

Bio-Based Futureproofing

In search for context-feasible and user-adoptable biogenic strategies for Polish inter-war townhouses revival.



Research Plan

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Introduction.

Research Theme.

A pattern can be observed along "Grochowska", a prominent street in the "Grochów" section of Praga-Południe district in Warsaw. Long and short rows of residential townhouses are positioned along the avenue. They are strikingly similar to each other in their main topology as if having almost the same DNA, but through some phenotypical conditioning showing small variations from one to another. (Fig. 1)



Fig. 1 Dataset of building facades along Grochowska. Adapted from Google Street View.

In the Praga district, they were usually built to provide housing for incoming workers in the emerging industrial hub of right-bank Warsaw.¹

Shortly after the end of the 1st World War, Grochów as the biggest district, territory wise, had only 13% of its buildings made of brick, mostly single storey, which attributed to 90.7% of all residential building

¹ Aleksander Łupienko, "Kamienice Czynszowe Warszawy," *Instytut Historii PAN*1, no. 1 (2015), <http://rcin.org.pl>.

stock.² Only a few buildings had access to running water or sewage.³ During the first half of inter-war period, much of Grochów was still like a '*Far-West*' of Warsaw, with vast slums for homeless people covering swampy regions.⁴ But thanks to multiple stimulus plans, the district was developing fast, especially during 1933-1939, when the Grochowska street got a hard surface makeover and over 80 town houses were built along the street.⁵ Those townhouses were the first non-representational brick-and-mortar architecture in the area filled with otherwise dilapidated single-storey wooden huts and a chaotic mix of suburb-village dwellings scattered around rail-dominated landscape, fields and wetlands.⁶

Rows were formed by building the townhouses in batches or one after the other, possibly by the same construction teams and craftsmen, with general knowledge from the industry at the time about low-cost housing (Fig. 2). Thus, the similarity between them. They were, unlike the common post-war big plate residential blocks, not built with a modular system in mind. I see, however, a potential to treat them as a family, or of the same building "species" at least. That family of buildings, importantly, is not exclusive to Grochowska Street, as I could observe rows of such buildings in other parts of Warsaw or even other cities in Poland (Fig. 3).

What they share, without doubt, is the sorry state most of them are in. In some places the insulation is non-existent and bare brick is exposed to the outside (Fig. 4). There is a need in society to properly revive and sufficiently futureproof them so that their energy efficiency adheres to or even surpasses upcoming regulations. As they share similar characteristics, I see a potential to do it at scale and in a systematic way so that most such buildings could benefit from the same set of guidelines. A similar approach but applied to post-war big-plate modular residential block complexes, naturally, enjoys a fair amount of academic and practice interest⁷, both in Poland and Europe in general. There seem to be, however, little effort put into the issue of the topical town houses. How to get it right? Where to start?

² Magistrat Miasta Stołecznego Warszawy, "Rocznik Wydziału Statystycznego Magistratu m. St. Warszawy. R. 1916," *Centralna Biblioteka Statystyczna* (Warszawa: Magistrat m.st. Warszawy, 1919), 105–15, https://mbc.cyfrowemazowsze.pl/dlibra/publication/40241/edition/37638/content?format_id=2.

³ Magistrat Miasta Stołecznego Warszawy, 111–13.

⁴ Bruno Kiciński and Ludwik Adam Dmuszewski, "Grochów," *Kurier Warszawski: wydanie wieczorne*. R. 109, 1929, nr 93, April 6, 1929, <https://crispa.uw.edu.pl/object/files/213113/display/PDF>.

⁵ Katarzyna Komar-Michalczyk, "Ku Nowoczesności - Rozwój Grochowa w Okresie Międzywojennym," *Kronika Warszawy* 1, no. 132 (2007): 27.

⁶ "KRONIKA WARSZAWY," *KRONIKA WARSZAWY* 1, no. 132 (2007).

⁷ Krzysztof Barnaś et al., "Algorithm for the Comprehensive Thermal Retrofit of Housing Stock Aided by Renewable Energy Supply: A Sustainable Case for Krakow," *Energy* 263 (January 15, 2023): 125774, <https://doi.org/10.1016/J.ENERGY.2022.125774>.



Fig. 2 Grochowska 281 during construction and Grochowska 283 just after completion. 1936. National Archive in Warsaw.



Fig. 3 Townhouse rows in different cities. Adapted from Google Earth.



Fig. 4 Examples of deterioration, Grochowska 271,275, 283. Google Street View, 202

Theoretical Basis.

Paradigm Shift

The global society needs to change drastically to avoid furthering the climatic catastrophe that looms ever stronger over us, and at the same time prepare for incoming effects of our past and current activity. Thus, climate mitigation and adaptation must go together in tandem within architecture and built environment practice. As per the last AR6 IPCC Report, if only CO₂ emissions were to be considered, it's estimated that built environment contributes 31% to the whole world emissions, and while this itself is alarming, it is also somewhat optimistic to consider that the AEC sector has great, "low hanging fruit" type potential to reduce its emissions by a large margin (Fig. 5).⁸ This, however, is progressing too slowly and needs to be accelerated.⁹ Given all the knowledge I have so far, giving my best to make it happen is one the only ethical options I can consider in the future.

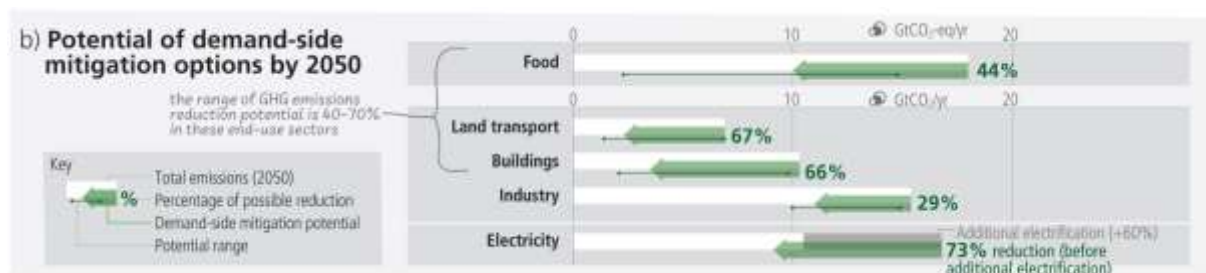


Fig. 5 Potential of demand-side mitigation of GHG emissions for Buildings and other sectors. IPCC AR6. 2022.

While the developing countries will need to find sustainable ways to provide newbuilt housing and healthy environments for their fast-growing populations, the gulf states will use their oil-based riches to invest heavily in carbon sinks or other, hopefully, ethical businesses. The decelerating developed old world, like Europe, according to Indy Johar from Dark Matter Labs, will have to find ways to mostly make use of what is already available. The reuse, refurbishment, retrofitting and in general future proofing is going to be the new normal for architecture practice.¹⁰

Biobased Future

With most of the growth happening in Asia and Africa. Europe's challenge lies in renovating its ageing building stock, 80% of which is expected to remain standing in 2050. Approximately 35% of EU buildings are at least 50 years old, and 97% fall short of future carbon reduction targets.¹¹ This underscores the importance of addressing both new construction and renovation in the pursuit of net-zero emissions.

Embodied carbon, or sometimes referred to as upfront carbon, encompassing emissions from material production to end-of-life, can contribute as much as 50% of a building's total carbon

⁸ IPCC, "Buildings," *Climate Change 2022 - Mitigation of Climate Change*, 2022, 953–1048, <https://doi.org/10.1017/9781009157926.011>.

⁹ Jennifer Hahn, "Architecture 'Lagging behind Other Sectors' Says IPCC Climate Report Author," April 6, 2022, <https://www.dezeen.com/2022/04/06/ipcc-climate-change-mitigation-report/>.

¹⁰ "Lecture: Indy Johar – Designing Our Futures | Live Stream - YouTube," accessed October 20, 2024, <https://www.youtube.com/live/knDC8hXDdHE>.

¹¹ World Green Building Council, Ramboll, and C40 Cities, "Bringing Embodied Carbon Upfront" (London, September 2019), 22, www.worldgbc.org/embodied-carbon.

footprint¹². The situation becomes increasingly significant as buildings become more operationally efficient, highlighting the urgency of minimizing upfront emissions.

To limit global warming to 1.5°C, the building industry must reduce its emissions by 96%.¹³ For new housing in Denmark, this translates to a target emission level of 0.4 kg CO₂eq/m²/year, assuming a constant construction rate, which is quite conservative. This reduction should ideally be achieved between 2029 and 2036.¹⁴ As Martha Lewis noted during the Obel Award Talk – *'we simply do not have the carbon budget left'*, nor confidence any more to build something long lasting hoping it wouldn't be demolished in 20 years, while overlooking obvious low embodied carbon alternatives.¹⁵ So, everything needs to happen with keeping track of the overall carbon balance of all interventions, keeping the embodied energy and pollution as low as possible in the long run, and bearing in mind the exergy and anergy flows to take advantage of them properly.¹⁶

So far, the safest, proven, and most natural solution is to simply build with what is readily and locally available, without much added energy or materials, meaning all biogenic materials like timber, hemp, natural fibres, bamboo, adobe and many others. Those have multiple benefits, among them, for example, carbon sequestration potential.¹⁷ They absorb carbon during their growth, and after harvest, new biomass can be planted in their spot, which can offset emissions from other lifecycle stages. Additionally, such materials can be easily recycled, which is true also for steel or some other carbon intensive materials, but recycling cannot be taken for granted oftentimes. Even better, if recycling is not possible, bio-based materials just biodegrade gracefully. One could go on mentioning other issues that commonly used non-bio-based materials share, like chemical or microplastic pollution etc.

There is additional, less technical and vaguely tangible virtue of bio-based materials, which is ingrained in us over millennia of shaping our built environment with what was available – the natural warmth and pleasant aesthetic familiarity to them. They simply can be digested. Only recently did people started seeing doubt in them while exploring all the new oil-, concrete- or steel- based alternatives.

Thus, delivering on all those qualities, I think, requires considering almost exclusively bio-based low embodied carbon material solutions. That is the first premise of my interest and position as an architect.

Giving Back

The second is that I wish to use my master graduation to develop a mature project, feasible for completion in near future (5-10 years). To ensure this, I chose to work in the context I am already familiar with, so I can save time and effort on otherwise time-consuming familiarizing myself with the new reality, searching for a fleeting sense of place, still risking high chances of mismatching the cultural context. I feel strong connection to my neighbourhood in Warsaw, I roughly know it's story and issues, experiencing the good and the bad while growing up there. I would like to give back to it and

¹² Lisa Burns et al., "Reducing Embodied Carbon in Cities: Nine Solutions for Greener Buildings and Communities," April 2024, 3.

¹³ Reduction Roadmap (2022), "Reduction Roadmap: Preconditions and Methodologies," 2022, 25.

¹⁴ Reduction Roadmap (2022), 27.

¹⁵ Sam Draper et al., "Embodied Emissions" (Obel Award Talks, July 3, 2023).

¹⁶ David Benjamin, ed., *Embodied Energy and Design: Making Architecture between Metrics and Narratives* (Columbia University GSAPP, 2017),

[https://discovery.upc.edu/iii/encore/record/C__Rb1498725__Sembodied energy__Orightresult__U__X6;jsessionid=E0F52135AB1C74325D4291193110D085?lang=cat](https://discovery.upc.edu/iii/encore/record/C__Rb1498725__Sembodied_energy__Orightresult__U__X6;jsessionid=E0F52135AB1C74325D4291193110D085?lang=cat).

¹⁷ World Green Building Council, Ramboll, and C40 Cities, "Bringing Embodied Carbon Upfront," 26.

its people, as otherwise not much effort has been put into making things better there. The situation is slowly changing for the better, some buildings are being revived,¹⁸ but I am afraid of complete gentrification of the area if not steered in the right direction, even with my small contribution of this graduation project that I could present to local authorities, people, and designers.

The User Aspect

I also strongly feel a connection with teachings of Giancarlo de Carlo relating to architecture of participation. The *'prospect of taking architecture away from the architects and giving it back to the people who use it'*,¹⁹ is one I am very interested in along the author (Fig. 6). I look forward to enabling as much as possible a democratisation of design and its pliability not only in the concept stage but also after completion, allowing a building to mutate and co-evolve with its users as much as it is reasonably possible. Too often it still happens that *'the wishes of future users are either ignored on principle or overthrown by the application of models which suit the interests of the promoters of the visions of the designer.'*²⁰

There is a considerable body of literature regarding the user adoption and preferences for refurbishment interventions, especially in western European²¹ and Mediterranean contexts²². "Beyond the Current" is one example of a long running research project regarding futureproofing of the Dutch inter- and post-war walk-in residential housing, thoroughly seeing into residents' comfort and aesthetic preferences on a large sample size.²³ Such research endeavours, however, to be done properly and yield meaningful contribution to knowledge, are not feasible within the timeframe given for graduation research. Thus, my research is going to be reduced in scope. There is, nonetheless, a need for such research done in the Polish context and I hope someone will begin the work soon. There are already publications in the Polish context that pertain to refurbishment of housing and public use buildings²⁴, however, they serve as general guidebooks in the building and economical context, not necessarily in architectural or aesthetic one.²⁵ They provide knowledge about the current market standards, which are by no means biobased, and yet, those do not consider sufficiently proven user adoption rate or their preferences.

¹⁸ "Kamienica Na Kamionku Zrewitalizowana – Mieszkaniec," accessed October 22, 2024, <https://mieszkaniec.pl/kamienica-na-kamionku-zrewitalizowana/>.

¹⁹ Giancarlo De Carlo, "An Architecture of Participation," *Perspecta* 17 (1980): 77, <http://www.nomads.usp.br/virus/virus18/?sec=4&item=3&lang=en>.

²⁰ De Carlo, 78.

²¹ Roberta Cucca and Michael Friesenecker, "Potential and Limitations of Innovative Housing Solutions in Planning for Degrowth: The Case of Vienna," *Local Environment* 27, no. 4 (2021): 502–16, <https://doi.org/10.1080/13549839.2021.1872513>.

²² Lise Desvallées, "Low-Carbon Retrofits in Social Housing: Energy Efficiency, Multidimensional Energy Poverty, and Domestic Comfort Strategies in Southern Europe," *Energy Research and Social Science* 85 (March 1, 2022), <https://doi.org/10.1016/j.erss.2021.102413>.

²³ "Beyond the Current," accessed October 16, 2024, <https://www.tudelft.nl/en/beyond-the-current>.

²⁴ Jerzy Sowa, "Termomodernizacja i Unowocześnienie Budynków Użyteczności Publicznej," *Fundacja Poszanowania Energii*, n.d.

²⁵ Andrzej Wiszniewski, "Modernizacja Systemu Zasilania w Ciepło Budynków Mieszkalnych," *Fundacja Poszanowania Energii*, n.d.



Fig. 6 Giancarlo de Carlo working with his team. (Perspecta, 1980)

The Pressing Issue.

Problem Statement

While the broad theme of working with existing building stock gains increasing attention in both theory and practice²⁶, in the wider Polish architectural discourse, especially in renovation, bio-based solutions are still considered a niche, experimental or somewhat fringe idea. The will in young generation to push change is strong, however it struggles to bring the proven ideas to the general practice and future end users. It feels like young innovative architects and established practices operate in two quite separate worlds. The fact that there is a lack of easily available knowledge base directed to laypeople in an accessible way possibly does not help in that reality.

Bio-based materials come with challenges to be aware of. With fast paced innovation and discreteness of the industry, it is often difficult to find reliable data about their properties. Environmental Product Declarations (EPDs) might help with that, but only a small percentage of suppliers go that far. On the other note, eager and bold designers sometimes tend to forget for whom the architecture is that they propose. Focusing on innovation for the sake of it or individual aesthetic ideas that might help provide some media traction or an edge in competitions. It can happen that people are not entirely happy for the interventions, feeling uncomfortable or even unsafe in their own living environments after completion.²⁷ Or else, combined with younger well-off generations interest in novel "trendy" atmospheres, the same strategies that were supposed to help original, often energy impoverished users, gentrify the housing complex or area and push them away from it.²⁸



Fig. 7 Adding Styrofoam insulation - Standard practice in Poland. Murator.pl²⁹

²⁶ Liliane Wong, "Adaptive Reuse: Extending the Lives of Buildings," 2017, 256.

²⁷ Katrin Grossmann and Sandra Huning, "Energy-Efficient Retrofitting and Affordable Housing: Open Questions for Urban Research and Practice.," 2015.

²⁸ Leo Oorschot and Thaleia Konstantinou, "Retrofit for Continuity! Sustainability and Gentrification of Tenement Apartment Blocks in Dutch Cities from Inter and Post War Period," *Living and Sustainability*, 2017.

²⁹ "Jak Obliczyć, Ile Potrzeba Styropianu Na Ocieplenie Domu i Jaki to Będzie Koszt? - Murator.Pl," accessed October 22, 2024, <https://murator.pl/budowa/elewacja/jak-obliczyc-ile-potrzeba-styropianu-na-ocieplenie-domu-i-jaki-to-bedzie-koszt-kalkulator-aa-cxka-GNWr-uSwt.html>.



Fig. 8 Insulating with straw - bio-based alternatives for futureproofing buildings.³⁰

Research Questions

Within the given timeframe and available resources, combined with my personal interests, I would like to explore the potentials for bio-based materials use in the Polish context, coming up with a collection of materials and techniques in general. Furthermore, exploring how such a readily available collection can help the innovation be more approachable and improve user adoption of biogenic solutions for futureproofing and architectural design in general. Additionally, I am concerned with people that the bio-based innovation is meant for directly, the users. What are their needs and priorities in regard to refurbishment, and consequently crucial for me and other designers – how bio-based solutions fit into those.

- Main Question - Viability and Knowledge Dissemination
 - *How can an accessible knowledge base of bio-based renovation techniques increase their market acceptance and practical application in the Polish architectural context?*
- Side Question - User-Centric Design and Impact
 - *What are the challenges and opportunities in implementing bio-based renovation strategies that balance innovation with the needs and preferences of existing users in inter-war Polish townhouses?*

³⁰ "Haus P&W | 0451_Casa_Steil_Mar," accessed October 22, 2024, <https://www.atelierschmidt.ch/sanierung-susch?pgid=jdue1rbe-7744018c-ef24-464c-bdc6-79566148255b>.

Methodological Plan and Positioning

Research Design Composition / Diagram

The research plan with motivation, methodology and possible outcomes presented in the below graph.

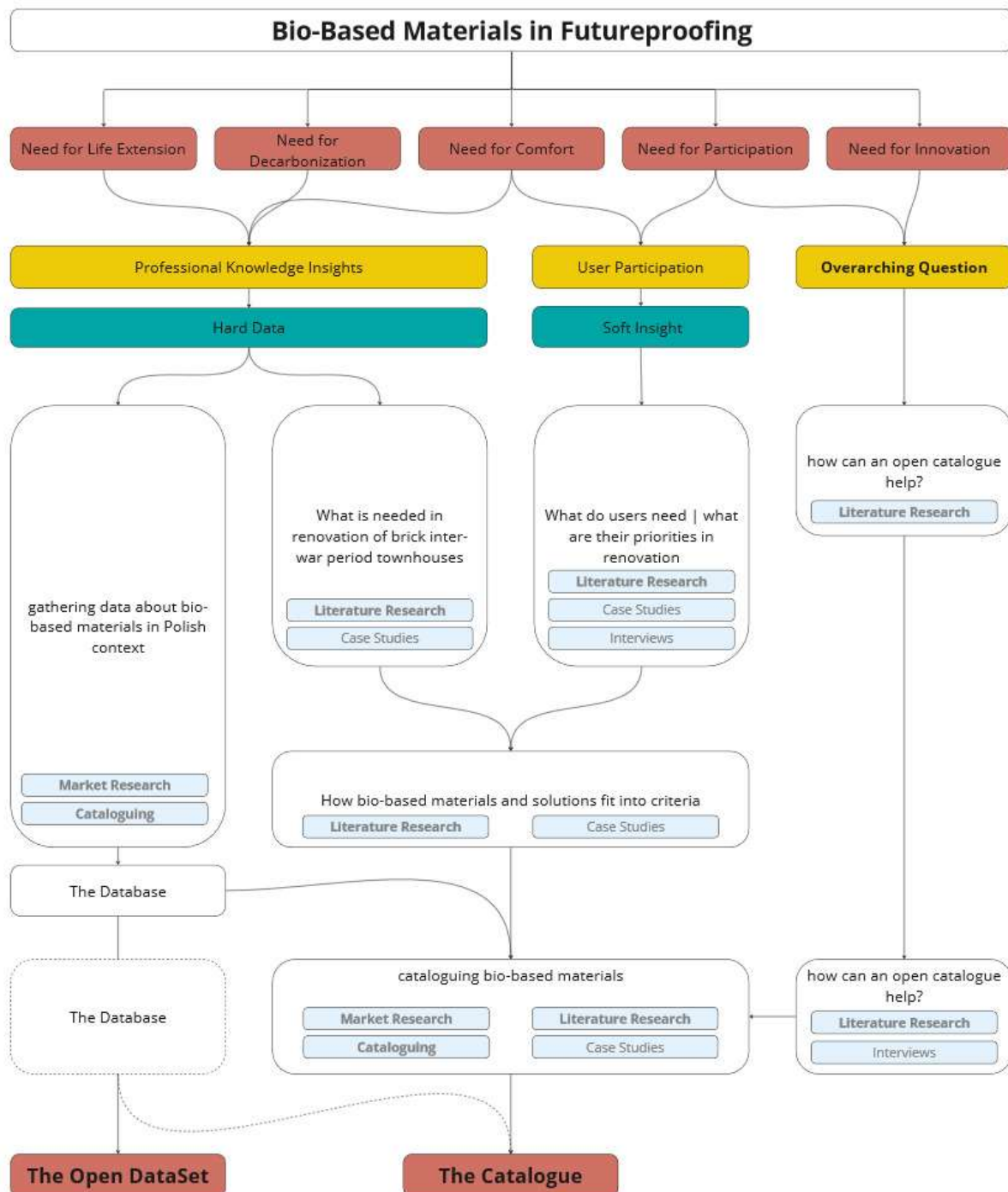


Fig. 9 Research Composition.

Research Methods

Steps and Methods

1. What is needed in Renovation of this type of townhouses in general
 - a. Literature Research
 - b. Case Studies
2. What do users need and what are their priorities in renovation.
 - a. *What parameters in materials are sought after for various purposes.*
 - b. *What are the challenges with using bio-based materials.*
 - c. Literature Research
 - d. Case studies
 - e. Interviews
3. How do bio-based materials fit into refurbishment process
 - a. *Where they give the most benefits*
 - b. *Where can they be applied*
 - c. *Where there is no point really to use bio-based*
 - d. Literature Research
4. Cataloguing materials and techniques
 - a. Market Research in Polish context
 - i. EPD browsing
 - ii. Quotations from Companies
 - b. Literature Research
 - c. Case Studies
5. How can an open catalogue like this help
 - a. Literature Research
 - b. Interviews

Literature Research

Literature Research will be the basis of all research I am going to pursue. It is going to include academic papers, reports, journals, professional publications, and books, available online interviews, and other publications. When looking for information, especially in non-academic sources, I will be aware of potential biases and private interests of publication issuers.

In terms of bio-based materials and solutions available on the Polish or more general Eastern European context, I plan on exploring academic and other published writing about current established and promising researched technologies.

Literature research will also help me to see about what matters to users for whom refurbishment practices are being planned and analyse accounts of users whose living spaces were improved, preferably with bio-based materials, and how they feel about the change. What are people's needs in future proofing, what metrics are important for them in the short and long run.

Case Studies

I will investigate case studies of Polish or Eastern European buildings to which a bio-based futureproofing intervention was applied successfully or unsuccessfully and try to extract knowledge out of those realised projects. Information for case studies will be collected either from various independent publishers, like a curated collection of case studies, or private accounts issued by the authors. When sourcing information from private authors, potential biases must be taken into account.

Polish Market Research

The starting point and somewhat a basis for the catalogue will be market research in the Polish context. I will explore what's available in the current setting and what might gain market viability in the near future. That would involve browsing websites of Polish construction and technology companies, and material or systems suppliers, asking for product brochures and EPDs, having calls with representatives, or possibly short interviews about current and future agendas of those companies, be it established or emerging ones. With earlier established metrics, based on the information I will be able to gather, I will be then annotating a database of bio-based materials, further used for the catalogue.

Interviews

To supplement the literature research, I plan on interviewing familiar researchers and practitioners in refurbishment or bio-based materials fields on proven strategies that can be applied now, and possible near future developments in the field.

While in Warsaw, I also plan to interview focus groups about general needs in terms of futureproofing in the local context of Grochowska residential row. The focus groups will be local authorities and a housing association of one of the buildings. What are people's needs, what they see as important or non-negotiable, what are they afraid or unsure of. Those in person interviews contrasted with accounts from academic research in search of common themes or possible discrepancies might help me define which bio-based solutions have less or more ground for success specifically in my design project.

Interviews will require thorough preparation, asking for publishing permission, and the extent of published information regarding the personal data of people being interviewed. Possibly the names of interviewees would be anonymised. A set of questions will be prepared beforehand.

Cataloguing

As I reflected with my veduta (Fig. 10) on my general interests at the beginning, it's in the realm of data cataloguing, curation, and data analysis to further use in design process. The final stage of research will be gathering all the collected data first into an easily parsable database, and then constructing a user readable and generally accessible booklet/ catalogue of strategies/ buildups. This will be started as soon as possible, but with more data and knowledge coming throughout the research, it might change a little towards the final version.

The metrics and parameters which are going to be filled for each entry, are going to be defined at the beginning, but might change over time. Those could be for example: Embodied Energy [MJ/kg], Global Warming Potential [kg CO₂eq/kg], Cost [PLN/kg], Thermal Conductivity [W/mK], etc...

I imagine that the outcome (which is described in more detail later) could be built upon later and evolve over time in a crowd source manner to benefit from updated data and continue its viability into the future. This would be translated into both English and Polish language.



Fig. 10 Veduta showing my initial fascination with collection and curating data into information and knowledge.

Expected Outcomes.

The outcome I envision is a collection of best practice bio-based material strategies for dealing with futureproofing of buildings falling into architectural category of inter-war period Polish town houses. This could also evolve into a guidebook for designers and possibly housing associations or local governments to inform about locally available bio-based possibilities to consider while performing revival works on the buildings. Another possibility is a collection / dataset of such strategies / envelope buildups that could be easily browsed on the internet.

The structure of the guide / dataset could be:

1. Buildups
 - a. Façade envelope
 - b. Interior walls
 - c. Roof
2. Layers
 - a. Insulation
 - b. Acoustic isolation
 - c. Cover panels
- d. Whole façade systems – like eco-cocoon (straw bale)
3. Materials
 - a. Timber
 - b. Wood fibre
 - c. Hay
 - d. Mycelium
 - e. ...

This then, in the form of a database, might as well be implemented in Grasshopper for preliminary concept stage live LCA calculations/ estimations. It could be essentially a bio-based material and buildup dataset for Poland that could be used further in my or other people's designs.... Or maybe, it could be an interactive website, in the likes of "Material Pyramid"³¹. Students, designers, and end-users could easily browse in search of knowledge or inspiration, making it easier to choose such options instead of established yet carbon-intensive "alternatives", and already have some indication on who might provide the materials or technologies (Fig. 11).



Fig. 11 Example of how the end result might look like – a context specific catalogue with most important parameters.

³¹ "Byggeriets Materialepyramide," accessed October 22, 2024, <https://www.materialepyramiden.dk/>.

Relevance of the Research.

The research outcomes that I imagine have the potential to fill out the knowledge/ information/ data gap that exists in the Polish renovation practice about readily available and promising bio-based solutions. It could help make bio-based options more approachable and trustworthy from conservative designers' and homeowners' perspectives. Depending on the form of the publication, it could also serve as a helpful resource for students. Moreover, it can, by a large amount, be applied also to newly built bio-based architecture, which broadens the scope of potential influence.

Interrelationship with the Design.

The outcomes of the research could be directly used as a basis or starting point in my design proposal, as it aims to search for a system for futureproofing of inter-war period townhouses, especially along Grochowska Street, using bio-based technologies. In my design as an initial idea, I would like to experiment with the systematic approach and mass customisation possibilities for those buildings' revival and futureproofing. I would possibly focus on two of the neighbouring buildings in a row to implement differentiating strategies in terms of their scope, aesthetic qualities and general spectrum of feasibility of the proposal. This would show the envisioned variety of end results coming out of the same set of rules and parts. In a way showing also my fascination with how complexity can emerge from quite a simple set of criteria. The developed guidebook/ dataset could be used in the preliminary concept stage to make strategic choices and further feedback on the initial collection itself by the "evaluation by design" method.

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