

how **architecture** can save the world from global **climate** change

tommy ashleigh jacob vince
thesis project for degree of masters in architecture
umeå school of architecture [UMA]

how **architecture** can save the world from global **climate** change

architectural suggestions on strategic use of greenhouse gas sequestering materials to antagonize atmospheric C[O₂], in the context of a boreal biome



the first of many to come, in
what will prove to be,
a very long and prosperous
career in the field of
architecture

devoted to everyone whom has
ever crossed my path, friend or
faux

I owe everything I am, and
everything I have achieved, to
you

tommy vince, umeå, june 2020

A handwritten signature in black ink, appearing to read 'Tommy Vince'. The signature is fluid and cursive, with a large initial 'T' and a long, sweeping underline.

table of content

: forewords

I: **theory of sequestration** : architecture's climate impact

I_{II}: **theory of sequestration** : towards an architecture

II: **sequestering architecture**: how architecture can contribute

II_{II}: **sequestering architecture**: a detailed proposed unit in context

II_{III}: **sequestering architecture**: a proposed collective in context

II_{IIII}: **sequestering architecture**: and the consequences it produces

III: **proposal for the cosmopolitan** : fluid architecture: [re]assembled

III_{II}: **proposal for the cosmopolitan** : versatile responsive architecture

III_{III}: **proposal for the cosmopolitan** : [re]assembled cosmopolitanism

IIII: **a new rendered timeline**

IIII: **further readings:** acknowledgement & bibliography

“Att kalla ett trädplantage för en skog är att göra oss blinda för skillnaden mellan dem - det som med detta synbortfall går förlorat är inte bara medvetenheten om naturskogens komplexitet, utan djupast upplevelsen av världens outgrundligas skönhet.”

“To call a tree plantation a forest is to render us blind towards the differences between the two - this loss of clarity not only causes us to lose a conscious sight of the complexity of nature, but most importantly the experience of the world’s endless beauty.” [transl.]

helena granström

I feel the same way about sustainable architecture.

tommy vince



photo: aapo rautio, portrait of tommy vince [edit.] tommy
vince, hanstholm, denmark 2018
sony alpha slt-a33 + tamron af, 70-300 mm

forewords

thoughts on the development

I am extremely excited to be able to share this book with you! Not only has it required a lot of energy and effort from me, my family and friends, but I strongly believe that it will have value in the mind of anyone who has read it. Sustainable actions are drastically called for in 2020 and I believe that it is our obligation, as citizens of the world, to focus our energy and resources in the direction of that calling. From the standpoint I found myself in, refining and mediating the information and knowledge I possessed became the course of action I found sensible to take in order to have the strongest influence possible. **With this book, I hope to create a deepened debate on architecture and its climate implications, as well as spark innovation within the field of architectural design!** In the spirit of creativity and innovation please know now that I strongly encourage the freedom of information for the benefit of awareness and the development of society, so question not if **I approve any form of copying and [re]use of any material in this book.** From the date that it shall find its way to the bookstore, it will already have begun to be outdated and if it has not already sparked an outcome it will equally prove to be a net negative burden on climate. Feast away on this body of work and by the time you put it down, turn to action!

This book took shape during the scholar year of 19/20, while I was undergoing my final year in a five-year program in architecture, at Umeå School of Architecture [UMA] in Umeå, Sweden. The outcome was not foreseen at the time, nor was the topic of the thesis. Originally there was another topic which I held more dearly, surrounding the topic of the architect's contemporary graphical communication tools. I found the topic intriguing on numerous levels, seeing the accumulating workload building up, overwhelming the profession and stressing resources and profits of the industry. Anyone from the architectural profession has probably touched upon this issue, more or less, I'm sure. If not, then when presented for the first time with the invoice of an outsourced render gig. The question I was trying to formulate was, how do we communicate the complexity of architectural proposals in a single method of communication. Including all of the values of today's understanding of change, coherent with the unpredictable course of life, collective engagement, sustainability, construction detail and what they communicate. Every little bit of cultural value that enriches the lives of the protagonist in contact with the architecture in a single image. All of these qualities in one singular method of drawing, ultimately neglecting the desperate solution of producing a [1] drawing for each and every one of these aspects, a time and resource heavy means of production. Resources that could be used to consult other clients and projects for the benefit of a wider architectural good in the built environment. It was a question that similarly bares value to the architectural profession.

The topic, together with the topic at hand were both aired equally among the colleagues of my studio during the autumn of 2019. Though, more excited about the topic of investigating a contemporary architectural media expression, the other proved to stand out. The provocation

that the topic of sequestering architectural mass to create a reduced C[O₂] footprint seemed to produce was surprising to me at the time. I was met with the most absurd arguments that questioned the relevance of the topic and challenged the overall environmental benefit, ultimately expressing how stupid of an idea it was. **In parallel I could see the passion and energy that this seemingly new take on sustainable architecture produced.** Later, during the spring of 2020 I found a quote from a man, similarly invested in sustainable issues, an environmentalist if one would like, that seemed to deal with relatable experiences;

“To be an environmentalist, to see what others refuse to see, is to everyday fight against hostility, denial and above all indifference. It is to fight against almost everyone sitting on positions of power. It is to be stuck in an endless cycle between determination and despair.¹”

George Monbiot

Through these, somewhat heated discussions, arose the realization of how complex the topic of sustainability is and naturally, how easy it is to misunderstand and create strong preconceptions about it.

The complexity arises along with the influence of time. Time, and the various perspectives we can take on time, creates, in itself, endless results and outcomes. A narrow timeframe concluding a sustainable result, can alter and become the total opposite seen in the perspective of another time frame. What is sustainable today, might be unsustainable tomorrow. Something that is sustainable within a five [5] year timeframe, might be catastrophic over a 1000-year time period. Without burdening the topic with a

valuation, an example can be found in the current debate on nuclear power which finds itself deeply entangled in this contradiction. **A similar complexity will prove to be embodied within the topic of carbon binding materials, as well as to the topic of carbon sequestration, which will be discussed further in the upcoming chapters.**

I had an understanding for the complexity of the issue and had myself clung to optimistic titles of sustainable solutions, so I knew how easy it was to oversee and misunderstand the long-term results. But, what shocked me was how strongly people persisted with their opinion even when presented with a further nuanced and complex reading of ecological flows of resources. Subseeding those meetings it dawned on me which topic would have the biggest influence and value to the architectural profession. I understood that if I can communicate the issue of this book in a clear way, then there might be a possibility of more honest sustainable solutions being developed in the future. I felt obligated to share the knowledge I had stumbled upon and moreover, synthesize it in a way that communicated it in the most accurate way possible.

The title of this book was first formulated in September 6th 2019. At the time, I had been focused on producing wood architecture for the past three [3] years, elevating from a childhood relationship to wood towards slowly understanding and celebrating its imbedded qualities. Going through the projects of my architectural education it is evident how the same ideas snapped up at some lecture here and there, project or craftsperson, starting a long series of so-called slow hunches². Thoughts and ideas resurfacing in a looping motion, slowly crystalizing a deeper understanding, further criticised and refined development towards the desire of reaching a form of omni-truth. What

really kept this catalyst turning where two frequently returning topics. **The first, [1] pushed by the tutors and mentors of the architecture school, and likewise an all common aspiration for architects; how do we express the material's qualities in the most celebrational way possible? And then secondly, [2] surrounding the topic of wood as a C[O₂] binder and its potential effect on climate; how can architecture contribute to reducing the impact of global climate change.**

The first topic took a tour of a couple of years involving an exploration and learning period, searching and understanding wood as a material in relation to available products. It would like to be said that I believe that I have at least developed one project that really celebrates wood as an expressive architectural construction material, found either in my 1st year pavilion *1628*³, or in my 4th year project, *CLT*⁴, devoted to a quote, influenced by a similar yearning;

“even a brick wants to be something”⁵

Louis Kahn, 1901-1974

CLT can be found in chapter III. The second topic of material C[O₂] binding, took a few years to fully understand. Through the development of my projects at UMA, one can follow the development from an infant utilization wood as a C[O₂] storage bank towards actually understanding how to effectively create a positive footprint in the global climate from the arm of architectural practice. The topic will be explained further in the upcoming chapters, but let it be understood that the complexity of really wrapping your head around a theory derived from a series of slow hunches which took time to mature. If, one finds the body of this

book somehow hard to understand, then please remember that I felt the same way for an extensive period of time!

To clarify the choice of writing carbon [C] with an optional reading of carbon dioxide C[O₂] by such, C[O₂], touches upon the reality of CO₂ particles in the atmosphere being the primary issue with the global warming development, while the real problem is the emitted C atoms into the atmosphere, extracted from sequestered state [fossil fuel reservoirs]. It is therefore desired to emphasize that issue surrounds C and that solving the challenges of reducing C atoms from the terrestrial layer will in length solve the problem of high C[O₂]-density in the atmosphere.

The use of the term sequestration [noun], to sequester [verb] derives from academic writing on the topic. The act of capturing C[O₂] and storing it in a secure location, isolated from the atmosphere and terrestrial biome has many names. It might have to do with it being a fairly new term of discussion, searching for grip in the public debate. Either way, I am sure that the any reader of this book must have come across a similar term as it features the news regularly nowadays. Populistic and scientific terms come about in the media in manners of Carbon Capture and Storage [CCS], Carbon Density Reduction [CDR], Carbon Sequestration and Storage [CSS], Carbon Dioxide Removal [CDR], binding carbon, Carbon Capturing [CC], Direct Air Capture with Carbon Storage [DACCS], Greenhouse Gas Removal [GGR], soil carbon sequestration, carbon sink, carbon drawdown, carbon removal, negative emissions, negative emission technologies, net negative emissions.⁶ They all aim to title the same act. For the duration of this text, the term C[O₂] sequestration will be used.

During the development of this thesis and likewise the book in hand, an emphasis has been laid on the readability connected to the joy attracted by imagery, likewise an architect's most accessible means of communication possible. I have tried to keep each spread of this book simple and clear to one objective, with an accurate title, an image, and an image text that explains the overall thought of the spread. The main body text will further act as a deepening exploration for the curious mind, devoted to the reader with time and interest, yet of course written in an accessible manner. **In this sense, this book is a kind of blend of a coffee table book and an architect specific read.** The sources are naturally linked with footnotes, but I am rather displaying them as hints towards thoughts, rather than supportive of facts, even though the latter occurs appropriately.

Exactly how to communicate through the media of still two dimensional imagery is something of an ongoing discussion within graphic design and something I have benefited greatly from friends and colleagues whom have generously taken their time to share their thoughts and insights. Connecting back to the optional topic of my thesis study, the one of contemporary architectural expressiveness, that ultimately finds its way into this project by questioning the appropriate tools for producing imagery. To an architect there are an abundance of tools at hand, with an increasing number for each year. But, what I wanted to do was capture and utilize the tools of the protagonist of contemporary society. Yet, still from the position as an architectural author. Desiring an accurate form of artistic expression in order to connect, and further excel the possibility of getting the message across to a broader audience. The result is of course visible just by flicking through the pages of this book, but I thought I would share some of the developing thoughts, as food for thought.

An artist can only master an expression developed with tools that it masters. For society to master a tool and an artistic expression, it needs a lot of practice and a widespread distribution, for the maximum multiplying factor of a probable success. Practice and repetition in volume lay the foundation for a mastered expression that historian may come to define as significant for a time, a generation and a society's values. Artistically concluded as contemporary. Relative to a historical context, contemporary society's tool is the camera together with postprocessing digital tools. There is no other media more widely spread, more frequently used, more appreciated and developed in our society than the camera. To be even more specific the tool is the smartphone, with its camera and postprocessing software. The media of photography as we experience it, as much a captured moment as a manipulated image, challenges both our fantasy and the reality. Photography succeeds because it can pretend to be realistic, yet simultaneously be capable of creating new truths. The bizarre paradox with photography is that ingredients of realism is the most powerful tool of creating imaginary interpretations. Similarly known strategies of creating convincing lies. In that sense photography is just like a dream. Once in it you believe what you see, though as soon as you realize and analyze its details, you dawn on the reality of it being an illusion. A very powerful form of communicating and without a doubt an artistic expression mastered by contemporary cosmopolitan. It is therefore reflective of our time that this book strives to utilize a similar artistic expression. Photography and post-processing, included with the skills obtained through architectural practice, sketching and drawing.

The book constitutes of three [III] overall topics. The first [I] surrounds the topic of the necessity of introducing methods of C[O₂] sequestration within the field of architecture to

answer to the IPCC's projected scenarios of limiting global temperature variation by a maximum of +1,5 degrees Celsius, and how to theoretically approach this from the architectural profession.

The second chapter [II] depicts an alternative proposal, illustrating the realism of an architectural intervention guided by the theory of sequestering architecture stated in chapter [I].

The third chapter [III] elevates a couple of proposals for the cosmopolitan fabric, which have the necessity of answering to programs that arise with urbanization and the architecture that it demands, which has proven to be troublesome to combine with a sustainable resource management and an overall positive C[O₂] footprint. These projects are focused on answering to the fluid nature of urban civilization, answering to a constant iteration of demands and doing so in the most seamless and resource conscious way possible. **To my understanding, combining sequestering strategies in urban architecture seems conflicting in nature; urbanity being fluid, global and highly temporary while sequestering architecture takes a characteristic expression of being local, long-term and absolute.** The primary conflict arises with a dividing interest in the perspective of framing time, where one chooses to have a wider lens, the other thrives on shorter intervals. Cosmopolitan spaces must therefore respond strongly to fluid adaptation, allowing its architecture to constantly be ready to shift, with the minimum amount of effort possible, read cost of energy. To answer to the need of urbanization, I therefor included proposals for such spaces, to above all, highlight the fact that a sustainable and balanced climate is foremost achieved when we minimize our total running costs. That be said, there are plenty of reasons to postpone

the dismissal of sequestering architecture in the urban space, for to my knowledge it has not yet been explored at length, nor has it been granted to much thought from my side.

Within the topic of fluid architecture, there are plenty of developed theoretical projects, as it is a hot topic among architectural scholars today. So, please read my proposals as optional paths, and more importantly objects that help tie the bag together. **A totality of a proposed C[O₂] neutral urban way of living with some form of C[O₂] reductive architecture surrounding the urban life, a form of symbiotic interplay.**

Chapter four [IIII] includes a render, an art piece of the project as a whole, a manifesto of sort if one likes. A playful visualization to spur the mind and stimulate the imagination of what has been developed, in a contemporary fashion! The piece speaks of the valuation of time, cropped in a timeline manner. The method of production stays true to dialog on contemporary forms of architectural expression, using primarily the camera, a smartphone camera as a tool of documentation and digital manipulating it to create an alternative interpretation of the current situation and its future, similar to augmented reality applications and social media filters. As an overlay, the scientific field is layered on top of the perspective, in direct relation to it, but still, somewhat, separated from the life of society itself, all too similar to the prevailing status in the world today.

If any of the arguments appear to be misunderstood, false, in any way hard to digest or found directly uncomfortable, then please contact me through appropriate channels. For, I would very much like to hear your opinion, objection and input.

For the duration of this book I wish that you, the reader, will find insight, curiosity, and further topics of interest surrounding the prevailing issue of [re]introducing a sustainable relationship to climate. I hope that I have made my arguments clear for everyone to understand, as the pages unravel. **I hope that you and everyone you come to touch and affect may move forward through life contributing with ideas, solutions and actions that will help push the objective of sustainable design into a better direction and result, if only just by a little!**

Thank you for your time and attention, by far your most valuable resource!

1 G. Monbiot, G., *Out of the Wreckage: A New Politics for an Age of Crisis*, Verso, 2017

2 Johnson, S., *Where Good Ideas Come From: the natural history of innovation*, London, England: Penguin Group, 2010

3 T. Vince, *1628*, <https://tommyvince.com/1628>, [accessed 2020]

4 T. Vince, *CLT*, <https://tommyvince.com/clt>, [accessed 2020]

5 L. Kahn, 1901-1974, architect

6 American University, *Carbon Removal Glossary*, Washington DC, U.S <https://www.american.edu/sis/centers/carbon-removal/carbon-removal-glossary.cfm>, [accessed nov 2020]

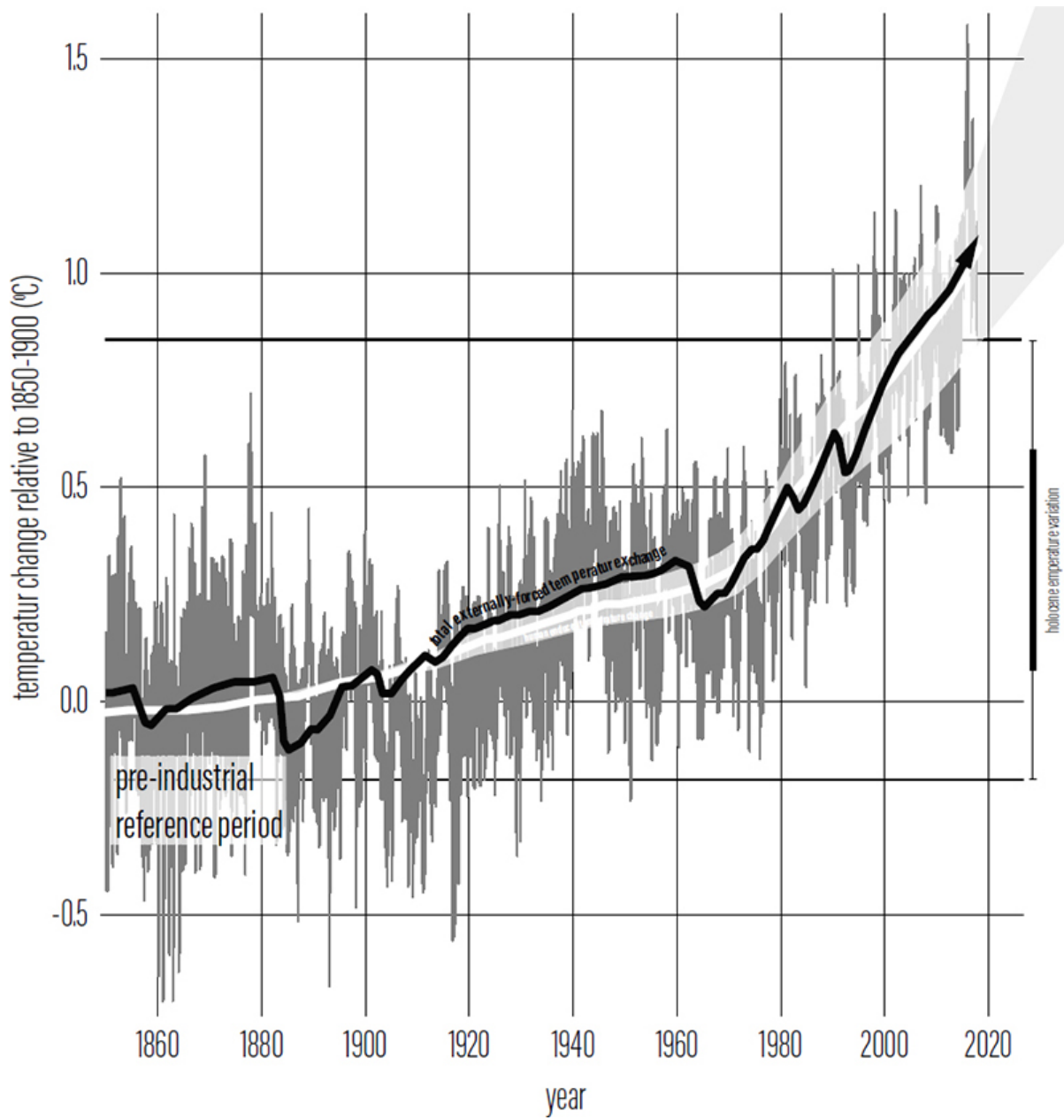
1

theory of sequestration

architecture's climate impact

“Nature doesn't have a design issue, humans do”

William McDonough & Micheal Braungart, 2002



global climate change

an anthropogenic impact

For over 40 years science has warned the world's population of the potential climate change connected to over-consumption and primarily of fossil fuels. Still, emissions continue to rise; carbon dioxide $C[O_2]$ levels are still increasing and up until today we have failed to complete any of the commitments of the Paris-agreement. Citizens of the world need to step up their game if we want to continue living in a climate that we are accustomed to, for by now, there is debate whether or not the temperature is rising.

“ climate change is a fact!” ¹

Greta Thunberg, 2019

Society has been inducing $C[O_2]$ exponentially to the terrestrial layer by burning fossil fuels since the industrial revolution. $C[O_2]$ that would have been locked up in sequestered state underground, otherwise far from escaping into the atmosphere. **This is a fact.** Carbon [C] combusted in the atmosphere reacts with oxygen and forms into carbon dioxide $C[O_2]$. **This is a fact.** $C[O_2]$ concentration in the atmosphere has exponentially increased the last century, far beyond historical variations. **This is a fact.** $C[O_2]$ in the atmosphere creates a greenhouse effect, by reflecting back the sun's radiation on the planet's surface, multiplying the heat radiation and driving up global temperature levels. **This is a fact.** Global climate temperatures are rising far

beyond historical temperature fluctuations, otherwise known as the Holocene variations. **This is a fact.** Consequently, all these facts come together to form a reasonable assumption that human induced climate change is a reality. **Global climate change is a fact.**

These are scientific facts on existing climate change and it has been so for a while now, but it was not until mid 2018, when Greta Thunberg sat herself outside the Swedish parliament that we can really say that the climate debate began for real. Today, school strikes occur every Friday under the banner *Fridays for Future*. The aim is to pressure decision makers globally towards acting in accordance with science, on behalf of inheriting generations and balancing climate.²

Whether or not the human species has induced an effect on the acting global climate change is beyond discussion, but just how much responsibility it must bear still is. Yet, it is questionable if such a debate is relevant at all. C[O₂] has under a short period of time been extracted from an isolated state and released into a pre-balanced ecosystem in which the human species thrives. Ultimately, creating a debt that is beginning to be felt. A debt that society must either learn to live with, embracing the suffering of all consequences, or must rid itself of. Taking the optimistic position of the latter, alternatives must be encouraged and communicated.

“The earth belongs... to the living... No man can by natural right oblige the lands he occupied, or the persons who succeeded him in that occupation, to the payments of debts contracted by him. For if he could, he might, during his own life, eat up the usufruct of the lands for several generations

*to come, and then the lands would belong to the dead, and not the living."*³

Thomas Jefferson, 1789

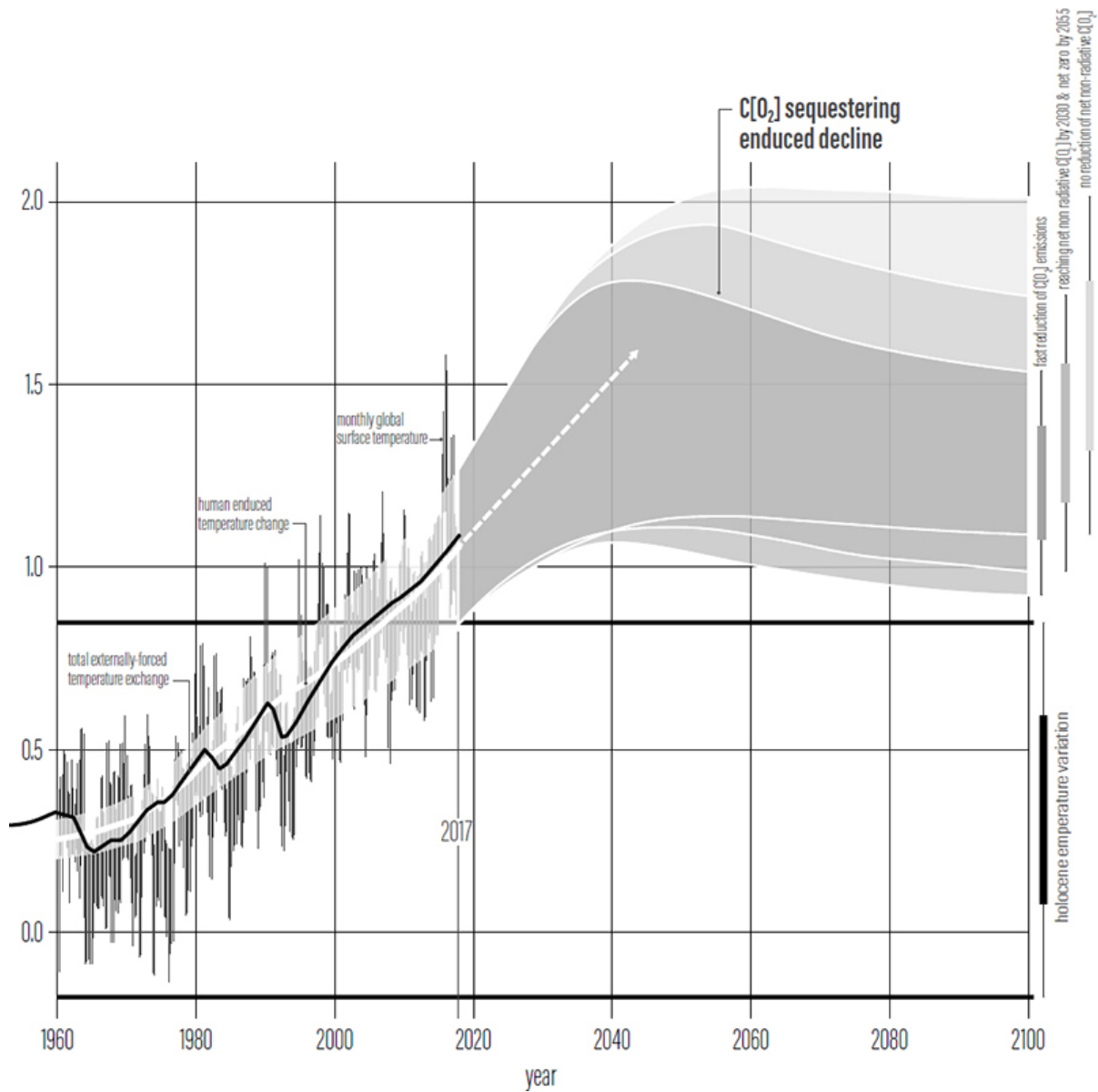
It ultimately becomes a matter of denouncing an excessive exploitation of climate indoctrinated by the generation of the 20th century and the neo-capitalistic set of values and repay the debt of C[O₂] to the ground. In doing so, successfully securing the stability and slow evolution of climate which upholds the livelihood of humankind.

diagram: IPCC, **temperature change relative to 1850-1900 [C°]**

[edit.] tommy vince

adobe photoshop, 2019

illustration showing the measured temperature levels rising, beyond the holocene temperature range.



¹ C. Alter, S. Haynes, J. Worland, 'Greta Thunberg', *Time 2019 : person of the year*, 23 December 2019

² G. Thunberg, *Fridays For Future*, <https://fridaysforfuture.se/> [accessed 20200925]

³ W. McDonough and M. Braungart, *Cradle-to-Cradle: remaking the way we make things*, United States, North Point Press, 2002, p.185

[re]balanced climate

sequestering terrestrial C[O₂]

The United Nations [UN] climate panel [IPCC] has together with the world's leading scientists summarized the reality of the situation with the following quote;

*“ **Limiting warming to 1.5°C implies reaching net zero CO₂ emissions globally around 2050** and concurrent deep reductions in emissions of non-CO₂ forcers, particularly methane (high confidence). Such mitigation pathways are characterized by energy-demand reductions, decarbonization of electricity and other fuels, electrification of energy end use, deep reductions in agricultural emissions, **and some form of Carbon Density Reduction [CDR] with carbon storage on land or sequestration in geological reservoirs.** Low energy demand and low demand for land- and GHG-intensive consumption goods facilitate limiting warming to as close as possible to 1.5°C.”⁴*

The highlighted phrases become increasingly interesting to the field of architecture and design, for it is supposed that we act within this space, articulating powerfully on the verb.

The IPCC follows up with projections of global temperature levels. The largest, indicating the projection when fossil fuels finally run out completely, meaning that society has

consumed to the extent of exhaustion everything that was available. While, the best projection indicates a fossil free society, TOGETHER with solutions which absorb and capture atmospheric C[O₂] and restore it in a sub-terrestrial layer. Yet, the IPCC doesn't offer any suggestions on which strategies or methods should be applied. It is however relatively achievable to roll out which strategies are not in harmony with this agenda; vegetational mass reduction such as deforestation, fossil fuel consumption and any other form of unbalancing of climate, most commonly connected to consumption.

IPCC has through various modules set an aim result of +1,5 degrees Celsius above preindustrial temperature levels. If the temperature average is kept below +1.5°C the global ecosystem, in its current state, will have a possible chance of sustaining in the state that we are accustomed to. Above +2,0oC and there is an extensive risk of an irreversible collapse of the ecosystem, beyond human control of rebuilding. At the current pace, the global temperature average will have exceeded +1.5°C by 2030⁵, some modules project it to be even sooner⁶.

The IPCC is clear with its evaluation that CDR or C[O₂] sequestration, as it will be called in this text, is necessary to reach the goal of +1.5°C. Acknowledging that call of duty, the profession of architecture should be asking itself, firstly how can it become fossil free and secondly how it can act as a sequestering agent within the global struggle of C[O₂] reduction!

“over the last century the voices warning of the dangers posed by dwindling natural resources, deforestation, the loss of bio-diversity, and air and water pollution, have been growing louder and more numerous. Increasingly, all around

the world and from all quarters, politicians, scientists, sociologists, philosophers and artists have been demanding respect for the environment and more sustainable forms of development.”⁷

It will take huge actions on societies' behavioral change to achieve the goal of +1.5°C, and realistically these huge actions should be taken by huge industries. **The construction and architectural industry are such huge actors, with a huge material mass output included in the built infrastructure. Similarly, proving a huge opportunity for C[O₂] sequestration.**

diagram: **global warming relative to 1850-1900 [°C]
and projections based on IPCC modeling**

[edit.] tommy vince, adobe illustrator, 2019

data from the united nation's [UN] intergovernmental
panel on climate change [IPCC]

*projected calculations of the global temperature increase,
where the best scenarios
include C[O₂] sequestering action.*





C[O₂]

the issue of rising C[O₂] levels in the atmosphere raises the demand for C[O₂] sequestering methods. to date, societies' options can be catagorized into two [2] conceptual strategies.



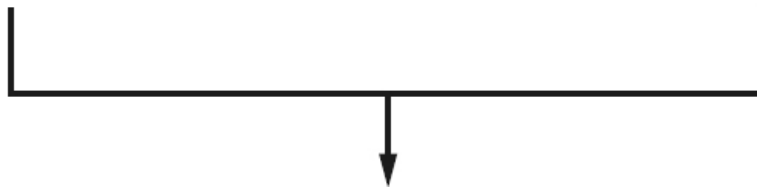
natural photosynthesis

natural processes include vegetational photosynthesis, a process that is already found in our ecosystem and is more or less autonomous from human intervention. It is extremely energy efficient in sequestering C[O₂] dependant on a renewable power source, the sun.



artificial / industrial

artificial C[O₂] sequestering processes are still in early stages, and could be looked upon more as visionary strategies. understanding the issue of creating perpetual machines indicates that these processes will most likely output more than they manage to sequester.



C[O₂] sequestration

sequestering C[O₂] from the atmosphere and securing it in an isolated state, creates a C[O₂] net reduction, which reduces the greenhouse effect and consequently antagonizes rising global temperature. C[O₂] storage may arguably occur either in space or, to date, preferably in the ground.

⁴ IPCC, Cross-Chapter Box 9, Chapter4 <https://www.ipcc.ch/sr15/> [accessed Oct 2019]