org/strategy/organisms-capture-radiation/.*
- *"Electrons Flowing like Liquid in Graphene Start a New Wave of Physics." n.d. Accessed March 11, 2018. https://phys.org/news/2017-08-electrons-liquid-graphene-physics.html.*
- *Johnson, Dexter. 2015. "Graphene Overcomes Achilles' Heel of Artificial Muscles." IEEE Spectrum: Technology, Engineering, and Science News. May 22, 2015. https://spectrum.ieee.org/nanoclast/semiconductors/materials/graphene-overcomes-achilles-heel-of-artificial-muscles.*
- *Bourzac, Katherine. n.d. "Wrapping Solar Cells around an Optical Fiber." MIT Technology Review. Accessed March 14, 2018. https://www.technologyreview.com/s/416052/wrapping-solar-cells-around-an-optical-fiber/.*
- *"Proof: Graphene Can Convert Sunlight to Electricity." n.d. Sciencenordic.Com. Accessed March 6, 2018. http://sciencenordic.com/proof-graphene-can-convert-sunlight-electricity.*
- *"Light-Transmitting Fibers : Venus's Flower Basket." n.d. AskNature (blog). Accessed March 5, 2018. https://asknature.org/strategy/light-transmitting-fibers/.*
- *"Printable Solar Cells Just Got a Little Closer: Research Removes a Key Barrier to Large-Scale Manufacture of Low-Cost, Printable Perovskite Solar Cells." n.d. ScienceDaily. Accessed January 2, 2018. https://www.sciencedaily.com/releases/2017/02/170216142800.htm.*
- *Yang, Jie, Guo-Qiang Qi, Yang Liu, Rui-Ying Bao, Zheng-Ying Liu, Wei Yang, Bang-hu Xie, and Ming-Bo Yang. 2016. "Hybrid Graphene Aerogels/Phase Change Material Composites: Thermal Conductivity, Shape-Stabilization and Light-to-Thermal Energy Storage." Carbon 100 (April): 693–702. https://doi.org/10.1016/j.carbon.2016.01.063.*

Appendix

Appendix 1


Mapping Global Transformations
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Circular Economy
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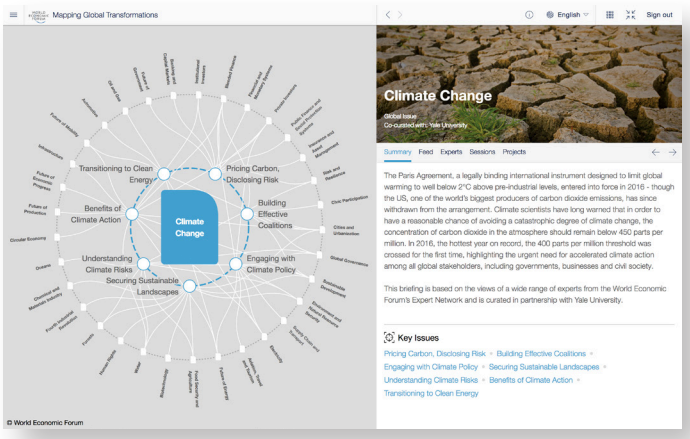
Co-curated with: Ellen MacArthur Foundation
Summary Feed Experts Sessions Projects
The shift from a "take, make and dispose" economic model towards more "circular" approaches, which promote continuous and regenerative flows of materials for use in manufacturing and consumption, is gaining ground. Importantly, scaling up the circular economy offers opportunity for economic growth, job creation and innovation. Accenture's 2015 book Waste to Wealth indicated that as much as $4.5 trillion of economic value could be gained by 2030 from "going circular" at scale, encouraging corporate leaders to rethink their business models in ways that design out waste.
This briefing is based on the views of a wide range of experts from the World Economic Forum's Expert Network and is curated in partnership with the Ellen MacArthur Foundation.
Key Issues
Production Risks • New Business Models • Urbanization • Role of Regulation • Connectivity
Circular Economy
Connectivity
Production Risks
Role of Regulation
New Business Models
Urbanization
World Economic Forum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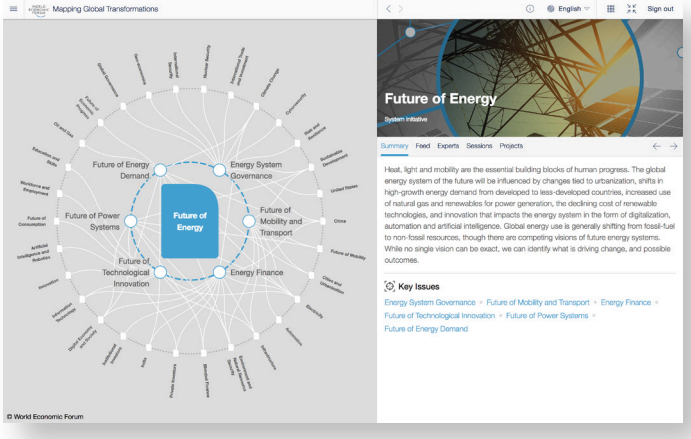
Climate Change
Global issue
Co-curated with: Yale University
Summary Feed Experts Sessions Projects
The Paris Agreement, a legally binding international instrument designed to limit global warming to well below 2°C above pre-industrial levels, entered into force in 2016 - though the US, one of the world's biggest producers of carbon dioxide emissions, has since withdrawn from the arrangement. Climate scientists have long warned that in order to have a reasonable chance of avoiding a catastrophic degree of climate change, the concentration of carbon dioxide in the atmosphere should remain below 450 parts per million. In 2016, the hottest year on record, the 400 parts per million threshold was crossed for the first time, highlighting the urgent need for accelerated climate action among all global stakeholders, including governments, businesses and civil society.
This briefing is based on the views of a wide range of experts from the World Economic Forum's Expert Network and is curated in partnership with Yale University.
Key Issues
Pricing Carbon, Disclosing Risk • Building Effective Coalitions • Engaging with Climate Policy • Securing Sustainable Landscapes • Understanding Climate Risks • Benefits of Climate Action • Transitioning to Clean Energy
Climate Change
Transitioning to Clean Energy
Pricing Carbon, Disclosing Risk
Benefits of Climate Action
Building Effective Coalitions
Understanding Climate Risks
Engaging with Climate Policy
Securing Sustainable Landscapes
World Economic Forum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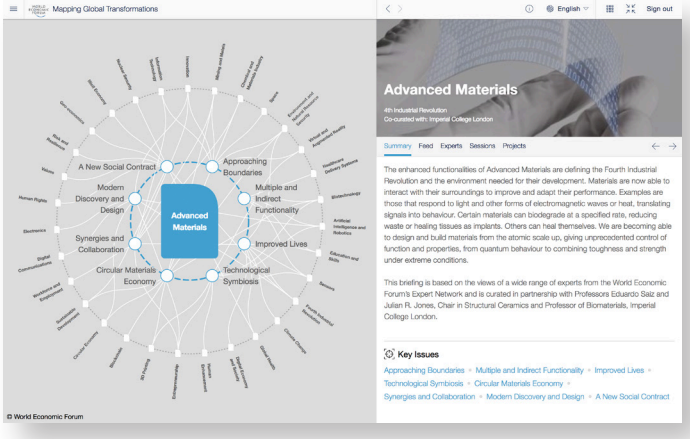
Future of Energy
System Initiative
Summary Feed Experts Sessions Projects
Heat, light and mobility are the essential building blocks of human progress. The global energy system of the future will be influenced by changes tied to urbanization, shifts in high-growth energy demand from developed to less-developed countries, increased use of natural gas and renewables for power generation, the declining cost of renewable technologies, and innovation that impacts the energy system in the form of digitalization, automation and artificial intelligence. Global energy use is generally shifting from fossil-fuel to non-fossil resources, though there are competing visions of future energy systems. While no single vision can be exact, we can identify what is driving change, and possible outcomes.
Key Issues
Energy System Governance • Future of Mobility and Transport • Energy Finance • Future of Technological Innovation • Future of Power Systems • Future of Energy Demand
Future of Energy
Future of Energy Demand
Energy System Governance
Future of Power Systems
Future of Mobility and Transport
Future of Technological Innovation
Energy Finance
World Economic Forum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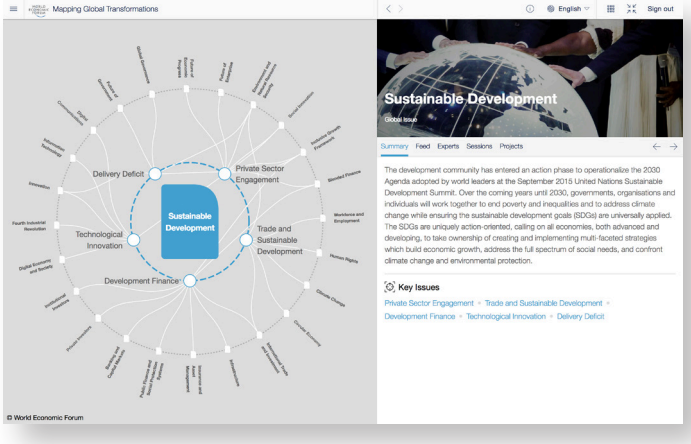
Advanced Materials
4th Industrial Revolution
Co-curated with: Imperial College London
Summary Feed Experts Sessions Projects
The enhanced functionalities of Advanced Materials are defining the Fourth Industrial Revolution and the environment needed for their development. Materials are now able to interact with their surroundings to improve and adapt their performance. Examples are those that respond to light and other forms of electromagnetic waves or heat, translating signals into behaviour. Certain materials can biodegrade at a specified rate, reducing waste or healing tissues as implants. Others can heal themselves. We are becoming able to design and build materials from the atomic scale up, giving unprecedented control of function and properties, from quantum behaviour to combining toughness and strength under extreme conditions.
This briefing is based on the views of a wide range of experts from the World Economic Forum's Expert Network and is curated in partnership with Professors Eduardo Saiz and Julian R. Jones, Chair in Structural Ceramics and Professor of Biomaterials, Imperial College London.
Key Issues
Approaching Boundaries • Multiple and Indirect Functionality • Improved Lives • Technological Symbiosis • Circular Materials Economy • Synergies and Collaboration • Modern Discovery and Design • A New Social Contract
Advanced Materials
A New Social Contract
Approaching Boundaries
Modern Discovery and Design
Multiple and Indirect Functionality
Synergies and Collaboration
Improved Lives
Circular Materials Economy
Technological Symbiosis
World Economic Forum


Mapping Global Transformations
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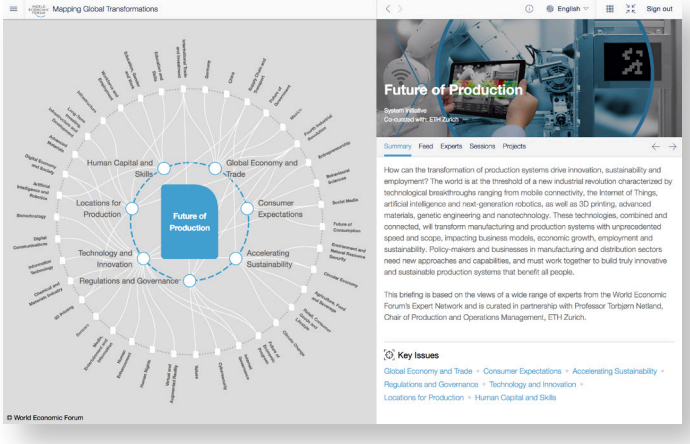
Sustainable Development
Global issue
Summary Feed Experts Sessions Projects
The development community has entered an action phase to operationalize the 2030 Agenda adopted by world leaders at the September 2015 United Nations Sustainable Development Summit. Over the coming years until 2030, governments, organisations and individuals will work together to end poverty and inequalities and to address climate change while ensuring the sustainable development goals (SDGs) are universally applied. The SDGs are uniquely action-oriented, calling on all economies, both advanced and developing, to take ownership of creating and implementing multi-faceted strategies which build economic growth, address the full spectrum of social needs, and confront climate change and environmental protection.
Key Issues
Private Sector Engagement • Trade and Sustainable Development • Development Finance • Technological Innovation • Delivery Deficit
Sustainable Development
Delivery Deficit
Private Sector Engagement
Technological Innovation
Trade and Sustainable Development
Development Finance
World Economic Forum


Mapping Global Transformations
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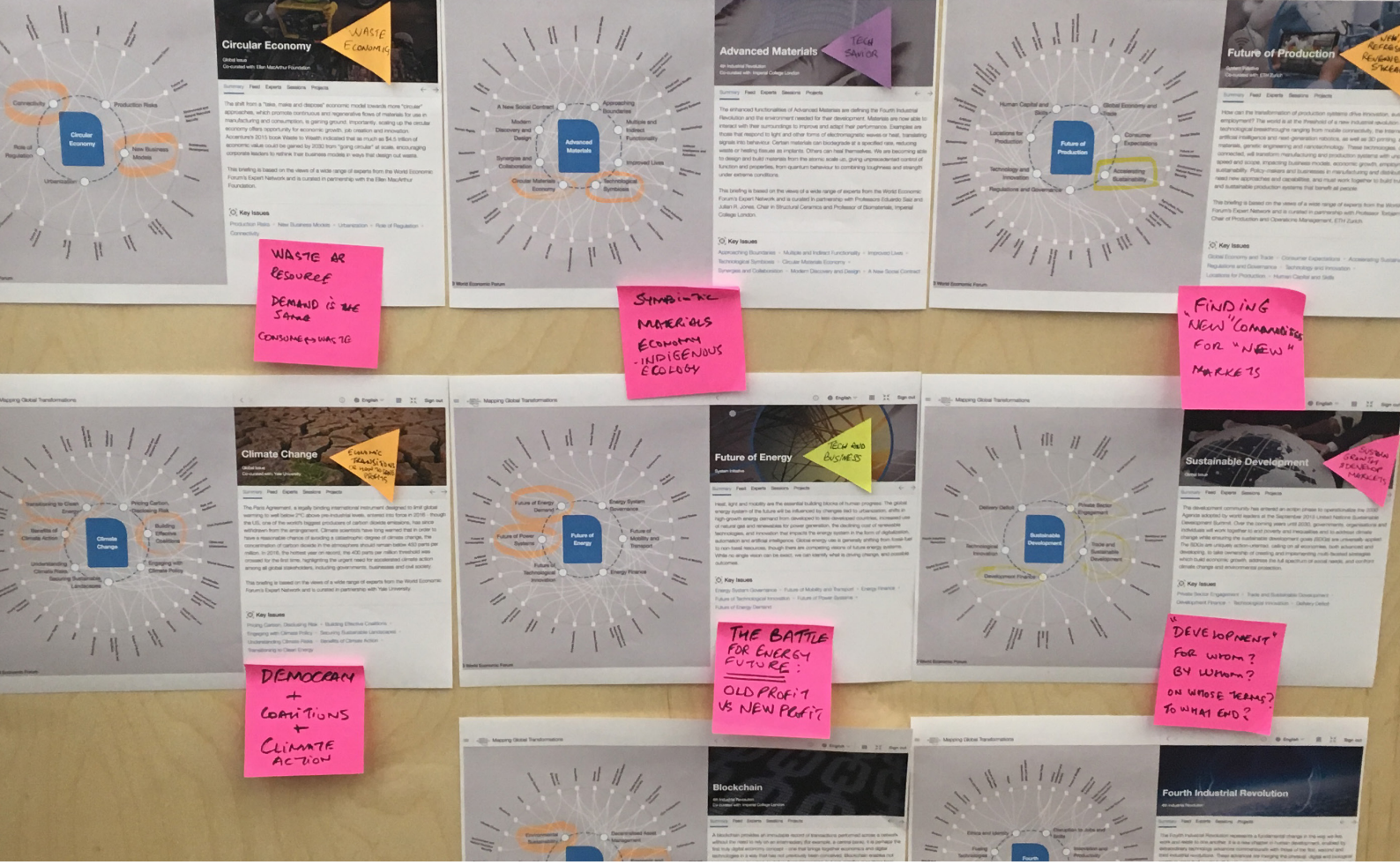
Future of Production
System Initiative
Co-curated with: ETH Zurich
Summary Feed Experts Sessions Projects
How can the transformation of production systems drive innovation, sustainability and employment? The world is at the threshold of a new industrial revolution characterized by technological breakthroughs ranging from mobile connectivity, the Internet of Things, artificial intelligence and next-generation robotics, as well as 3D printing, advanced materials, genetic engineering and nanotechnology. These technologies, combined and connected, will transform manufacturing and production systems with unprecedented speed and scope, impacting business models, economic growth, employment and sustainability. Policy-makers and businesses in manufacturing and distribution sectors need new approaches and capabilities, and must work together to build truly innovative and sustainable production systems that benefit all people.
This briefing is based on the views of a wide range of experts from the World Economic Forum's Expert Network and is curated in partnership with Professor Torbjørn Netland, Chair of Production and Operations Management, ETH Zurich.
Key Issues
Global Economy and Trade • Consumer Expectations • Accelerating Sustainability • Regulations and Governance • Technology and Innovation • Locations for Production • Human Capital and Skills
Future of Production
Human Capital and Skills
Global Economy and Trade
Locations for Production
Consumer Expectations
Technology and Innovation
Accelerating Sustainability
Regulations and Governance
World Economic Forum


Circular Economy
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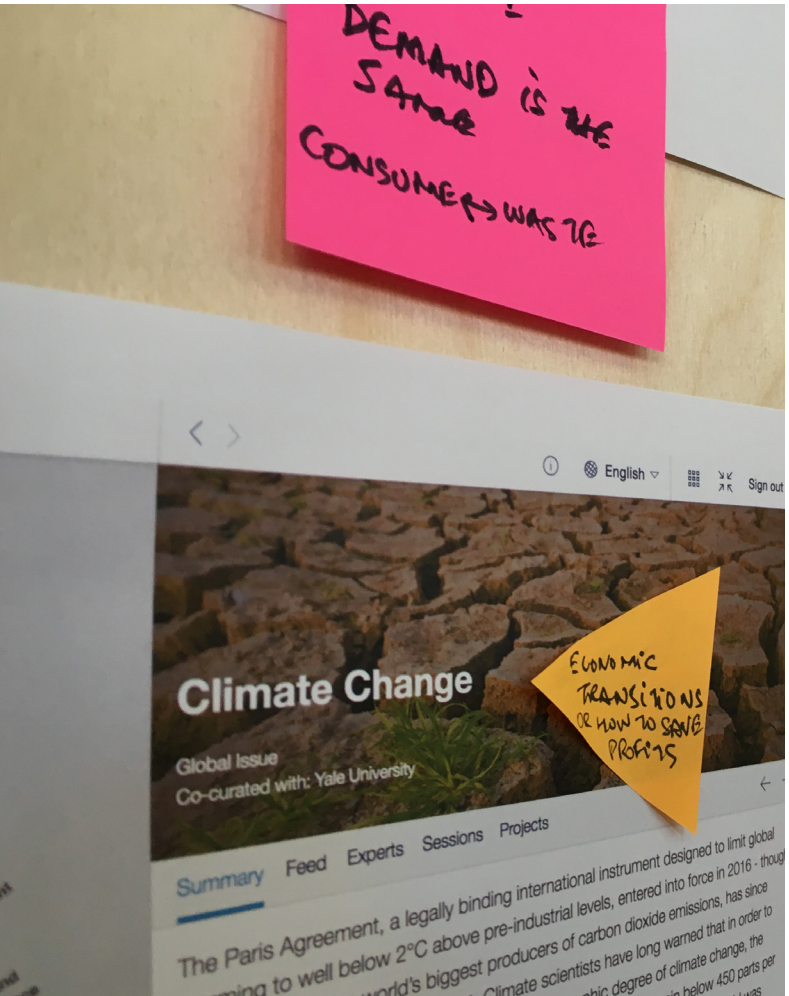
DEMAND IS THE SAME
CONSUMER→WASTE
Advanced Materials
TECH SAVIOR
SYMBIOTIC MATERIALS ECONOMY - INDIGENOUS ECOLOGY
Future of Production
FINDING NEW "COMMODITIES" FOR "NEW" MARKETS
Climate Change
ECONOMIC TRANSITIONS OR HOW TO SAVE PROFITS
DEMOCRACY + COALITIONS + CLIMATE ACTION
Future of Energy
TECH AND BUSINESS
THE BATTLE FOR ENERGY FUTURE: OLD PROFIT VS NEW PROFIT
Sustainable Development
DEVELOPMENT FOR WHOM? BY WHOM? ON WHOSE TERMS? TO WHAT END?
Blockchain
Fourth Industrial Revolution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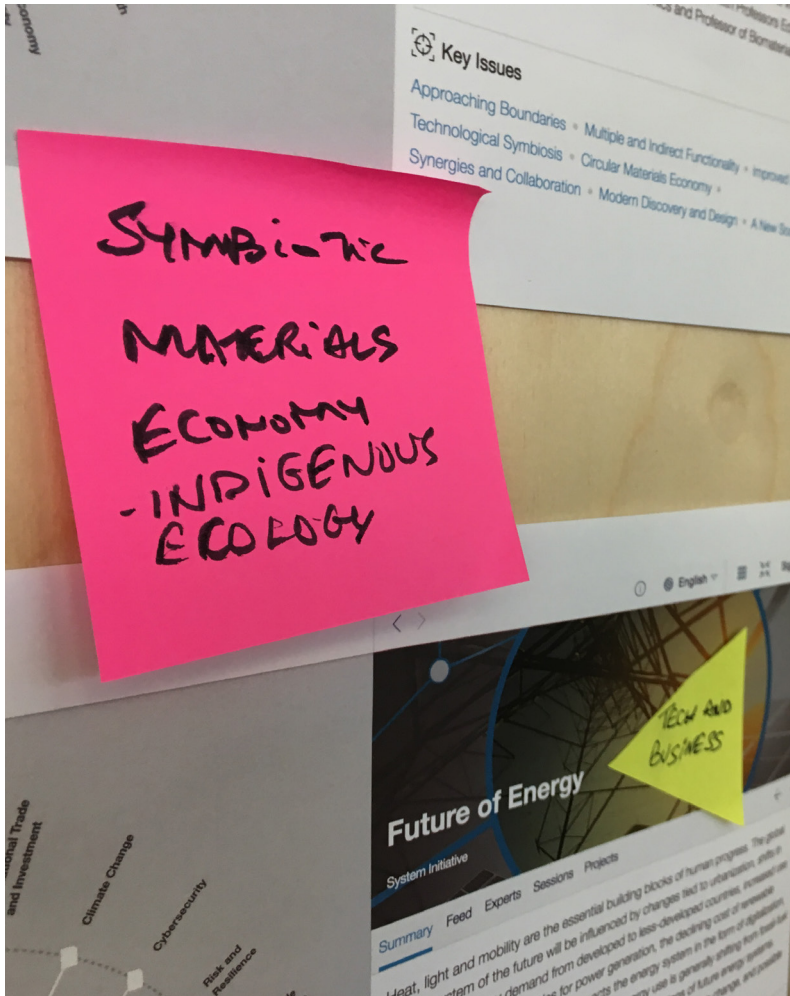
Climate Change
Global Issue
Co-curated with: Yale University
ECONOMIC TRANSITIONS OR HOW TO SAVE PROFITS
Summary
Feed
Experts
Sessions
Projects
The Paris Agreement, a legally binding international instrument designed to limit global


Key Issues
Approaching Boundaries
Multiple and Indirect Functionality
Technological Symbiosis
Circular Materials Economy
Synergies and Collaboration
Modern Discovery and Design
SYMBIOTIC MATERIALS ECONOMY - INDIGENOUS ECOLOGY
Future of Energy
System Initiative
TECH AND BUSINESS
Summary
Feed
Experts
Sessions
Projects

Appendix 2

Audio Interview with Hanne Cecilie Geirbo:

https://ahocloud.box.com/s/39pl2gxdc5k9iilcq9i2cjxuapy583pn

Audio Interview with Karen O'Brien:

https://ahocloud.box.com/s/ef0pb44y340srbzvg5m172vtrcrpjam6

Appendix 3

Future Drivers Chart:

For a more clear look at the chart please refer to the digital file:
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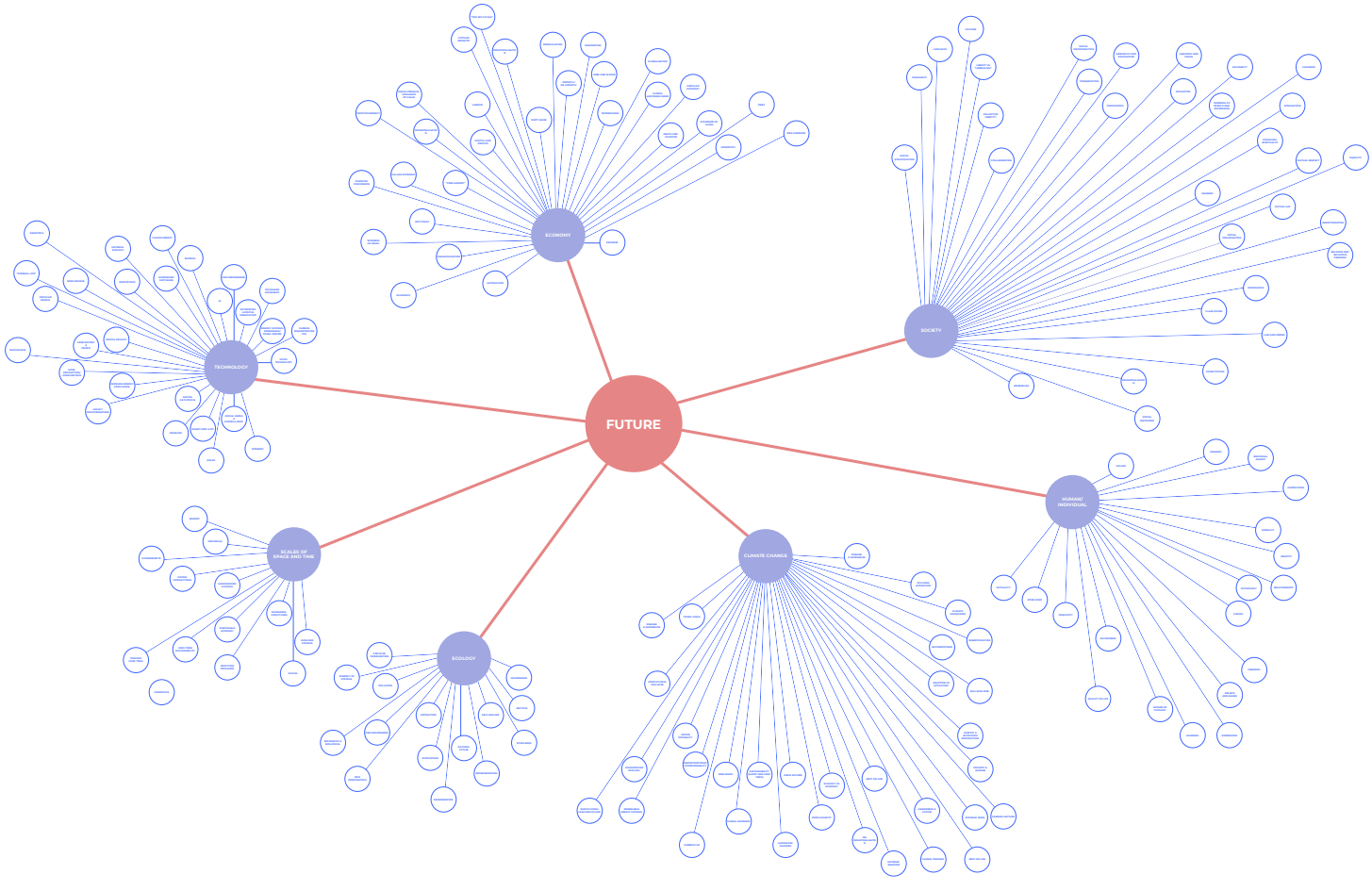

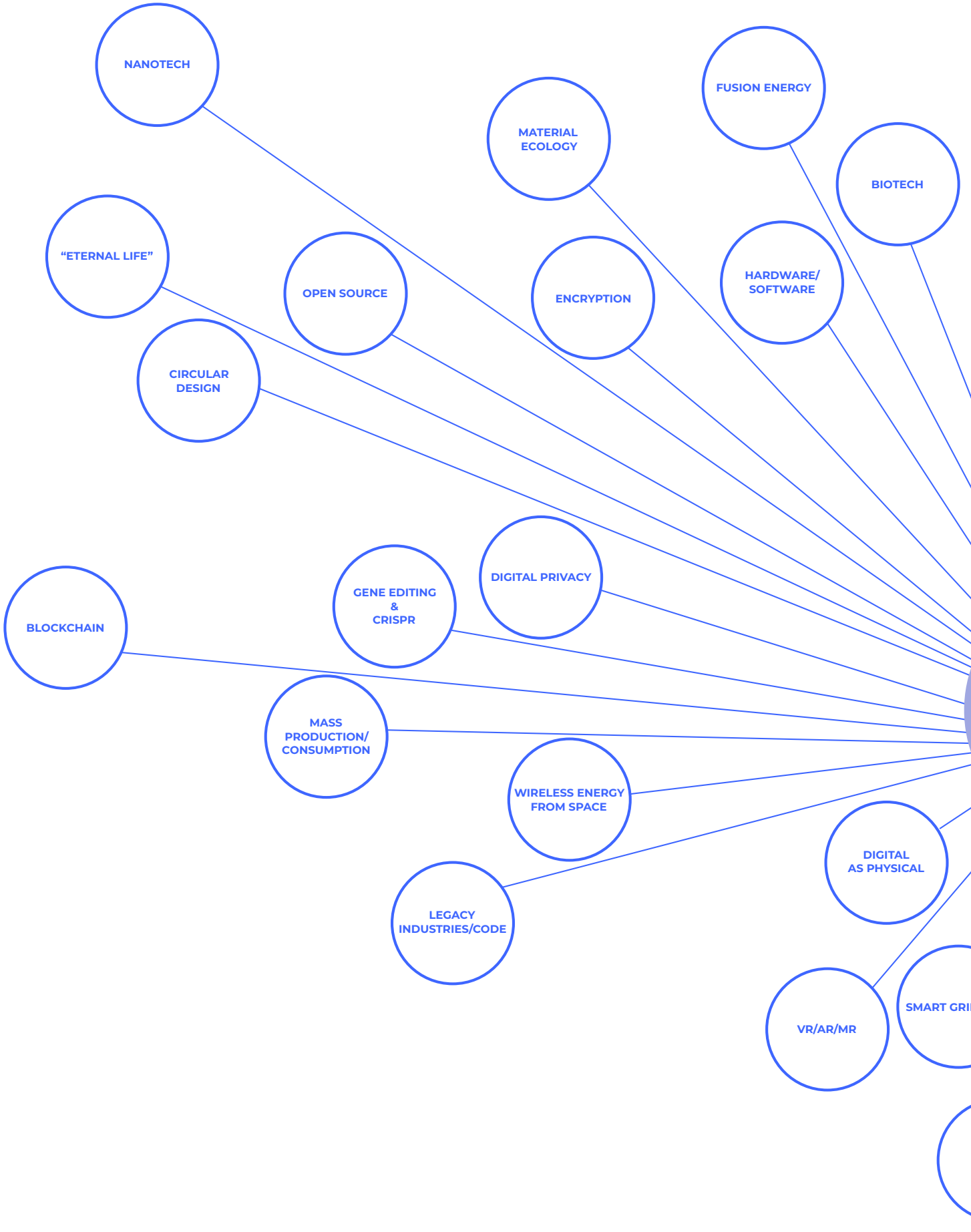
NANOTECH
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BIOTECH
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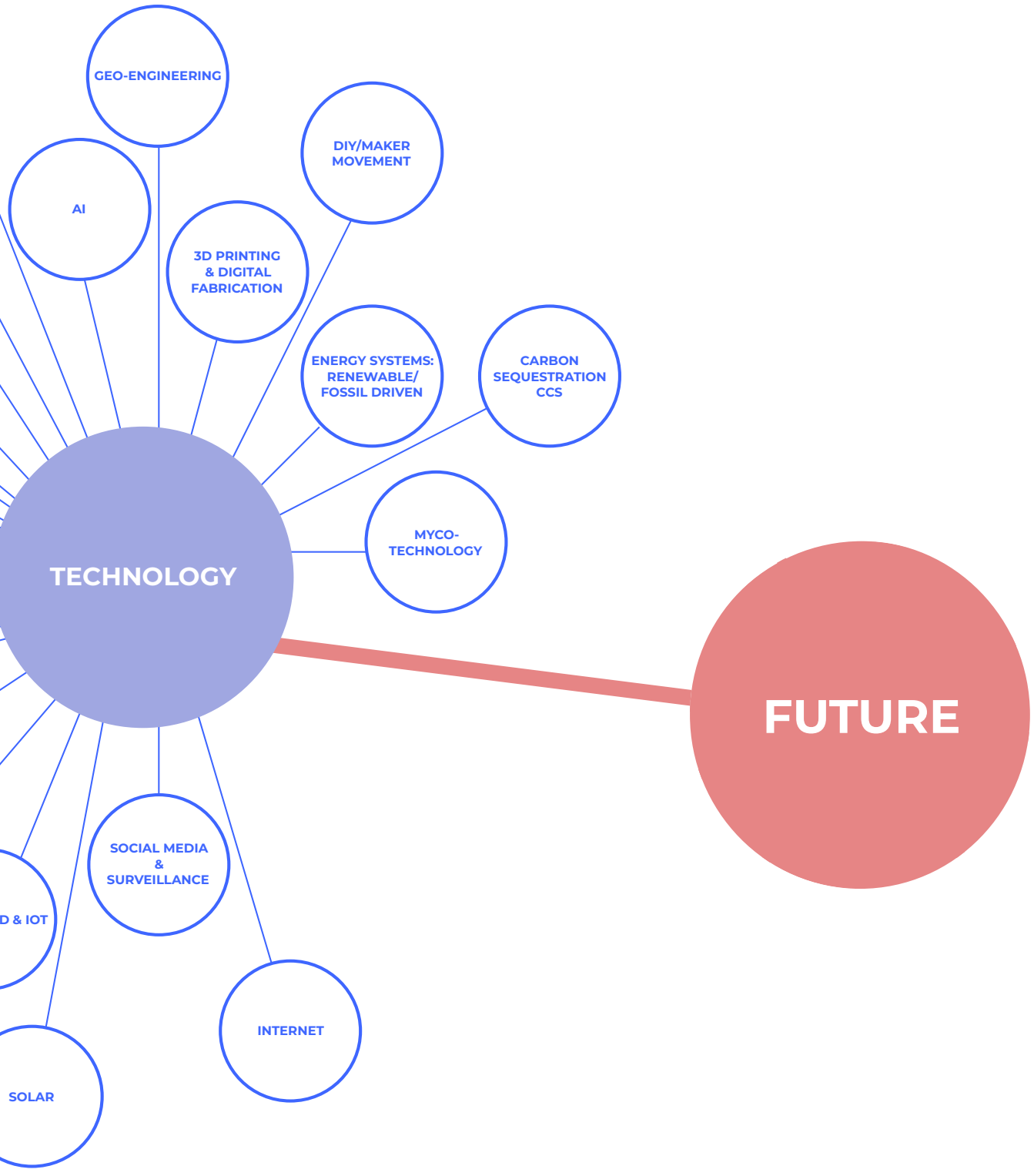
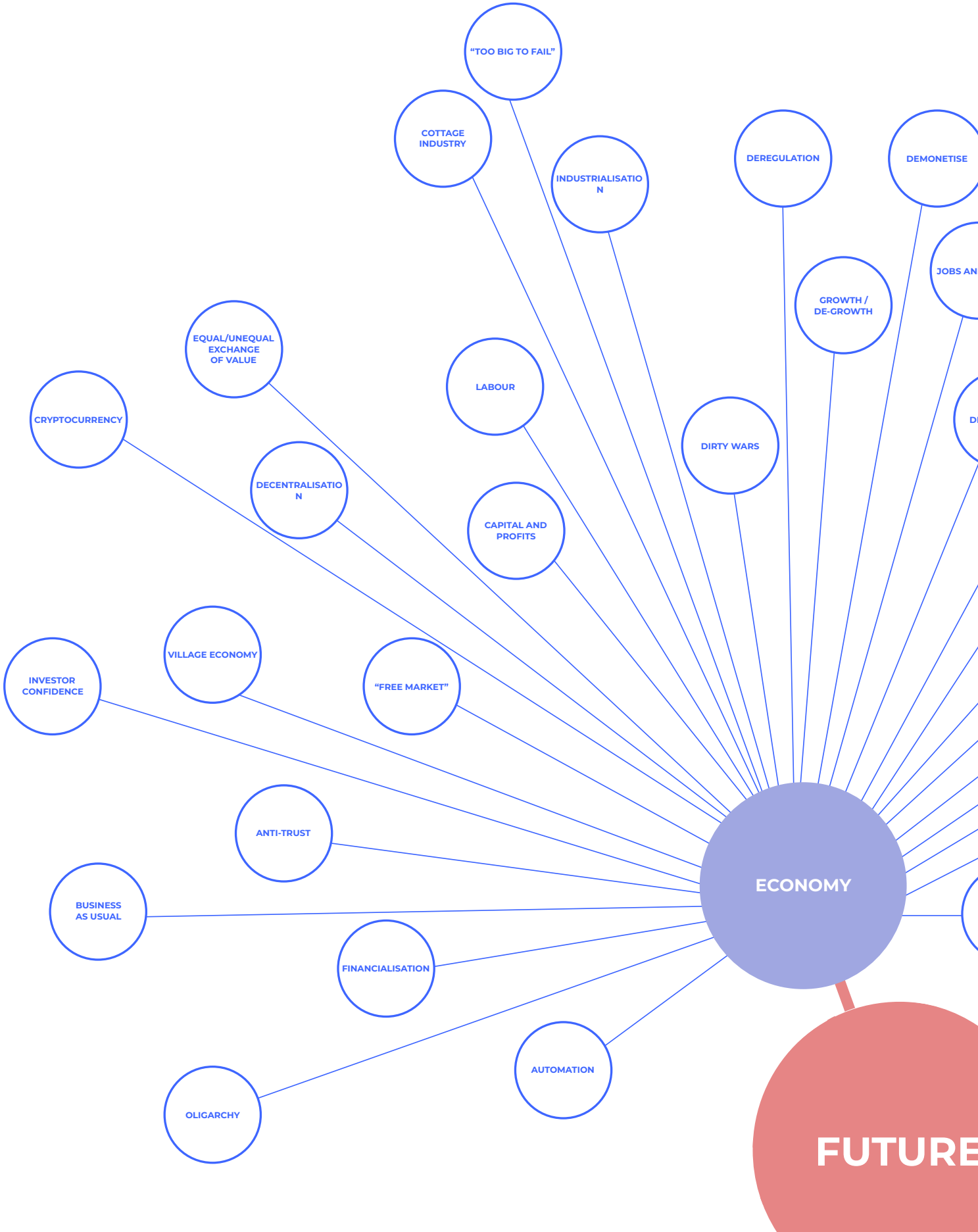
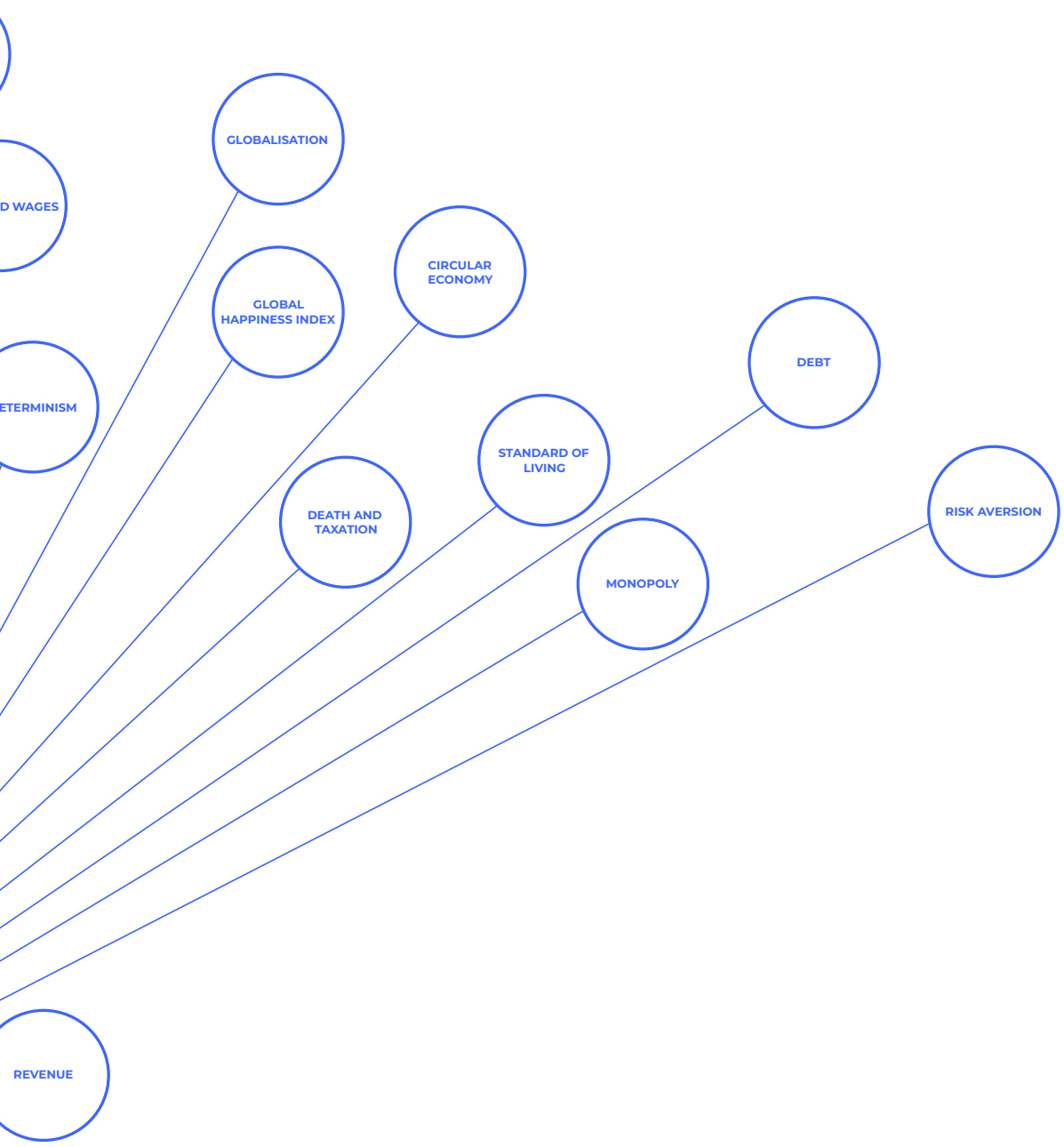
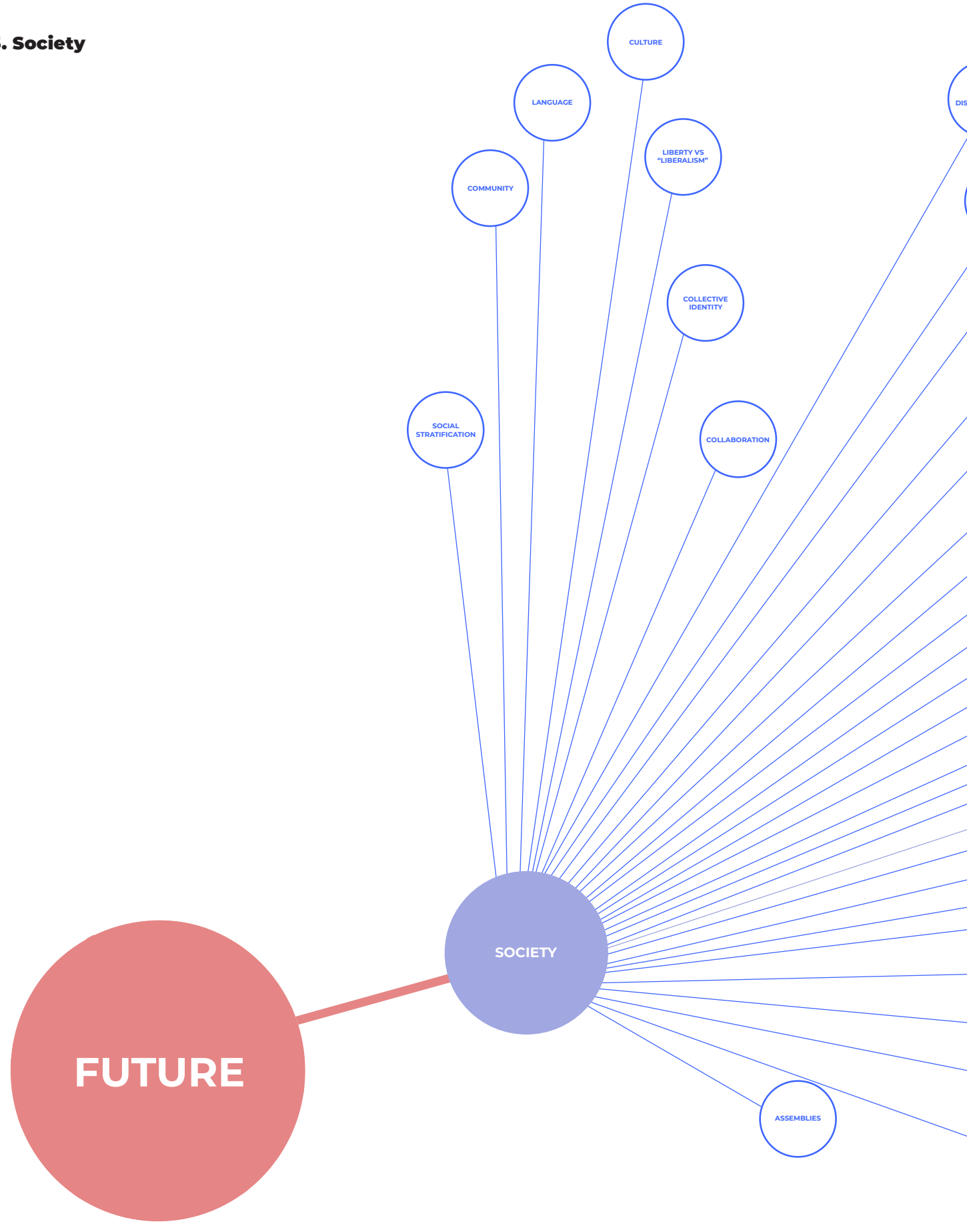
OPEN SOURCE
ENCRYPTION
HARDWARE/ SOFTWARE
CIRCULAR DESIGN
BLOCKCHAIN
GENE EDITING & CRISPR
DIGITAL PRIVACY
MASS PRODUCTION/ CONSUMPTION
WIRELESS ENERGY FROM SPACE
DIGITAL AS PHYSICAL
LEGACY INDUSTRIES/CODE
VR/AR/MR
SMART GRI

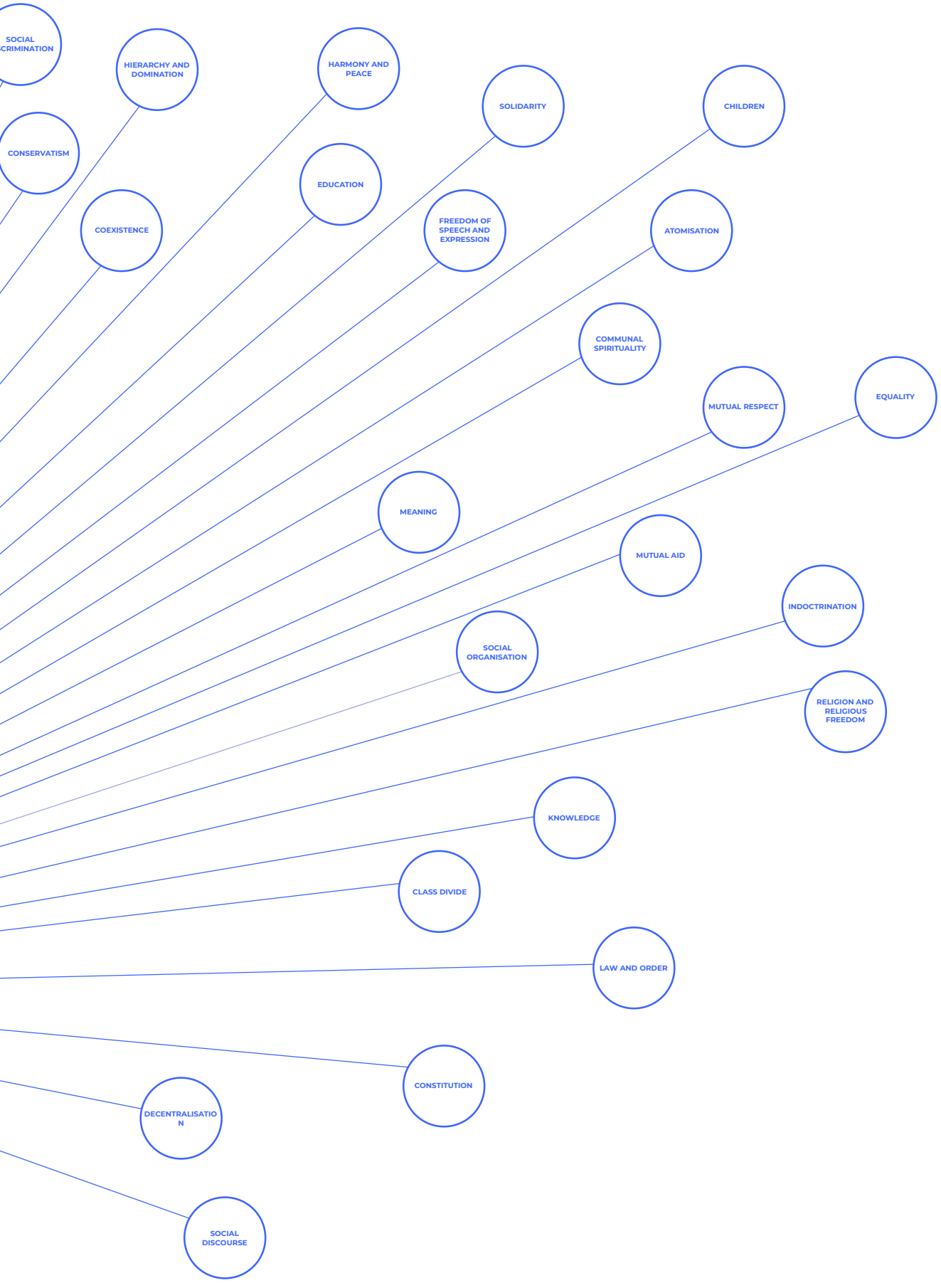

GEO-ENGINEERING
AI
DIY/MAKER MOVEMENT
3D PRINTING & DIGITAL FABRICATION
ENERGY SYSTEMS: RENEWABLE/ FOSSIL DRIVEN
CARBON SEQUESTRATION CCS
MYCO-TECHNOLOGY
TECHNOLOGY
FUTURE
SOCIAL MEDIA & SURVEILLANCE
D & IOT
INTERNET
SOLAR


"TOO BIG TO FAIL"
COTTAGE INDUSTRY
INDUSTRIALISATIO N
DEREGULATION
DEMONETISE
JOBS AN
GROWTH / DE-GROWTH
EQUAL/UNEQUAL EXCHANGE OF VALUE
LABOUR
CRYPTOCURRENCY
DIRTY WARS
DECENTRALISATIO N
CAPITAL AND PROFITS
VILLAGE ECONOMY
INVESTOR CONFIDENCE
"FREE MARKET"
ANTI-TRUST
BUSINESS AS USUAL
ECONOMY
FINANCIALISATION
AUTOMATION
OLIGARCHY
FUTURE

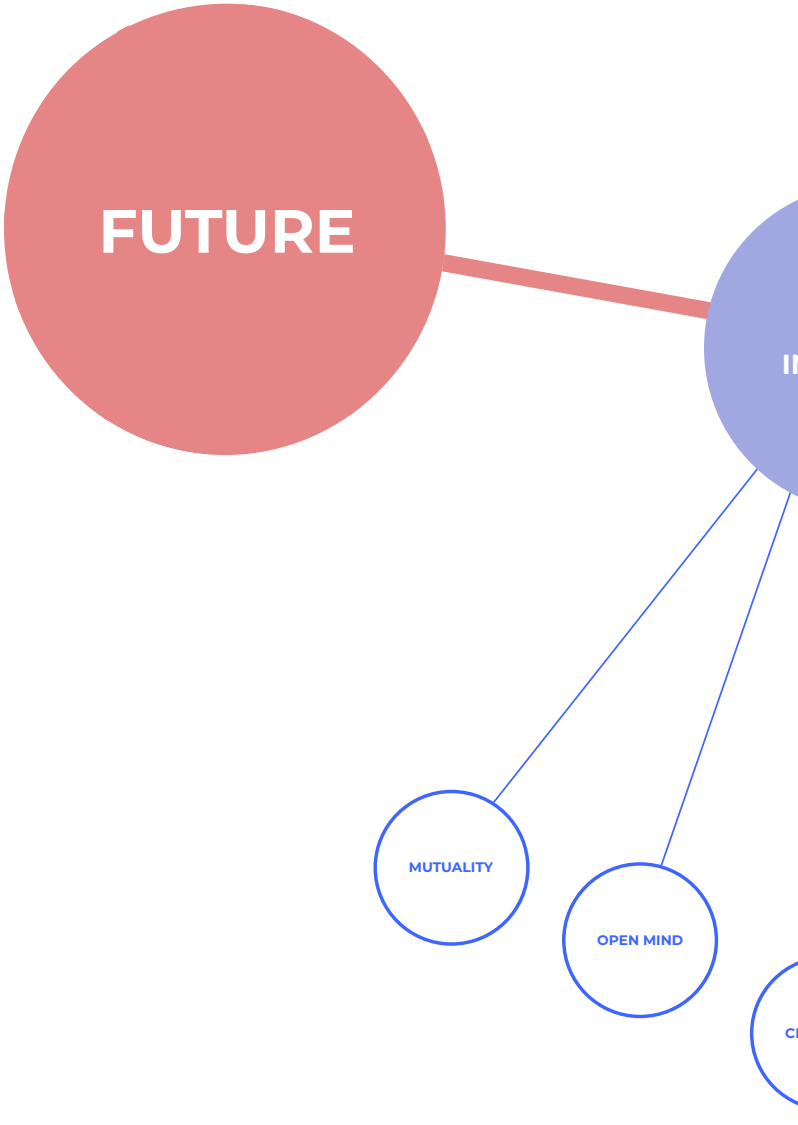

D WAGES
GLOBALISATION
ETERMINISM
GLOBAL HAPPINESS INDEX
CIRCULAR ECONOMY
DEBT
STANDARD OF LIVING
DEATH AND TAXATION
RISK AVERSION
MONOPOLY
REVENUE

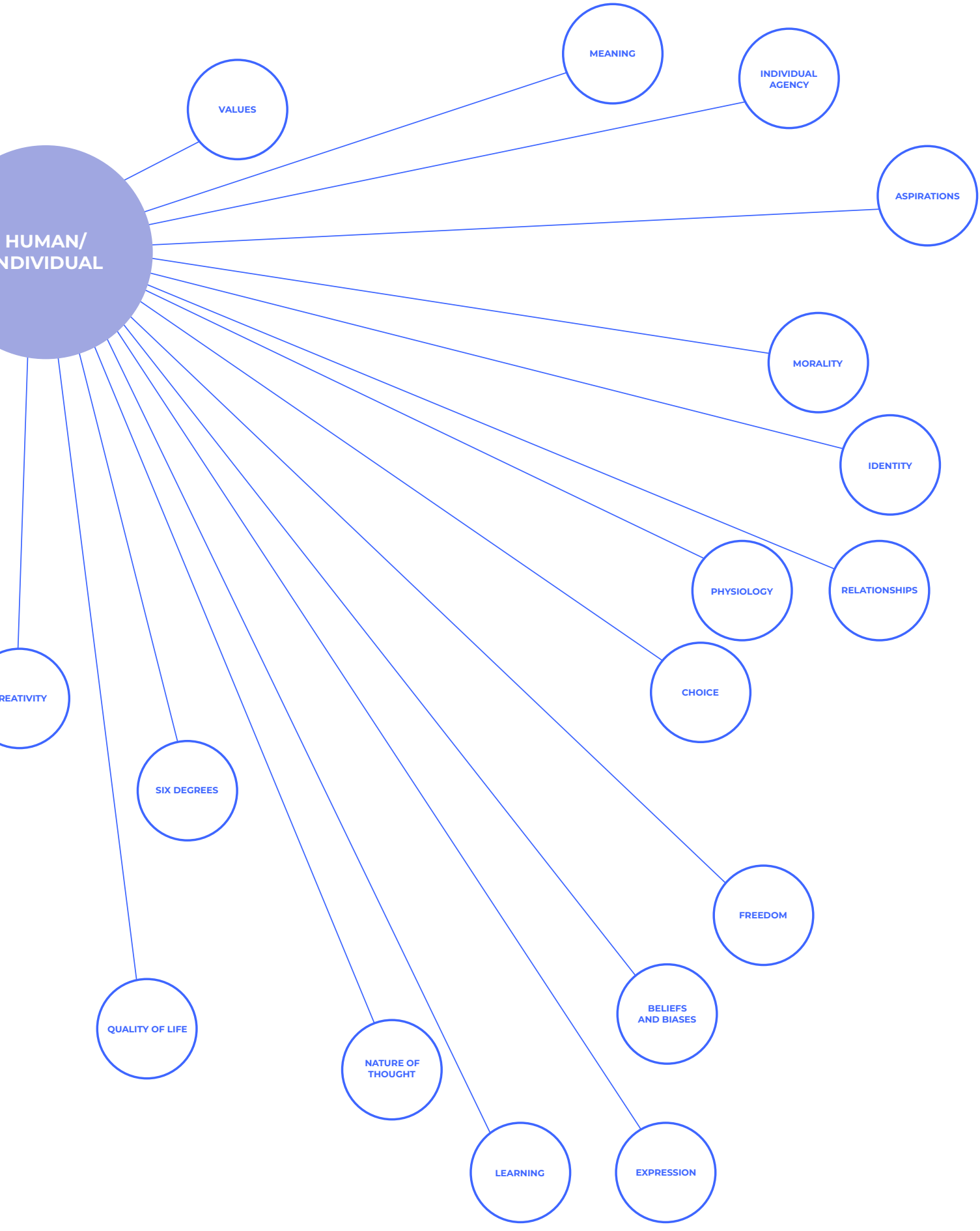
3. Society


CULTURE
LANGUAGE
LIBERTY VS "LIBERALISM"
COMMUNITY
COLLECTIVE IDENTITY
SOCIAL STRATIFICATION
COLLABORATION
SOCIETY
FUTURE
ASSEMBLIES

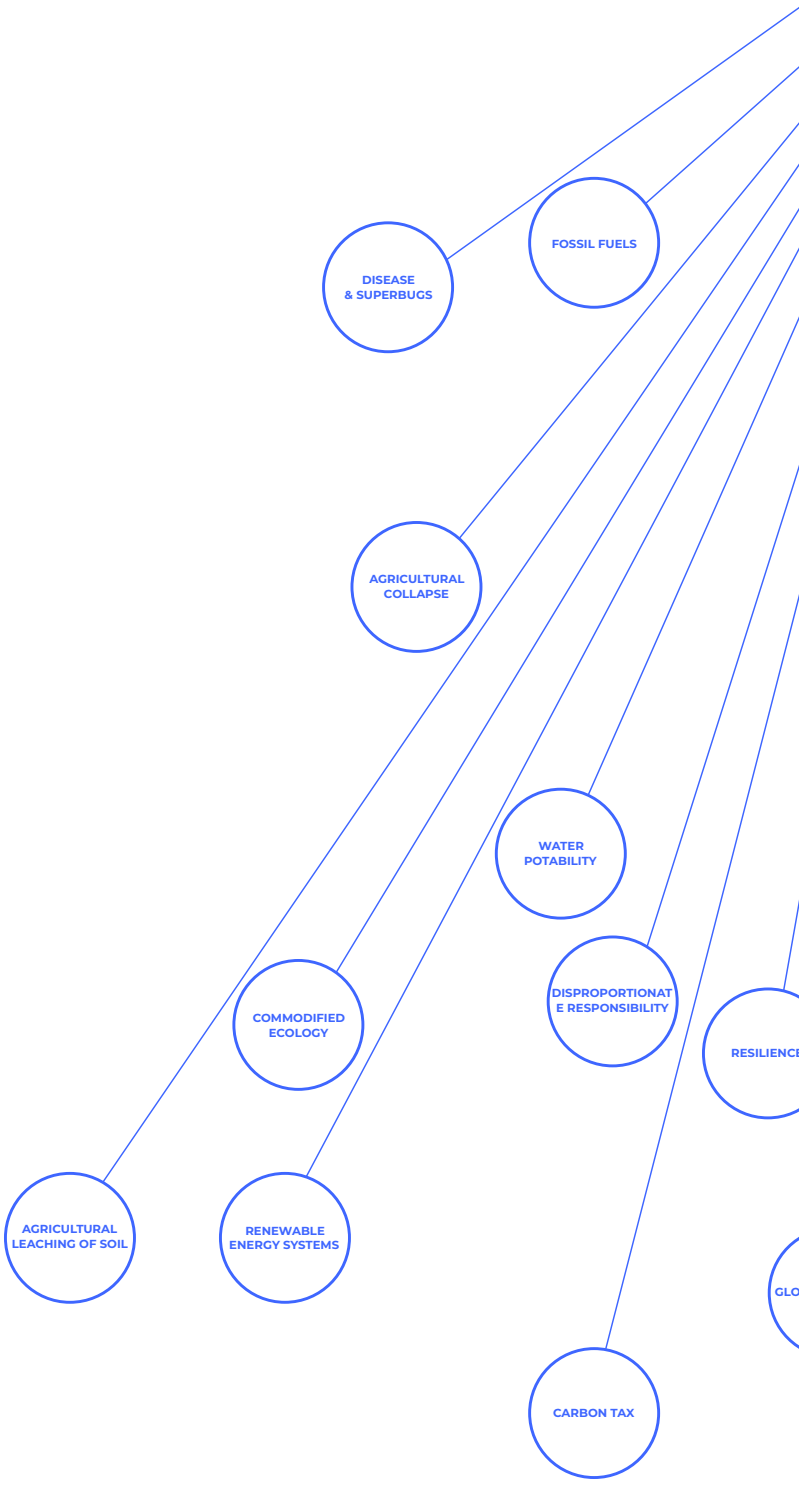

SOCIAL DISCRIMINATION
HIERARCHY AND DOMINATION
HARMONY AND PEACE
SOLIDARITY
CHILDREN
CONSERVATISM
EDUCATION
COEXISTENCE
FREEDOM OF SPEECH AND EXPRESSION
ATOMISATION
COMMUNAL SPIRITUALITY
MUTUAL RESPECT
EQUALITY
MEANING
MUTUAL AID
INDOCTRINATION
SOCIAL ORGANISATION
RELIGION AND RELIGIOUS FREEDOM
KNOWLEDGE
CLASS DIVIDE
LAW AND ORDER
CONSTITUTION
DECENTRALISATION
SOCIAL DISCOURSE

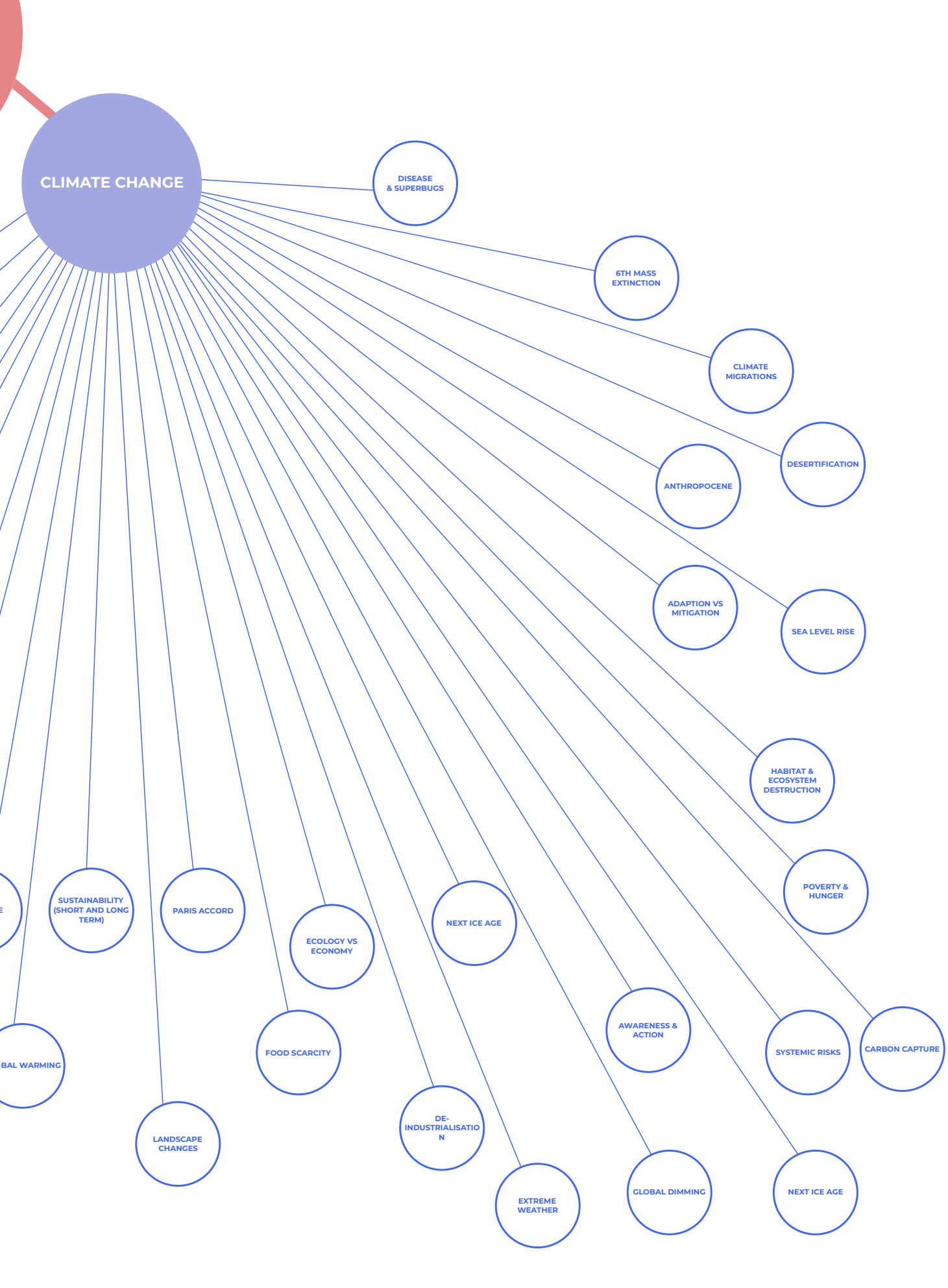
4. Human/Individual



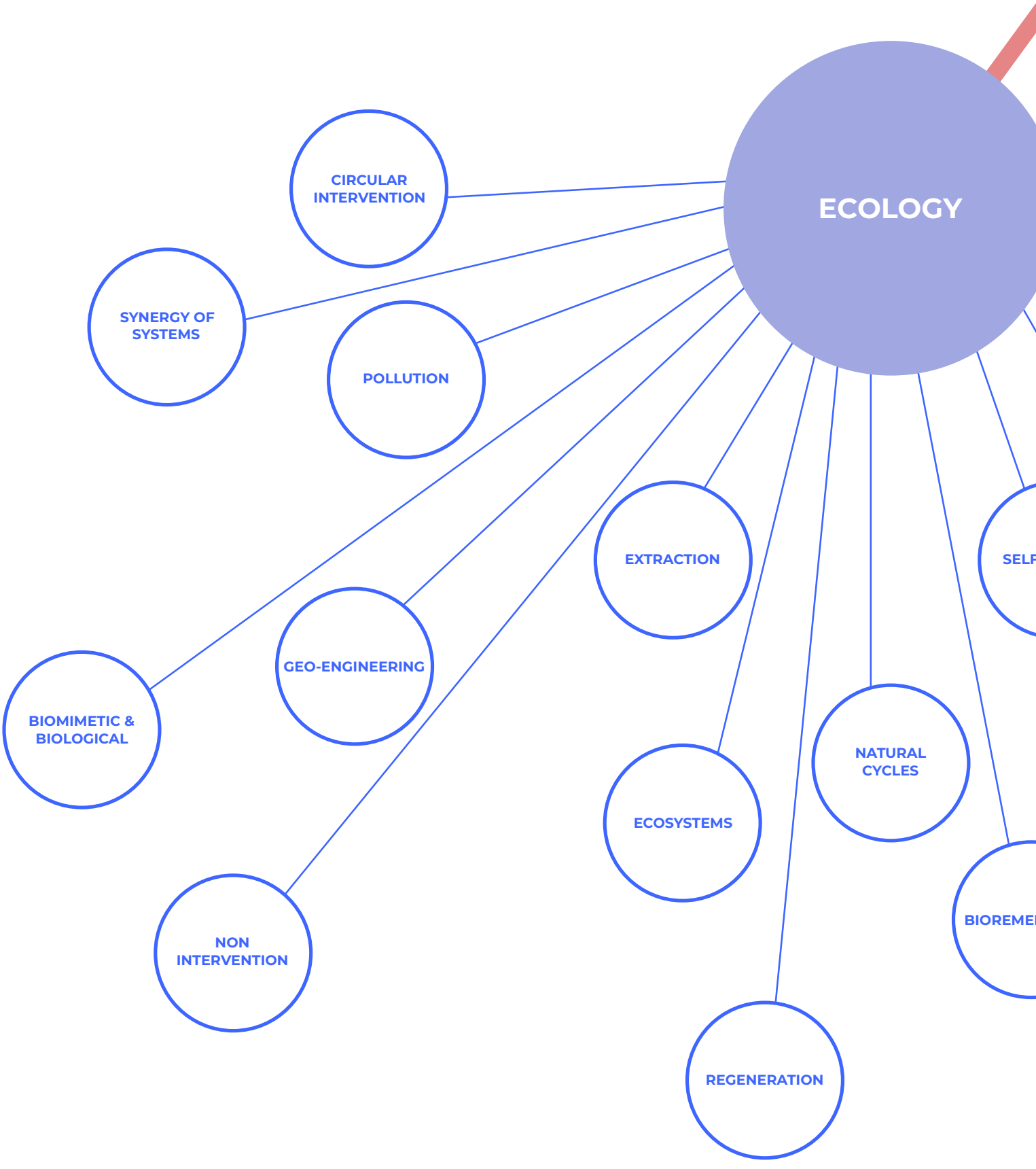

HUMAN/
NDIVIDUAL
VALUES
MEANING
INDIVIDUAL
AGENCY
ASPIRATIONS
MORALITY
IDENTITY
PHYSIOLOGY
RELATIONSHIPS
CHOICE
REATIVITY
SIX DEGREES
FREEDOM
QUALITY OF LIFE
BELIEFS
AND BIASES
NATURE OF
THOUGHT
LEARNING
EXPRESSION

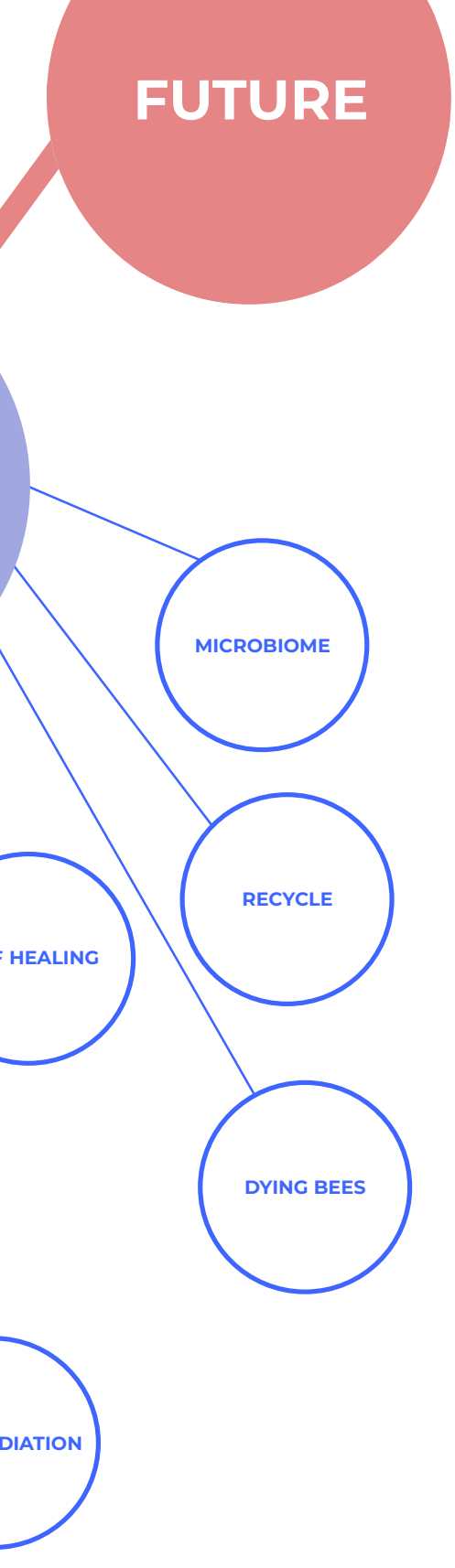
5. Climate Change



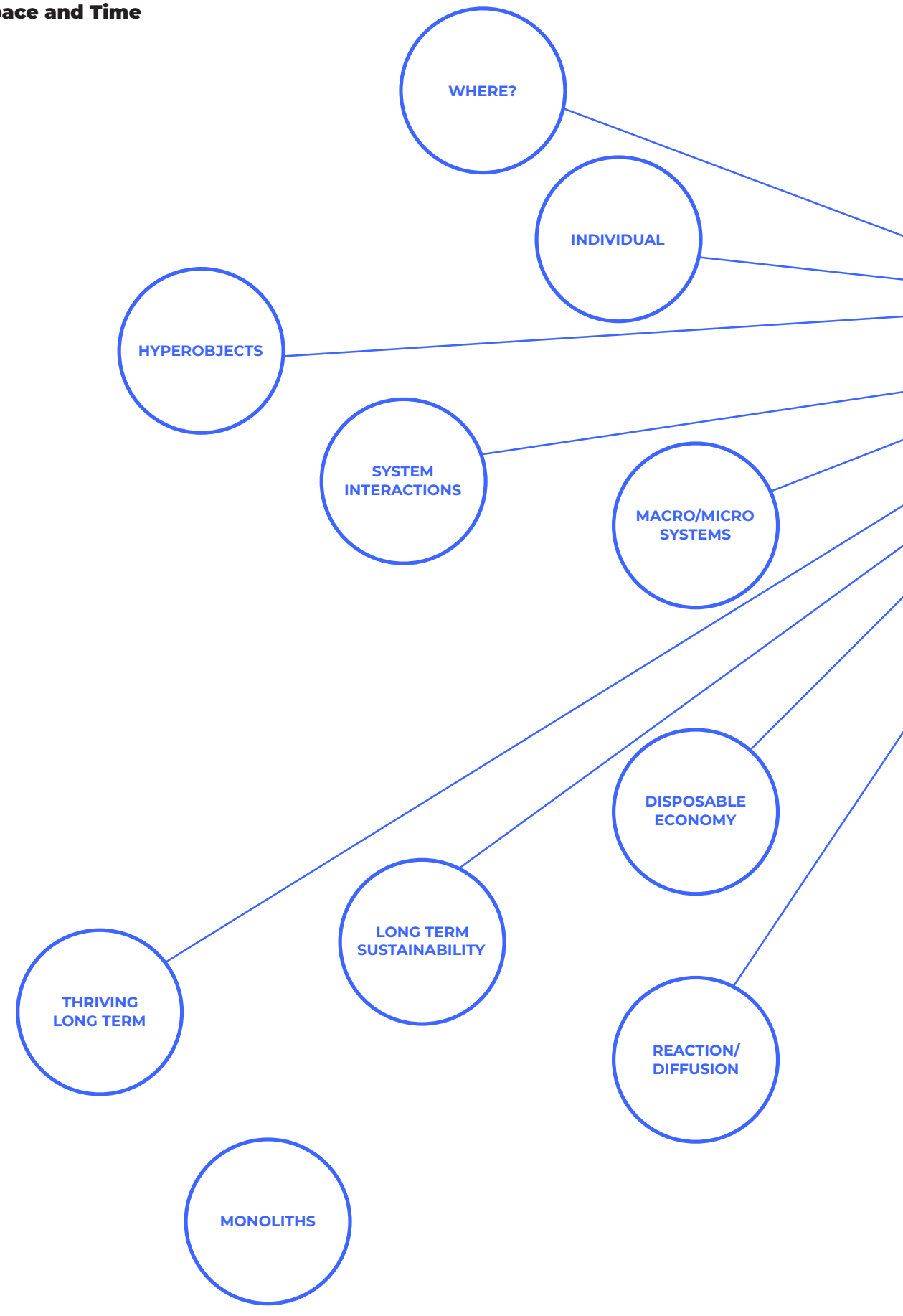

CLIMATE CHANGE
DISEASE & SUPERBUGS
6TH MASS EXTINCTION
CLIMATE MIGRATIONS
DESERTIFICATION
ANTHROPOCENE
ADAPTION VS MITIGATION
SEA LEVEL RISE
HABITAT & ECOSYSTEM DESTRUCTION
POVERTY & HUNGER
CARBON CAPTURE
SYSTEMIC RISKS
AWARENESS & ACTION
NEXT ICE AGE
GLOBAL DIMMING
EXTREME WEATHER
DE-INDUSTRIALISATION
LANDSCAPE CHANGES
FOOD SCARCITY
ECOLOGY VS ECONOMY
NEXT ICE AGE
PARIS ACCORD
SUSTAINABILITY (SHORT AND LONG TERM)
BAL WARMING

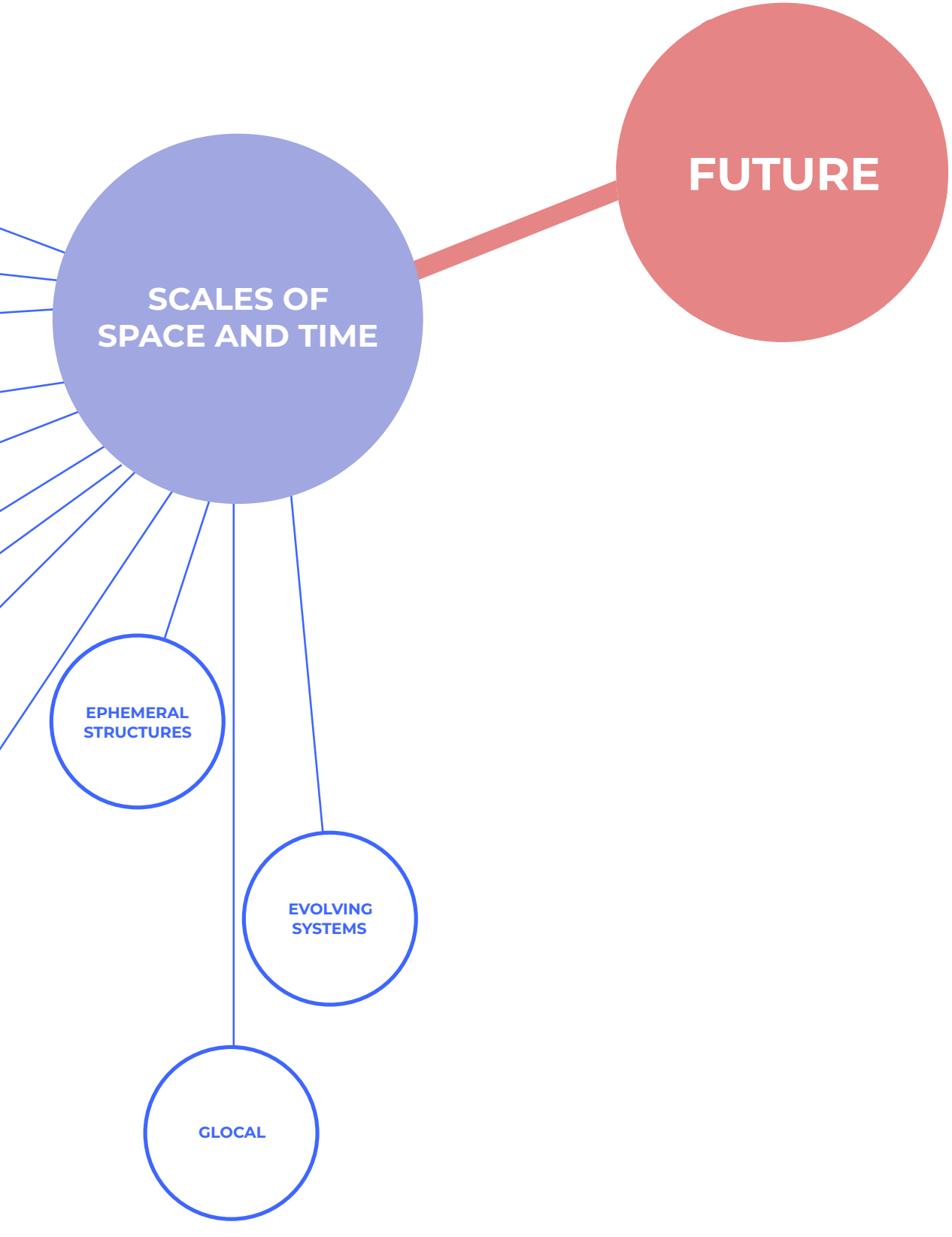
6. Ecology


ECOLOGY
CIRCULAR INTERVENTION
SYNERGY OF SYSTEMS
POLLUTION
EXTRACTION
GEO-ENGINEERING
BIOMIMETIC & BIOLOGICAL
NATURAL CYCLES
ECOSYSTEMS
NON INTERVENTION
REGENERATION


FUTURE
MICROBIOME
RECYCLE
F HEALING
DYING BEES
DIATION

7. Scales of Space and Time

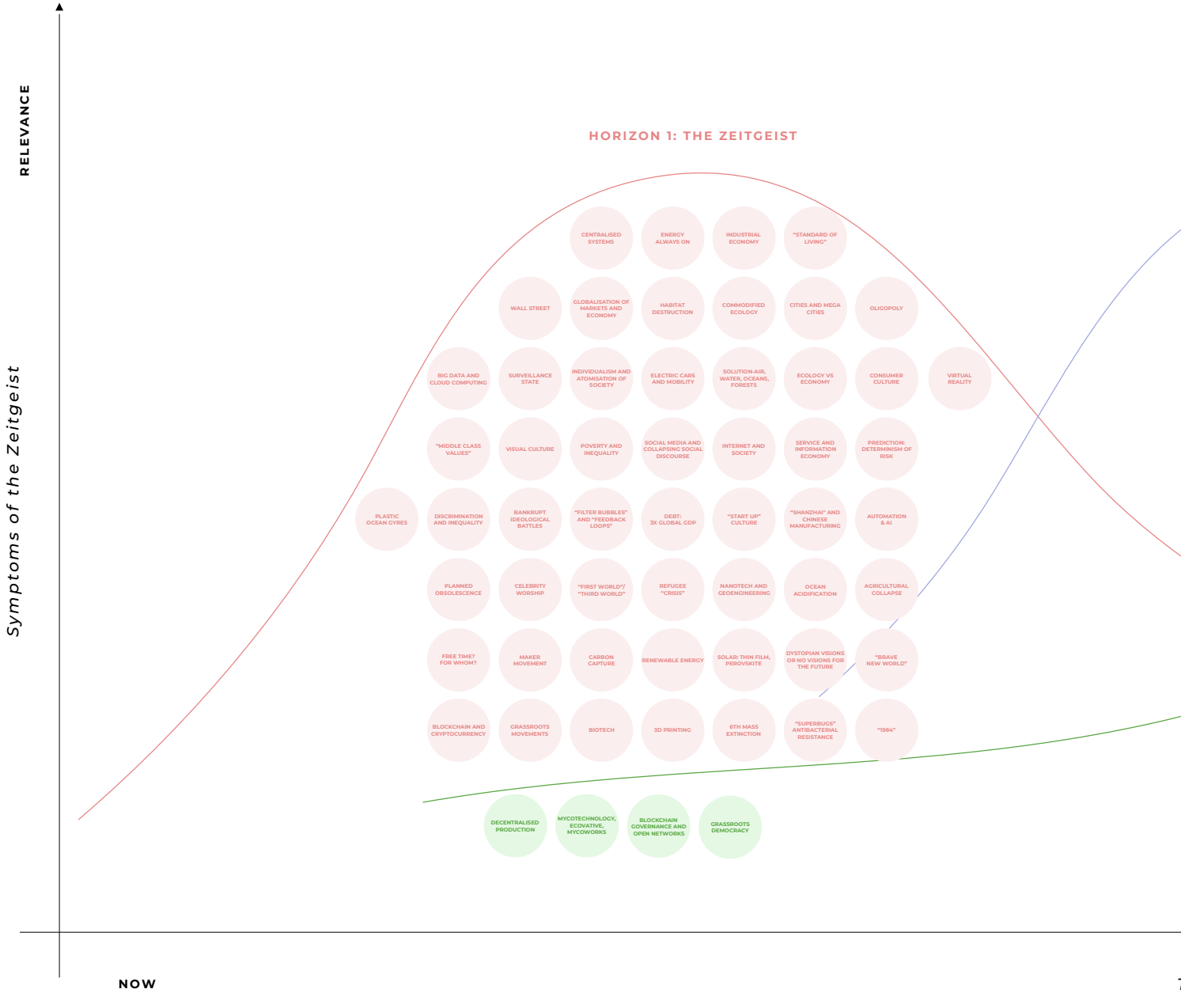



FUTURE
SCALES OF SPACE AND TIME
EPHEMERAL STRUCTURES
EVOLVING SYSTEMS
GLOCAL

Appendix 4

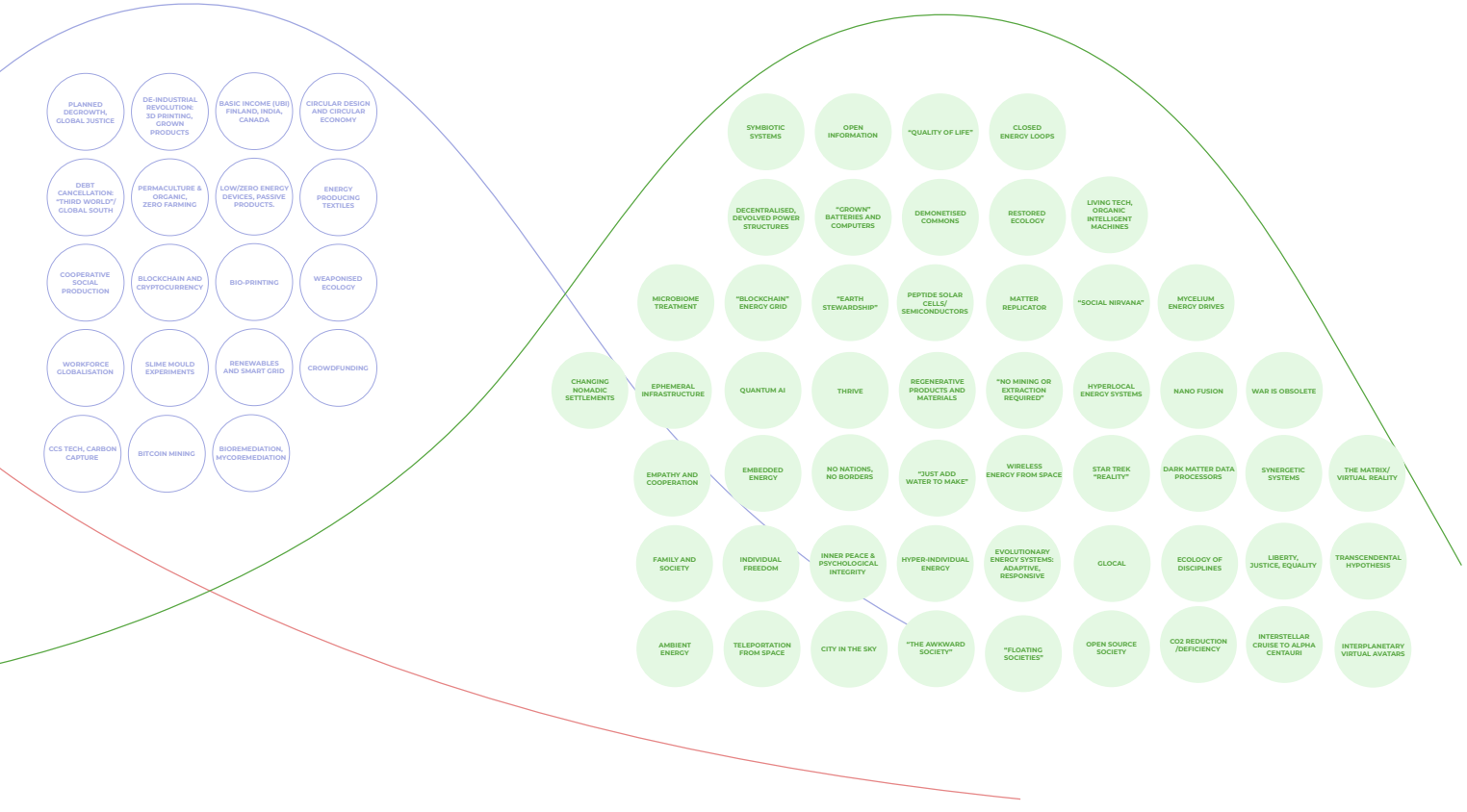
Three Horizons Chart:

For a more clear look at the charts please refer to the digital file:
https://drive.google.com/open?id=1i0trIyuuvQcuHaDqk_jPZ0V5YqsefZz-



HORIZON 2: TRANSITIONS

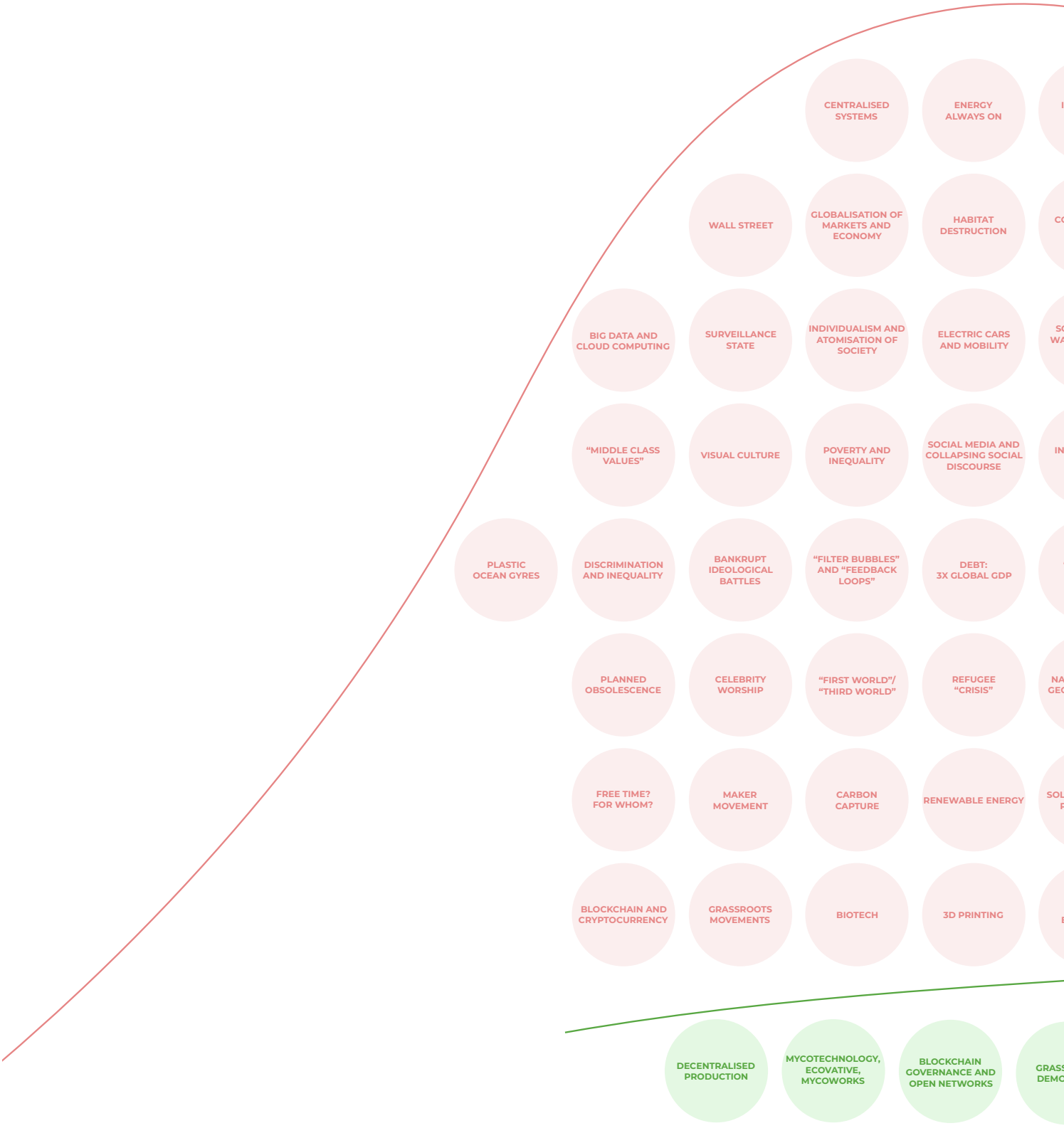
HORIZON 3: HOPEFUL FUTURES



Time

FAR FUTURE

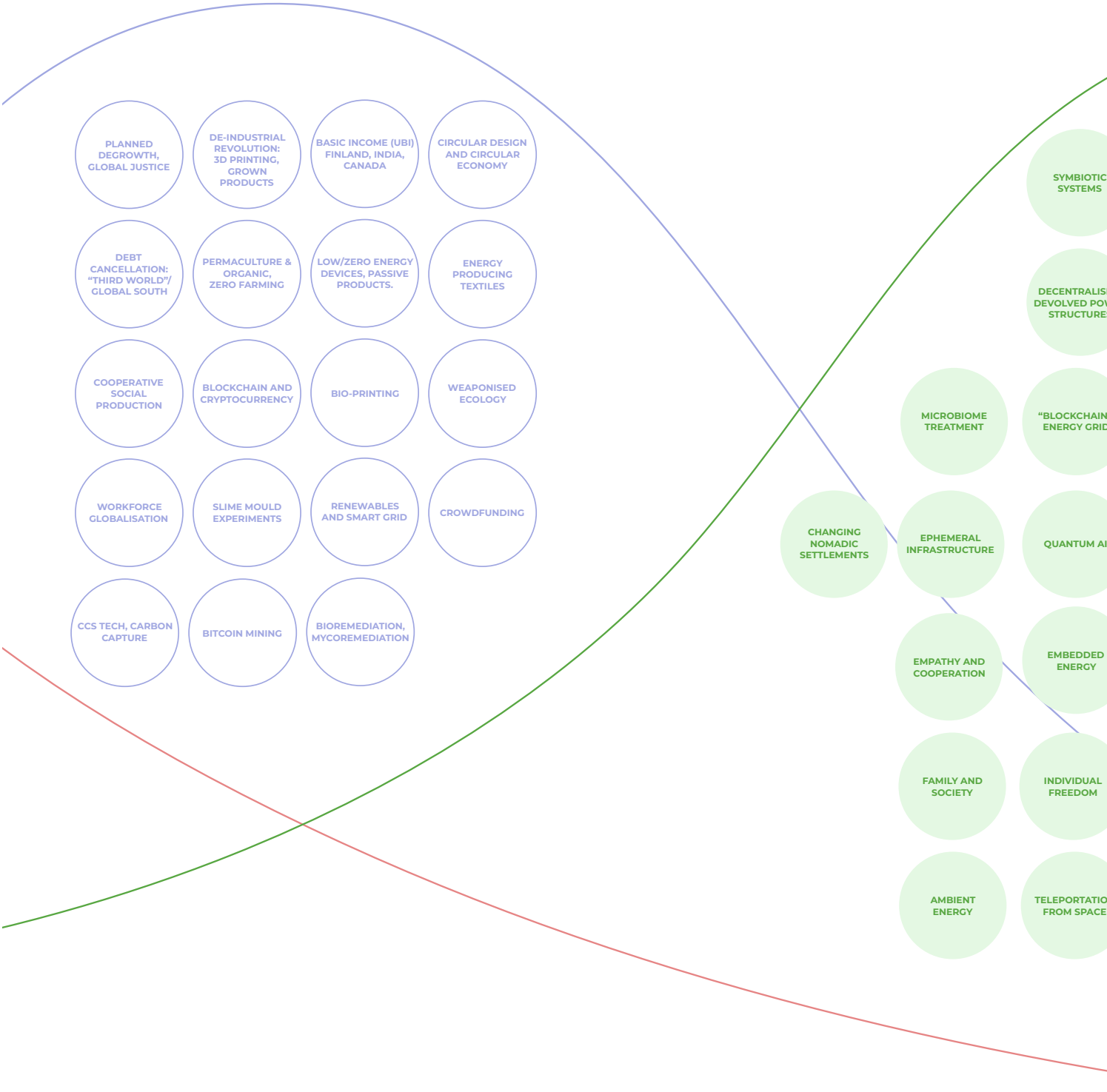
HORIZON 1: THE Z



EITGEIST


NDUSTRIAL ECONOMY
"STANDARD OF LIVING"
OMMODIFIED ECOLOGY
CITIES AND MEGA CITIES
OLIGOPOLY
OLUTION-AIR, ATER, OCEANS, FORESTS
ECOLOGY VS ECONOMY
CONSUMER CULTURE
VIRTUAL REALITY
TERNET AND SOCIETY
SERVICE AND INFORMATION ECONOMY
PREDICTION: DETERMINISM OF RISK
"START UP" CULTURE
"SHANZHAI" AND CHINESE MANUFACTURING
AUTOMATION & AI
ANOTECH AND DENGINEERING
OCEAN ACIDIFICATION
AGRICULTURAL COLLAPSE
LAR: THIN FILM, PEROVSKITE
DYSTOPIAN VISIONS OR NO VISIONS FOR THE FUTURE
"BRAVE NEW WORLD"
6TH MASS EXTINCTION
"SUPERBUGS" ANTIBACTERIAL RESISTANCE
"1984"
SROOTS OCRACY

HORIZON 2: TRANSITIONS



HORIZON 3: HOPEFUL FUTURES

Appendix 5

To view and print these cards please go to:
https://drive.google.com/open?id=1S1KMZtbBVssyphOVTtHMCFSNm4v5HVph

LOCATION CARDS:

Delhi	***Antarctica***	***Sao Paulo***	***Toronto***
Cape Town	***Mombasa***	***Dubai***	***Hong Kong***
Reykjavík	***Osaka***	***Changsha***	***Chernobyl***


Vladivostok
Vladivostok
Baltimore
Baltimore
Oslo
Oslo
Dhaka
Dhaka

TIME CARDS:


2025
2025
2050
2050
2075
2075
2100
2100

FUTURE DRIVERS:

No Mining and Extraction needed

Mining for minerals and metals becomes obsolete as new materials and circular economies become prevalent.

No Mining and Extraction needed

Nano Fusion Breakthrough

Nuclear fusion breakthrough results in 'nano' fusion modules that are small enough to fit in a garage.

Nano Fusion Breakthrough

Living Technology

Further experiments in biotech unveil computers and materials that are a symbiotic combination of organic, living cells and semiconductors.

Living Technology

Nomadic Settlements

Climate change refugees are widespread and move from place to place in small, self sustained groups.

Nomadic Settlements

6th Mass Extinction

Large scale extinction events happen starting with collapse of whole ecosystems and the resulting chain reaction.

6th Mass Extinction

Space Exploration

Space expeditions to other stars and exoplanets are carried out in the pursuit of new understanding of our place in the universe.

Space Exploration

Solidarity and Cooperation

Declining democratic freedoms means people start connecting with each other through dialogue and engagement beyond political, sexuality and social lines for finding common ground.

Solidarity and Cooperation

Full Cost Accounting

Cost calculations for resources, energy and future costs and impacts are taken into account.

Full Cost Accounting

Human Rights and Quality of Life

Standard of living is discarded and instead quality of life is used as a measure of progress and wealth.

Human Rights and Quality of Life

Global South vs Global North

The so called third word countries take to demanding for equality on the world stage and reparations for slavery, genocide and economic oppression.

Global South vs Global North

Hyper-Individual Energy Production

Individuals become both the consumer and producer of energy.

Hyper-Individual Energy Production

Automation and AI

Automation of dangerous jobs takes over and AI takes care of the computation and organization of data and its application.

Automation and AI

Self Sustained Megacities

Megacities become self contained with resources through practices such as rooftop farming, urban mining, circular material cycles etc.

Dissolving Borders

A new global movement manages to win the right to dissolve borders when most countries end up signing open border treaties.

Space Colonization

Space colonization missions to the asteroid belt and other planets is looked into for resource extraction.

Mycelium Energy Drive

A strain of fungi is discovered in Chernobyl that converts nuclear waste products into usable forms of energy.

Changing Landscapes

Rising sea levels, desertification and changing weather patterns leads to landscapes changing at an unpredictable rate.

Body & Gene Hacking

Gene editing becomes commonplace where people can modify their bodies and immune system to give them supra-human abilities and appearances.

Cooperative Social Production

Communities buy back failing/ bankrupt manufacturing facilities and start running them on a CO-OP model to fabricate things their societies would actually need.

Poverty & Inequality

The worlds richest 20 people now own 85 percent of the world's wealth. Figures of people living in poverty rises further with the collapse of the working classes.

Universal Basic Income

Universal basic income becomes commonplace globally and instantly eradicates poverty across the world.

Floating Cities

Floating cities dot the skies after new discoveries in building materials and lack of urban land in cities make architecture in the skies more viable.

"Just Add Water" to Make

Products and materials function or are fabricated using basic properties of water and elementary forces.

Growing Computers and Technology

Biotechnology makes it possible to refine biological materials and grow technological components like batteries, processors, semiconductors, superconductors.

Restored Ecology

Ecological cycles and systems recover and heal from past onslaughts. Non interventions and restoration by rewilding are taken up.

Carbon Capture

Carbon Sequestration at source and zero emissions process becomes a mandated policy for all large scale industries.

Myco- technology & Biodesign

Fungal mycelium becomes a source of biological materials along with other discoveries such as bacterial leather and virus batteries that can be grown as needed.

Shift to Permacultures

Paradigm shift away from mono-cultures to permaculture practices in agriculture, society and technology.

Biological Solar Cells

Enzyme based , efficient organic solar cells are discovered that disrupt the silicon solar technology.

Extinct Bees and Agricultural Collapse

Agricultural belts around the world collapse due to a combination of leaching of nutrients in soil from decades of chemical fertilizers and pesticides that caused mass collapse of bee populations and thereby pollination.

Geo-engineering & Nanotechnology

Hyperbolic tech solutions such as cloud seeding, blanketing the sun, gene editing with CRISPR-Cas9 and graphene nanotechnology are used to curb the effects of climate change.

Extreme Weather Aberrations

Climate change accelerates extreme weather patterns that continue to wreak havoc in many parts of the world with extreme storms, forest fires, droughts and flooding becoming common.

Open Information

Information becomes open to and for the public. Patents and intellectual property are abolished. Open source hardware and software goes mainstream.

Systems & Synergies

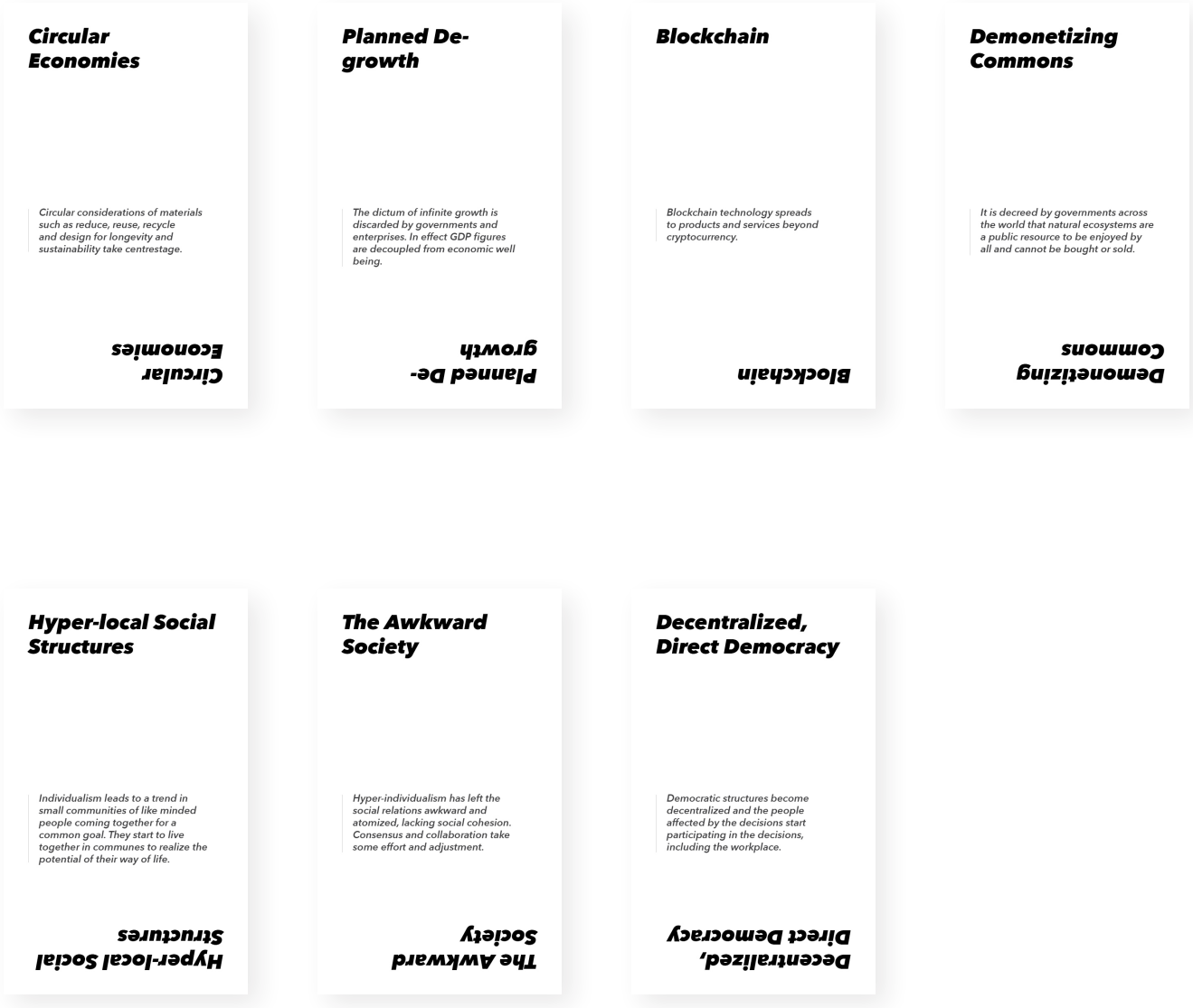
A socio-economic shift starts to take shape to find synergy within the global and local ecological framework.

Regenerative Products and Materials

The advent of biological materials like mycelium bricks and virus batteries leads to nurturing materials technology instead of manufacturing.

Shift to Zero Embedded Energy

Product costs are audited for embedded energies in material processing and extraction along with energy in use.



Appendix 6

Video of Futures Poker session with ProtoHype Studio course:

https://youtu.be/gakmcjBr0e0

Appendix 7

12 Speculative Future Fictions, results of the Futures Poker exercise:
https://drive.google.com/open?id=1Uq4LVV6xWl72dnhJtL46OdKbtV80YbKF

1. ”Material abundance in an augmented world”

Year : 2050

Place: Mombasa

Drivers:

Body and Gene Hacking

“Just Add Water” to make

Universal Basic Income

Scenario:

It’s been a year since the introduction of basic income across the globe has eradicated poverty on a mass scale. The people then are “free” to spend on their whims and desires. This creates a whole new market of body morphing clinics that allow for all kinds of augmentations like strength enhancement, immune resistance, hyper-vision etc. Except for a few outliers, the more money you have the more modified you are. Basic needs like food clothing and shelter become guaranteed and simpler with gene editing, such that food is now grown in dried up sachets, on the plants themselves which the people buy as dried spongy meals they hydrate to bring out the flavours. Basic products are organically grown in such a manner, in pill form that once hydrated blossoms into the tool needed.

2. ”Floating regenerative megacity expansion”

Year : 2050

Place: Dubai

Drivers:

Mycotechnology & Biodesign

Floating Cities

Extreme Weather

Scenario:

Dubai is in an economic crisis. Rising cases of extreme weather phenomenon has made the city vulnerable. It had called architects from all over the world 10 years ago to build the world’s first floating city in the sky inspired by Buckminster Fuller’s work a century ago. The extremely powerful sandstorms for instance have made huge losses to national productivity. Their vision is to create a utopian city in the sky that will use the latest bio-technology and bio inspired design to make claim to the world that Dubai is still at the cutting edge of design and architecture. The architects for this job propose using fungal mycelium structures that are light weight and resilient to extreme amount of stress. They propose batteries made of viruses and enzymes that can help keep the toxic footprint of the city low. Two cities, one a research and observatory lab in the sky, and the other a floating megacity on the sea, 10 miles off the coast are built after years of research and collaboration.

3. ”Open Source Bio-computing inter-societies”

Year : 2100

Place: Vladivostok

Drivers:

Open Information

Decentralised, Direct Democracy

Living Technology

Scenario:

Vladivostok is the last paradise on earth. The city has an autonomous, decentralised structure where citizens are directly in control of the decision making in society and economy. From the 2050s open information was used as a principled means of organisation, which means they are in constant contact with other similar communes across the world and practise in knowledge sharing and technology transfer for common goals. This sort of collaboration leads to advances in biotechnology and biomimicry that allows for organic computing as a fusion of plant cells and biological semiconductors. These computational devices are synced to other such devices built by other communities across the world to form the first biological internet. Such a technology has allowed for the development of the mind body interface that helps human beings tap into this “internet” which makes a GUI or a screen redundant. The rate of constant evolution of this technology which is open source means the accelerated advances in the technological discoveries without the burden of economic goals. Exploration therefore become a social value unto itself.

4. “2025: A space fairing collective movement”

Year : 2025

Place: Antarctica

Drivers:

Space Exploration

Global South vs Global North

Planned De-Growth

Scenario:

In 2025, reports of a major chunk of the land ice breaking away from the continent is heard on the media networks. The news, shocking as it were reveals another mystery. As the glacier gave way to the surface underneath, an object, a monolith for lack of a better word, revealed itself to the world at large. The monolith showed technological complexity yet seemed familiar in its framework. After months of testing, the global team of scientists informed the citizens that the object is indeed from interstellar space from a planet called Proxima b. There were traces of organic matter that showed signs of a similar carbon based life form but in a much more complex genetic make up than anything known to man.

The news forces the whole world to take notice and it is decided to plan a mission to find the origin of the device. The mission is tasked with creating von Neumann probes for exploration and discovery. This task is so monumental that most governments start directing public policy towards that goal. To do this, the resources and technological know how would be required to engage most of the working population in creative and meaningful work. This poses a challenge to the present economic and social order, that means transformation of the economy to a planned de-growth model, reduction in consumption. This causes the global south countries to stall proceedings by calling for equitable responsibility for the crisis in their economies to the global north countries. This stand off is an inevitable one as the whole world has to come together not just in material cooperation but also in intellectual capacities that open up a new creative realms of enquiry.

5. ”Energy prosumer citizens & collaborative society”

Year : 2050

Place: Toronto

Drivers:

Hyper-Individual Energy

Shift to Zero Embedded Energy

Demonetising Commons

Scenario:

The city of Toronto starts abolishing trading of the commons, through a public referendum it is now illegal to profit from nature, which also means that logging, private nature reserves are taken under public purview. This leads to a winding down of mining and logging activities around the city that causes a radical shift to urban mining, recycling of aluminium, metals etc. Urban farming practise takes hold and that corresponds to the creation of community spaces and renewed urban planning that focuses on full housing and mixed planning. The recycling plant of the city is tasked to strip precious metals and other materials from the automobiles now scrap. The city is rediscovered as a pedestrian city. To reduce energy dependency, there is renewed research into generating energy enabled by the human body. This way , the member of a community share their energy by physical contact. The surrounding forests then become a place for small communities to go and perform community rituals. The more people connect with each other the more energy they create and can perform tasks like powering up communities. People travel and use machines that need the energy from individuals transferred to the vehicles they travel in. So a smaller vehicle can only carry a few people and for a short distance but a large one can carry larger number of people over further distances.

6. “Off-shore, floating seaweed farms”

Year : 2075

Place: Cape Town

Drivers:

Floating Cities

Solidarity and Cooperation

Extinct Bees and Agricultural Collapse

Scenario:

After two decades of infertile soils, Cape Town residents decide to look for better sources of food and they find that off shore seaweed is a viable source of nutrition. A giant floating seaweed and fish farm is built off the coast and houses seaweed farmer to sustain the population while the rest of the population is busy trying to set up pollination teams to design and develop robotic bees to pollinate the fields. The crops have to survive amidst reduced fertility of the soil.

7. ”Radioactive blockchain society with advanced bio-computing”

Year : 2075

Place: Chernobyl

Drivers:

Changing Landscapes

Living Technology

Hyper-Local Social Structures

Scenario:

With rapidly changing landscapes, human settlement in 2075 cannot afford to stay in one place. So for the sake of coordination societies then break up into smaller more manageable groups that keep in constant contact with each other. These communities may be small but since they are constantly in touch with each other, there is an advanced level of knowledge sharing and technology transfer through a direct communication system. These are enabled by some kind of living computer technology that was one of the early fusions of biotechnology and computer processing. These living, biological computers help in advanced computation technologies to exist as common but highly specialised systems of higher level information processing. The menial tasks are performed by digital and electro-mechanical systems, the kind ubiquitous to the early half of the 21st century. These communes travel around from place to place depending on where liveable conditions exist at a particular moment. This means they travel with their food vessels from place to place that protects the food from radioactivity. The communication and power systems are set up in temporary buoys to be moved from place to place with ease and conduct their business over long distances without physical connections.

8. “Interstellar body enhancements for space explorations”

Year : 2050

Place: Oslo

Drivers:

Floating Cities

Body and Gene hacking

Space Exploration

Scenario:

Oslo has grown too big to support more construction projects. The citizens protest against any high rises from coming up in the city. The oil crash of 2045 has also left the country looking to ways in which to boost the economy. It is decided that the new frontier of space must be explored and in doing so build an economy around scientific inquiry. A new space age opens up and for this floating research stations the size of a small city are constructed at an altitude of five kilometres above Oslo to serve as a launch and recovery of interstellar spacecrafts. These stations also act a giant energy harvesting systems that beam down energy to the city of Oslo for domestic use. These stations carry out experiments in body morphing and gene editing to make a human body adaptable to interstellar space conditions like implantable critical systems, embedded skin tattoos that act as supercritical conductors and energy packs.

9. ”Solar Crystal towers of bio-Dubai”

Year : 2050

Place: Dubai

Drivers:

Regenerative Products and Materials

Hyper-Individual Energy Production

Self Sustained Mega-Cities

Scenario:

Dubai is going through a crisis. Trade has dried up and they undergo a shift in policy whereby the government decides that the city will now be a self sustained paradise. This means that city turns to internal sources of raw materials available in the city. Local municipalities implement circular consumption models and distribute water filtration units to each household for purification at source. Food is grown on scaffolds and roofs to optimise land area in the cities. Each household is required to produce their own energy as they are fitted with an energy producing device that converts different forms of energy to use. The technological shift also comes to energy requirements of machines and systems in the households. These systems are connected to each other via a blockchain network that is supporting each other on this system. For supplying the city transportation and cooling system with power, a massive crystal tower is grown in the middle of the city to absorb and reflect sunlight to similar towers that absorb this light and convert it to usable forms of energy.

10. “Hyper-individual collaborative Bio Suits for energy and food”

Year : 2100

Place: Delhi

Drivers:

The Awkward Society

Living Technology

Hyper-Individual Energy

Scenario:

Delhi in 2100 is a barren city that has been taken over by the Thar desert. The air is heavily laded with lead and mercury that has lead to decimation of the human population in the area. The few communities that do survive here are the ones that could survive based on the discoveries of living, bio-intelligent systems that could create a symbiotic entity with these humans for survival. These systems are thus designed as survival suits that are worn by each indivdual that would provide both food, water, purified air and energy for these life supporting systems. These suits help harness sun’s energy into energy for life-supporting systems. For both food and pure air, these suits are lugged around by the humans in the day so that the crops can receive adequate sunlight for photosynthesis. A harvest ceremony would mean the community gathers round to eat together as the suits allow for growth of food on the surface ‘skin’.

11. ”Fungal Nuclear Waste Digestor in a Japanese home”

Year : 2050

Place: Osaka

Drivers:

Circular Economy

Blockchain

Mycelium Energy Drive

Scenario:

The discovery of a radioactivity loving fungal mycelium sparks massive interests in developing a device that could harness and capture nuclear radioactivity into usable forms of energy. In homes in Osaka, scores of households have started installing these devices that feed discarded nuclear waste in a safe container to this fungus that then churns out ‘fruits’ that are then used to produce usable forms of heat and energy. This system then is connected to other such systems on a community network that keeps a track of what each unit is producing. This minimal device is actually is not sold as a product but in fact people pay for the energy alone. This system leads to a remarkable long life span of these systems that make for constant improvements in efficiency and longevity of the system.

12. “Smart solar lens in the sky and Soap bubble droids”

Year : 2100

Place: Reykjavík

Drivers:

Changing Landscapes

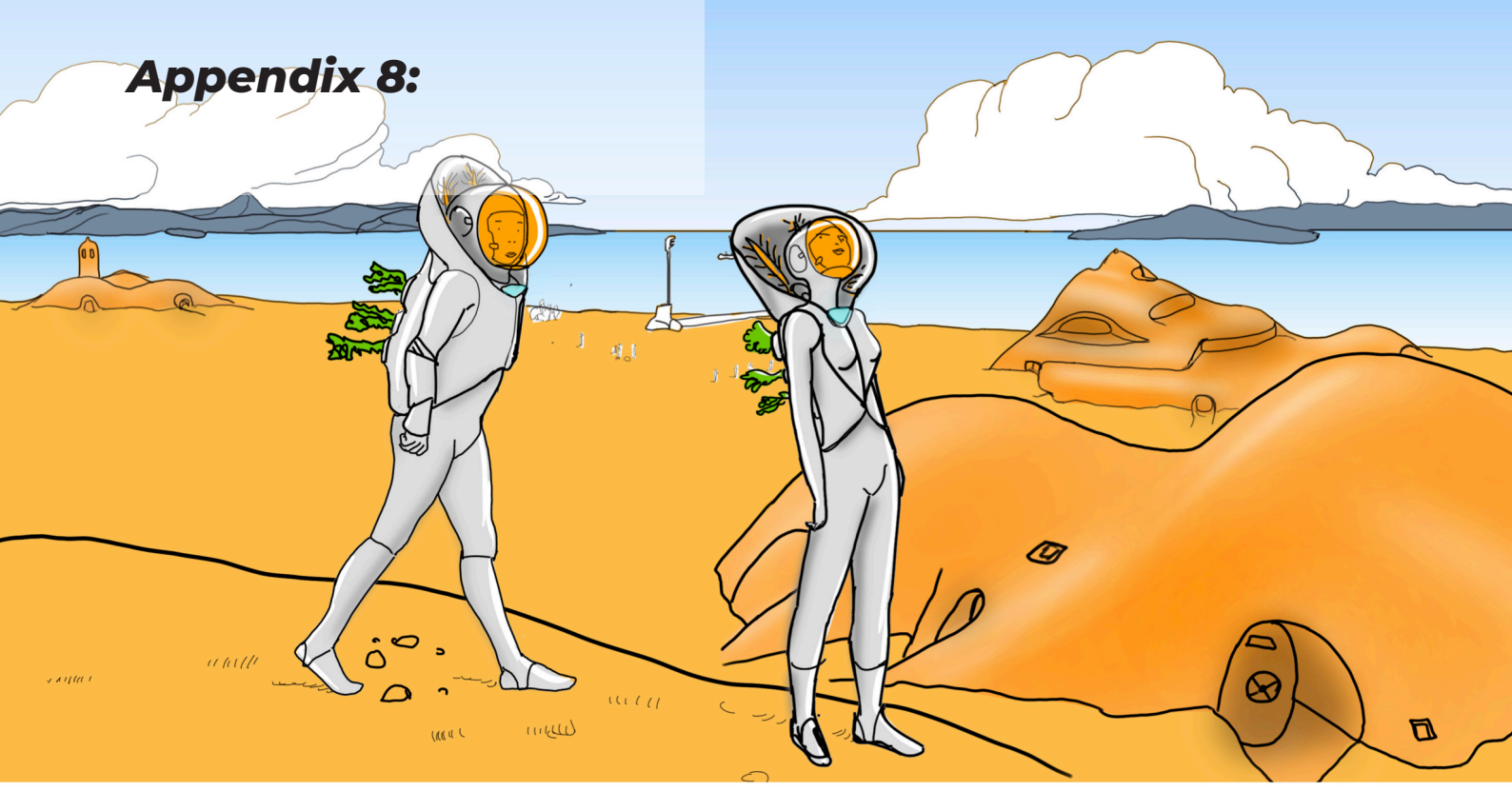
“Just Add Water” to make

Automation and AI

Scenario:

On a bright sunny day along the seaside in Reykjavík a small droid is rolling along the countryside in a planned and automated pattern. The sea level rise has changed the Reykjavík landscape more than once so that the people now reside in settlements up in the mountain. They sent these droids to maintain the energy farms that have sprung up by the seaside. This droid as part of its protocol is blowing, what look like soap bubbles into the air, these ‘bubbles’ do not pop but rather reach a certain height and stay there, while the suns rays hit the bubbles in the air and a concentrated beam of light reaches the sea where a buoy is floating containing what looks like a platfrom that lights up the moment the light hits the buoy. The droid keeps making these ‘bubbles’ that end up forming even bigger structures, distributing light to even more such buoys.

Appendix 8:



Hyper Individual Bio-suits

Year : 2100

Place: Delhi

Drivers: The Awkward Society, Living Technology, Hyper-Individual Energy

The Future Universe:

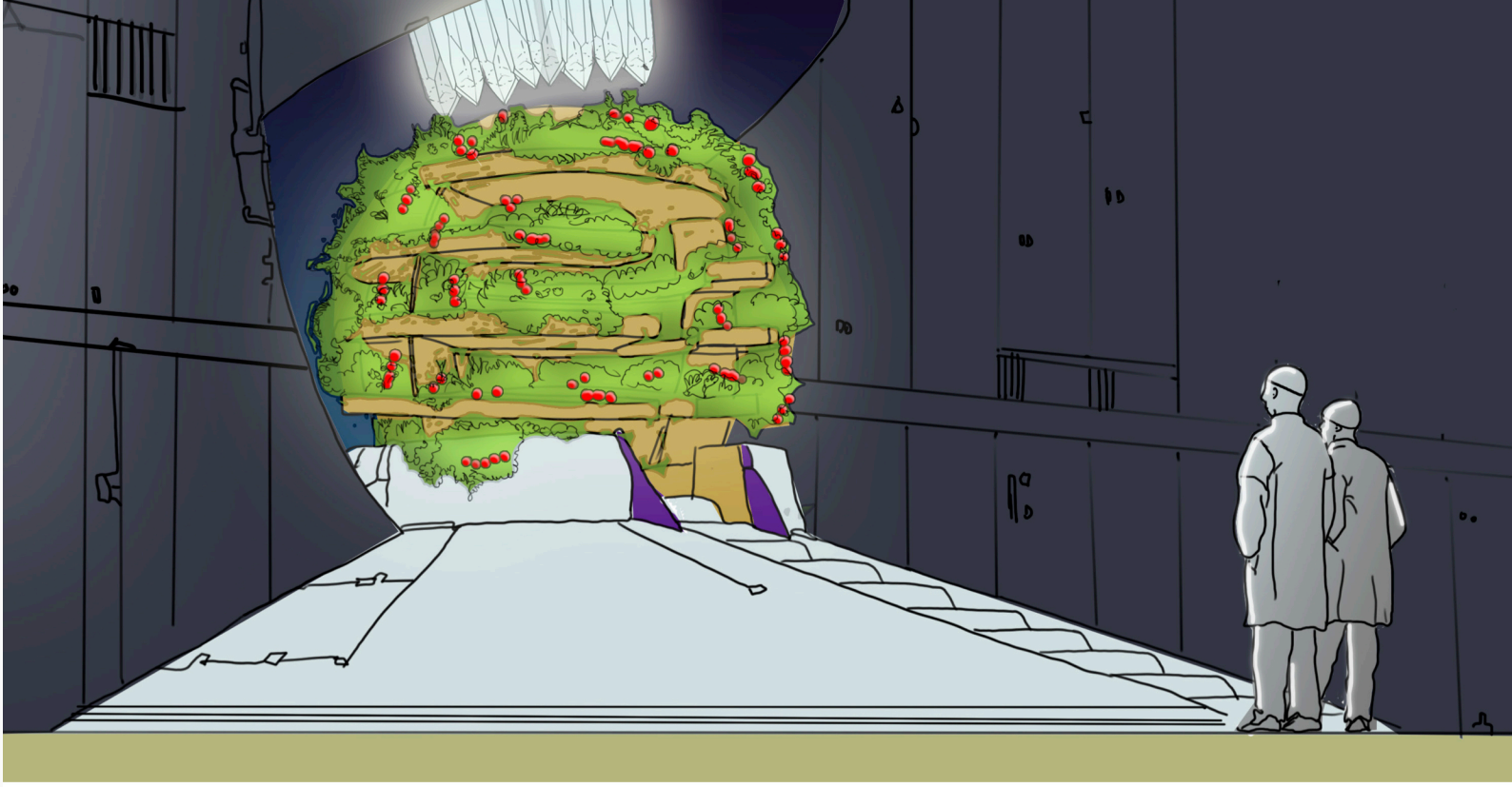
Delhi in 2100 is a barren city that has been taken over by the Thar desert. The air is heavily laden with lead and mercury that has made the air toxic to breathe. The few communities that do survive here are the ones that could survive based on the discoveries of living, bio-intelligent systems that could create a symbiotic entity with these humans for survival. These systems are thus designed as survival suits that are worn by each indivdual that would provide both food, water, purified air and energy for these life supporting systems. These suits help harness sun's energy into energy for life-supporting systems. For both food and pure air, these suits are lugged around by the humans in the day so that the crops can receive adequate sunlight for photosynthesis. A harvest ceremony would mean the community gathers round to eat together as the suits allow for growth of food on the surface 'skin'.

The Story:

Reberie had been cryo-frozen for four decades, so it was quite a challenge for him to realise where he was in the dark room, with walls made of carved stone, suggeting he was undergrounf. As he stepped out into what seemed to be a door, he was presented by a majestic roof of a dome overlooking the hustle of a small town. To his left he saw young teens lining far in the distance with what looked like spacesuits but unlike any he ever imagined before. The kids looked like bees waiting for the world outside. He found himself led into the watchtower looking out into the world. The barren, desert world. Deserts had left the world outside devoid of organic life. Reberie turned his head around to gaze at the wall holding the window to learn that these domes were actually made of hardened sand. He assumed that this is how people live now, under the earth, sheltered from the impacts of what remains of the world outside. He looked back to the kids now, looking closer at the suits they were wearing and he realised that they were part organic plant biomes for a garden, and part sophisticated energy and communications systems. He realised that these children and perhaps every citizen was tasked to wear these suits to grow food and bring home energy. Even space helmets they wore was used for the people to survive the toxic air outside and as he later found out, these suits would also act as long distance nodal networks, have their own biosolar system and also provide drinking water out of the desert air to city to drink.

"Gather round now children", Reberie turned around to see a woman called Bellin, giving instructions to a bunch of energetic young ones as they hurried towards her in the giant airlock. They were about to leave for their weekly hike into the outside world. The outside world where once people could roam and be free. Where now they need special suits to have air to breathe, water to drink and food to eat. Where once a megacity stood is now an unbreathable desert. "Now put on yout bio-suits, you too Ruhan. So our task today is to learn about teliogenesis. Don't forget your breathing masks or you'll be breathing lead and benzene directly into your lungs. We will also be meeting the other sector and when you come across them you must beam your hoodies to signal greetings and today's codebreaking problem to them. One more thing, make sure that your water recepticle has at least 5 liters of condensed atmospheric water by the end of the day, if not then you can look at me from the distance to call me and we can find your suit a nice place to breathe, maybe by the dead river."

The children were excited to have their first week of completely unsupervised exploration that was generally reserved for adults. As they gathered around the airlock dome, the children's eyes were fixed on the sign that read: "Welcome to the World".



Solar Crystals of Dubai

Year : 2050

Place: Dubai

Drivers: Regenerative Products and Materials, Hyper-Individual Energy Production, Self Sustained Mega-Cities

The Future Universe:

Dubai is going through a crisis. With the Big Economic Crunch and volatility trade has dried up and the city decides to shift policy whereby the city will transition into a self sustained paradise. This means that city turns to internal sources of raw materials available in the city. Local municipalities implement circular consumption models and distribute water filtration units to each household for purification at source. Urban farming with crops grown on scaffolds and roofs are looked at for optimising every bit of sunlit surface in the city. Households are retrofitted with an energy producing device that converts different forms of energy at source. The technological shift also comes to energy requirements of machines and systems in the households. These systems are connected to each other via a blockchain network that is supporting each other on this system. It turns out that Dubai's sandstorms now last for upto weeks on end blocking out the sun for long periods. For those many people who shifted to working as urban farmers after heavy duties on food imports, the lack of sunlight is a blow to their enterprise. The sandstorms have been good for some businesses that managed to set an extraction unit on the windward side of the city. It turns out that resource collectives could extract precious minerals from the storm and refine it to produce technological components without depending on imports. The government seeing the state of these farmers announced plans for giant crystal towers spread across the city in a move to get sunlight to the lower levels of the city. These towers the government said would help bringing genuine sunlight to the ground plane of the city which is hard to reach owing to the storms.

The Story:

Abu has a problem, he can't seem to catch a break with his tomato farm in his rooftop garden. The tomatoes seem to suffer from a lack of adequate sunlight. The sandstorms have become so frequent over the years that the city receives less sunlight in week than it did in a day. This sandstorm was good news for Beshir, Abu's neighbor who started his business of mineral extraction from sandstorm for high performance semiconductors but this also means the urban farms have now moved indoors using LED panels. Abu tried using the indoor containment farms that produce more yield but the tomato to him tasted "like water in sponge bath!". "Tomatoes taste best when they are grown in warm bright sunlight, like every crop should. How will I grow anything if I don't get the sun. These indoor lights are too expensive for the kind of tomatoes they grow! What is the point!" He figured he should talk to his friend, Michi who said that he has been working on this problem on his rooftop. Abu, now willing to try anything comes over to his farm two blocks from his and is astounded by what he sees. A indoor garden with the most fresh plants lit up by a bright hue of warm sunlight coming fro these massive crystalling structures hanging 5 feet above the plants. Michi explains to Abu that the light he sees is actually coming for the sun directly without any additional lighting. Abu looks out the window and realises that it is another duststorm outside, passing through the city. Michi, noticing Abu's confusion tells him "The light is tunneled through from a high point in the sky to this room. It's not just visible light. This light has the while spectrum of UV, IR and visible. The best part is that I can use it to heat and power this room too. Abu was dumbfounded but after a few months he was showing this system off to Beshir who was thinking of ways to make his basement workshop feel more useful now, as he plucked the sweetest, juiciest tomato he ever tasted from Abu's garden that afternoon.

Appendix 9

Link For Blockchain Radioactive: A VR Experience concept Film:

https://youtu.be/6ZQrbOBcWxk

Appendix 10

Link for audio of the Futures Discourse Session:

https://ahocloud.box.com/s/leu4qfgjm2xsa7tasymm93wbz8kgh5ng

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