FO219
MATERIAL PERSPECTIVES

MATERIAL PERSPECTIVES
TOWARDS REGENERATIVE BIOREGIONALISM IN THE OBERPFALZ

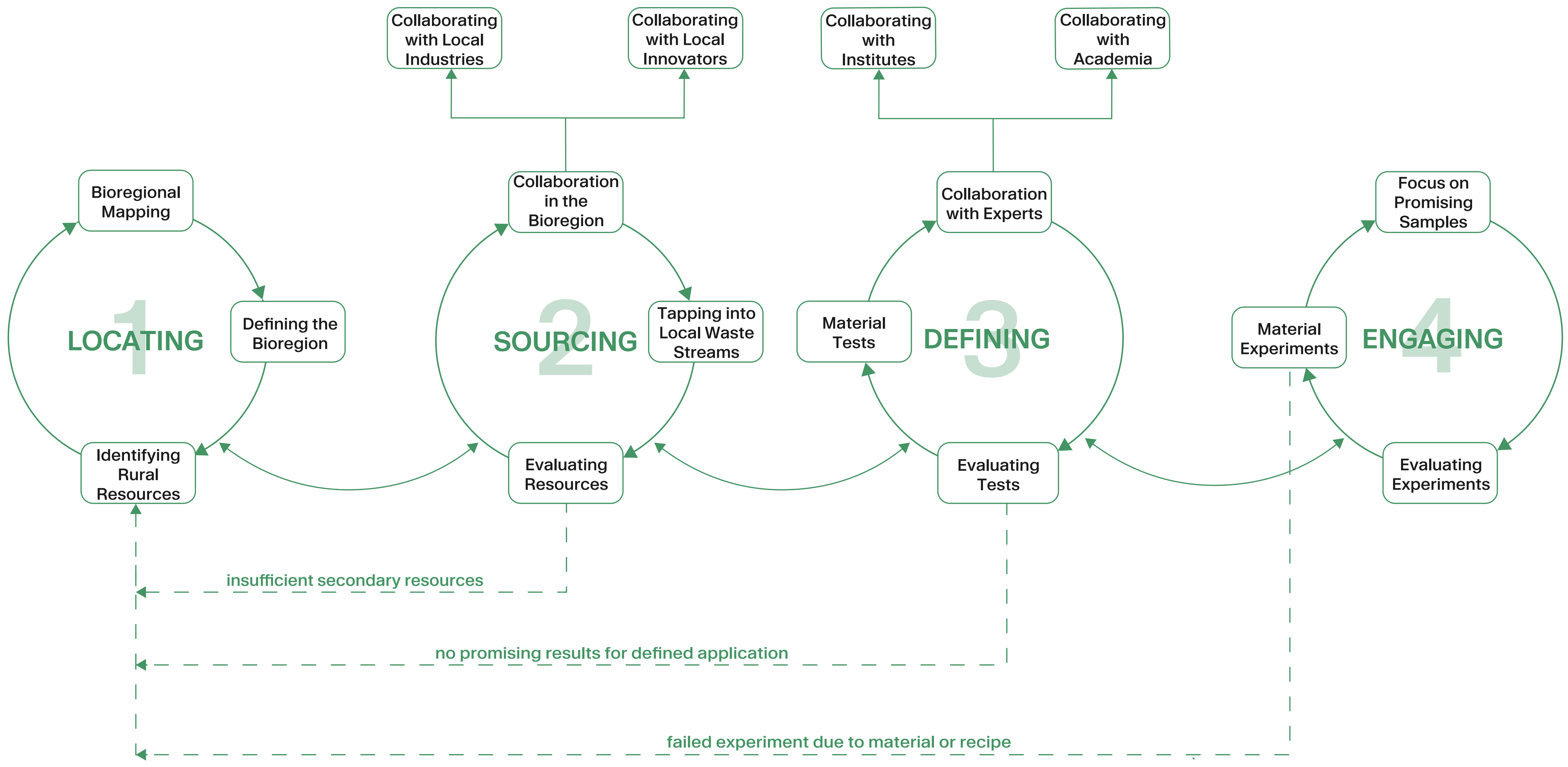
Our Master Thesis „Material Perspectives - Towards regenerative bioregionalism in the Oberpfalz“ explores the concept of regenerative bioregionalism, emphasizing the integration of undervalued local resources and circular practices within the construction industry. Focusing on the Oberpfalz region in Bavaria, Germany, the project identifies and repurposes industrial by-products—such as waste from glass, porcelain, and kaolin mining industries—into sustainable construction materials like geopolymers and supplementary cementitious materials (SCMs). This circular approach reduces environmental impact, supports biodiversity, and strengthens local economies.

The project targets architects, construction companies, local industries, policymakers, and communities seeking sustainable and region-specific building solutions. Through close collaboration with regional stakeholders, including academic institutions and industrial partners, the project fosters knowledge exchange and practical innovation.

Key objectives include reducing carbon footprints by minimizing energy-intensive primary materials, advancing the circular economy through the innovative use of regional waste, empowering local communities by creating economic opportunities, and setting a replicable framework for applying bioregional methodologies in other regions.

The project has achieved significant outcomes, including the comprehensive bioregional mapping of Oberpfalz, the successful testing of secondary materials for construction, and the establishment of a collaborative network between local industries and academia. These results contribute to shaping a circular industrial ecosystem and inspire scalable, sustainable building practices across Europe.

By creating a methodology that can be adapted and applied to other regions, Material Perspectives offers a blueprint for transforming the construction industry into a more sustainable and resilient sector, benefiting both the environment and local economies.



BIOREGIONAL METHODOLOGY

STEP 1 LOCATING: ECONOMICAL RESOURCES
REGIONAL PRODUCTION AND BY-PRODUCTS


INDUSTRY VISITS

LOCAL HEREDITARY PRODUCERS

Stone Quarries
- Bärnreuther Deuerlein Schotterwerk
- H. Geiger GmbH

Porcelain suppliers and manufacturers
- Strobel Quarzsand
- Gebrüder Dorfner
- Amberg Kaolin Eduard Kick GmbH & Co. KG
- Porzellanfabriken Christian Seltmann GmbH
- BHS Tabletop AG

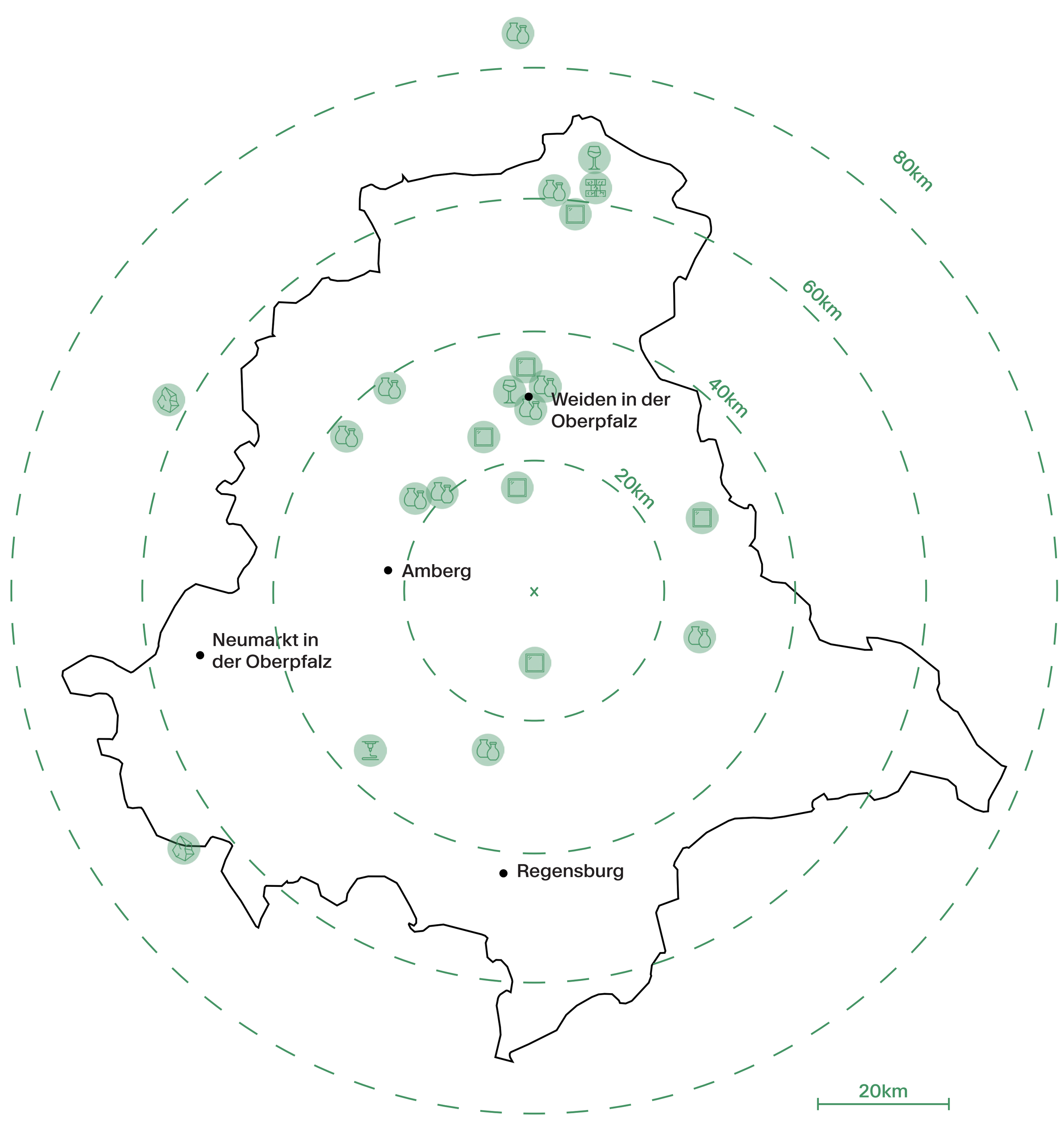
Drinkware Glass production
- Nachtmann Weiden Factory GmbH
- Glashütte Lamberts

Sheet glass production and processing industries
- Glas Schöninger GmbH
- Gründelglass
- Köhler GmbH
- Pilkington AG
- Flachglas Wernberg
- Glasbau GmbH
- Irlbacher Glas

LOCAL INNOVATIVE PRODUCERS

Additive Technologies
- FIT Additive Manufacturing Group
- Additive Tectonics

Recycled Foam Glass
- GLAPOR Werk Mitterteich GmbH



INDUSTRY IN THE OBERPFALZ

STEP 2 SOURCING: MATERIAL ARCHIVE
COLLECTED SECONDARY MATERIALS

M-01
Glass Grinding Sludge
20 t/a
finely ground glass from drinkware production and heavy metal particles due to tool abrasion

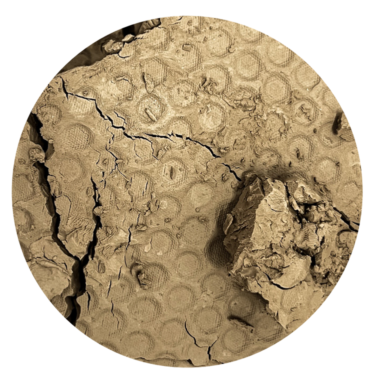
M-02
Oily Glass Shards
n.s.
broken glass from drinkware production and engine oil

M-03
Brick from Melting Furnace
n.s.
sand, clay, lime, iron oxide

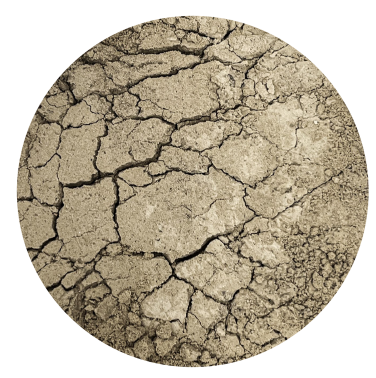
M-04
Filter Dust from Melting Furnace
20 t/a
quartz sand, sodium oxide, potassium oxide, zinc oxide, barium carbonate, etc. (ingredients for glass making)

M-05
Glass Grinding Sludge I
103 t/a (combined with M06)
finely ground glass from grinding machine I in the sheet glass production and heavy metal particles due to tool abrasion

M-06
Glass Grinding Sludge II
103 t/a (combined with M05)
finely ground glass from grinding machine II in the sheet glass production and heavy metal particles due to tool abrasion



M-07
Filter Presscake
160 t/a
lime sandstone, dolomite, clay



M-08
Dune Sand
n.s.
silica sand (round grained)

M-09
Kaolin Sludge
400 t/a
kaolin, quartz sand, feldspar

M-10
Ceramic Shards
300 t/a
kaolin, quartz sand, feldspar

M-11
Off-Cut Foam Brick
n.s.
offcuts from foam glass production, collected from the BioDesign Lab archive

M-12
Ultra-fine quartz
45.000 t/a
fine filling material

M-13
Kaolin VP 20101-02
40.000 t/a
residual material with kaolin content, pre-sifted

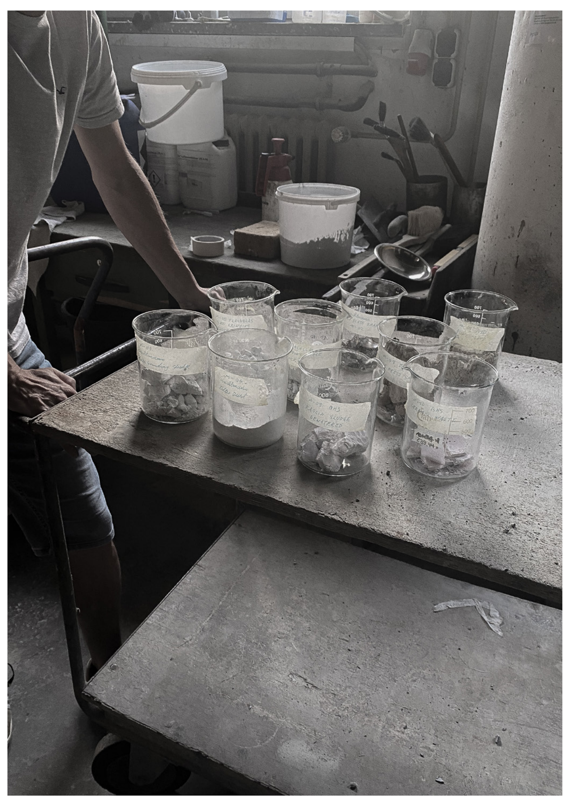
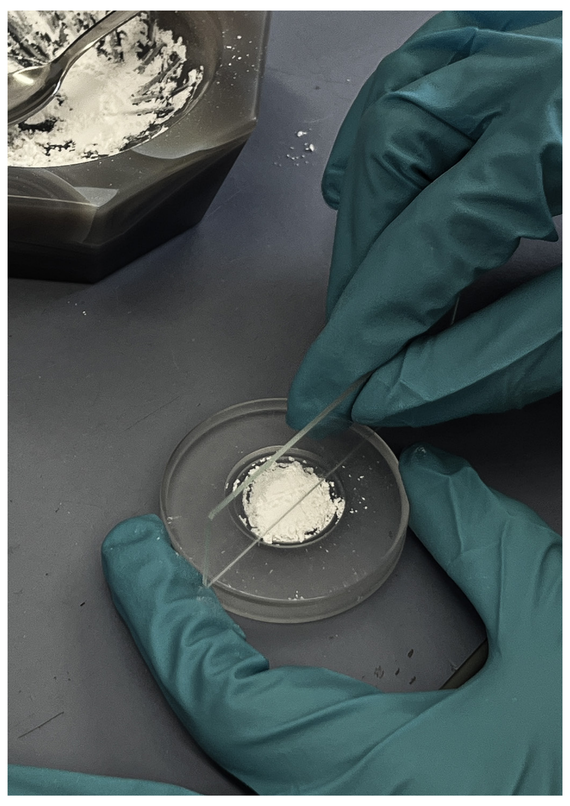
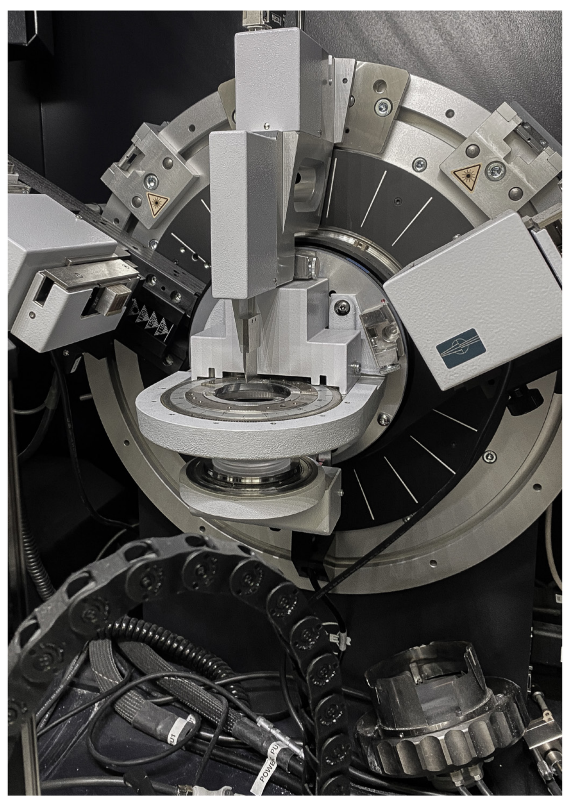
M-14
Kaolin VP 20101-06
40.000 t/a
residual material with kaolin content, pre-sifted and fired at 750 °C

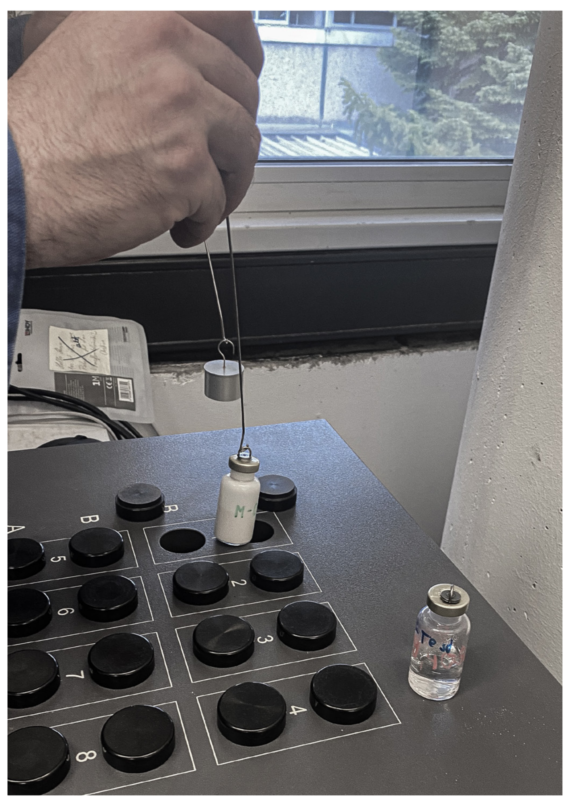
M-15
Quartz gravel
7.000 t/a
coarse filling material

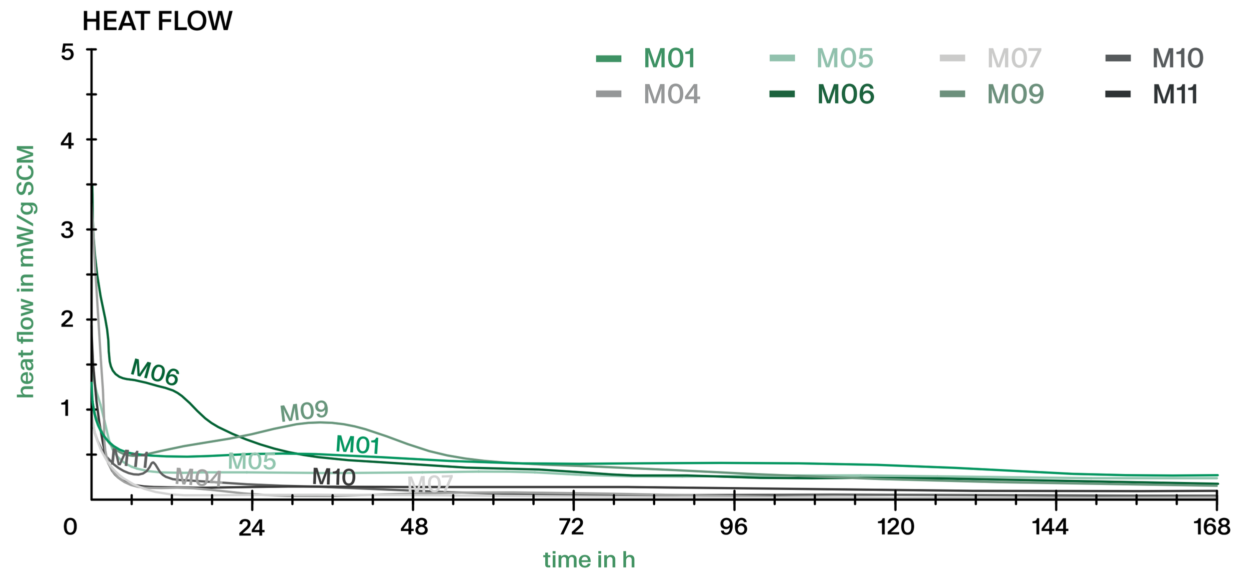
M-16
Metakaolin
not a residual material
product for reference purposes in future testing

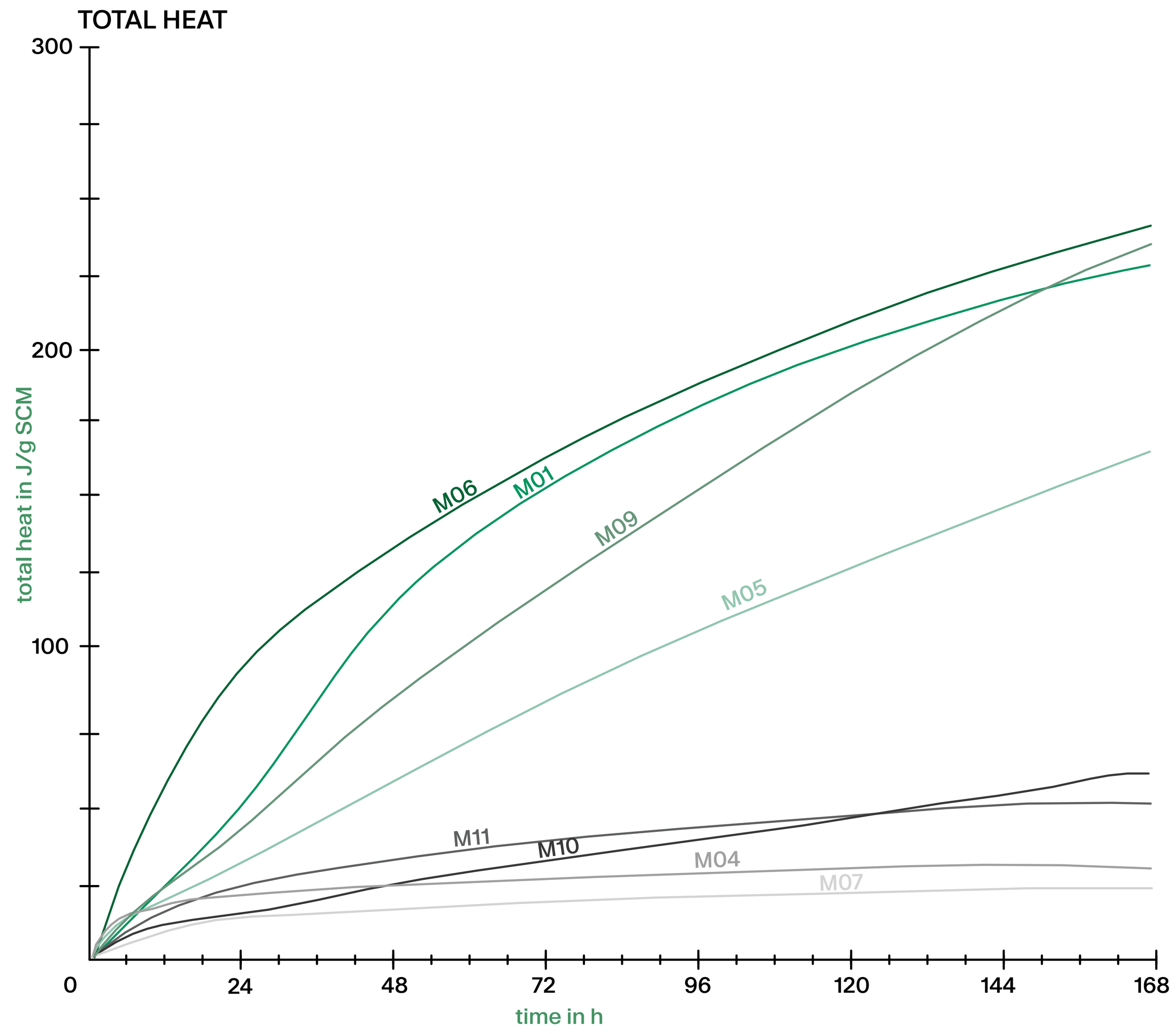
FO219
MATERIAL PERSPECTIVES

STEP 3 DEFINING SUITABLE SCOPES
ANALYSIS AND EVALUATION





REACTIVITY TESTING

STEP 4 ENGAGING: EXPERIMENTS AND RECIPES
POTENTIALS IN CONSTRUCTION

In the Defining phase, the potential of secondary materials is unlocked through extensive laboratory testing and material analysis. Partnering with the Center for Building Materials at the Technical University of Munich (TUM), we investigated by-products from local industries, including kaolin sludge, glass-grinding sludge, and ceramic shards. These waste materials, often discarded as landfill waste, were analyzed to identify their structural and chemical properties for potential applications in construction.

For example, kaolin sludge, a by-product of porcelain manufacturing, demonstrated exceptional reactivity, making it an ideal candidate for geopolymer binders. These binders offer a sustainable alternative to Portland cement, which is responsible for a significant portion of the construction industry's CO_2 emissions. Similarly, glass-grinding sludge, a by-product of crystal and sheet glass production, was tested as a supplementary cementitious material (SCM). When mixed with traditional cement, it provided strength-enhancing properties while reducing the carbon footprint.

Advanced testing techniques such as X-Ray Diffraction (XRD) and the R3 Reactivity Test allowed us to refine the composition and optimize the performance of these materials. By conducting iterative experiments, we were able to determine the most promising applications for each by-product. These included high-performance binders, mortar mixes, and structural components, demonstrating that waste materials can be redefined as valuable resources.

The Defining phase exemplifies how local waste streams can be harnessed to create innovative construction materials that not only meet but exceed the performance of conventional options. This approach aligns with the principles of regenerative design, transforming what was once discarded into a cornerstone for sustainable architecture.

The Engaging phase translates the results of material testing into tangible prototypes and scalable applications. Our focus was to move beyond laboratory experiments and demonstrate the real-world viability of these materials.

We began by developing geopolymer recipes that utilized kaolin sludge as the primary component. These recipes underwent mechanical and durability testing, confirming their strength, stability, and suitability for construction. Compared to traditional Portland cement, these geopolymers reduced CO_2 emissions by up to 40%, making them a groundbreaking alternative for sustainable building practices.

In addition to binders, we explored SCM-based mortar mixes derived from glass-grinding sludge. These mortars were tested for compressive strength, durability, and workability, proving their potential for structural and non-structural applications. By incorporating these by-products, we significantly reduced the need for energy-intensive raw materials, further advancing the principles of circular construction.

The success of this project highlights the transformative potential of regenerative bioregionalism for the construction industry. By focusing on local secondary materials, we demonstrated how waste streams can be reintegrated into the production cycle, creating a circular economy that benefits both the environment and local economies.

Looking ahead, the methodology developed in this thesis—Locating, Sourcing, Defining, and Engaging—can be adapted to other regions worldwide. Each bioregion has unique resources and challenges, but the principles of material testing, interdisciplinary collaboration, and community engagement are universally applicable.

One of the most promising outcomes is the potential to scale geopolymer binders and SCMs for widespread use. These materials not only reduce CO_2 emissions but also alleviate the environmental burden of mining virgin resources. By adopting these alternatives, the construction industry could achieve significant progress toward its decarbonization goals.

In addition, the integration of advanced manufacturing technologies such as 3D printing offers exciting possibilities for the future. This technology allows for the precise use of materials, reducing waste while enabling innovative designs that push the boundaries of architecture. Combined with regenerative materials, it opens up a new realm of possibilities for sustainable and adaptive construction practices.

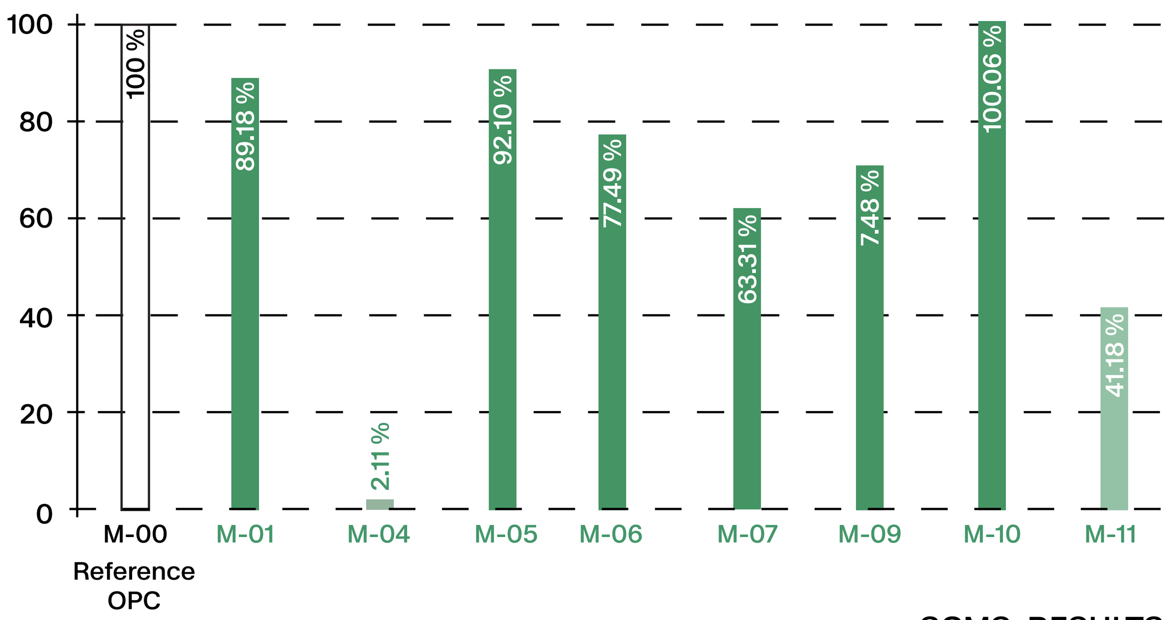
While the results of this project are promising, challenges remain. Regulatory barriers for new materials and skepticism within the industry are obstacles that must be addressed. Further research and pilot projects will be essential to build confidence in these materials and ensure their adoption at scale.

Despite these challenges, the outlook is optimistic. The Oberpfalz region serves as a model for how local industries, academic institutions, and designers can collaborate to achieve regenerative goals. This approach not only mitigates environmental impact but also fosters a stronger sense of regional identity and resilience.

This thesis demonstrates that a regenerative approach to construction is not only achievable but necessary. By rethinking materials through the lens of bioregionalism, we can create a built environment that harmonizes with natural systems while addressing the urgent need for sustainability. The future of architecture lies in innovation, collaboration, and a commitment to leaving a positive impact on the planet.

BENDING STRENGTH IN COMPARISON TO PORTLAND CEMENT IN %

COMPRESSION STRENGTH IN COMPARISON TO PORTLAND CEMENT IN %



SCMS: RESULTS