Universität für Bodenkultur Wien

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alchemia nova
institute for innovative phytochemistry & closed loop processes

Urban pop-up housing environments and their potential as local innovation systems

Executive Summary

November 2021

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	Date	Person(s)
Key Author(s)	30.11.2021	Marion Huber-Humer, Michael Ornetzeder, Doris Österreicher
Contributing Authors (alphabetical order)	31.10.2021	Gaetano Bertino, Tatjana Fischer, André Gazsó, Stefan Geier, Johannes Kisser, Jan Kotík, Thomas Märzinger, Christoph Pfeifer, Gloria Rose, Gerda Schneider, Julia Zeilinger

Principal Investigators:

Marion Huber-Humer, Michael Ornetzeder, Doris Österreicher

Project members (in alphabetical order for institutes and persons):

alchemia-nova (Institute of Innovative Phytochemistry & Closed Loop Processes): Gaetano Bertino, Johannes Kisser, Helene Pattermann, Veronika Reinberg

Austrian Academy of Sciences (ÖAW-ITA; Institute of Technology Assessment): André Gazsó, Michael Ornetzeder, Gloria Rose

University of Natural Resources and Life Science Vienna (BOKU):

Institute of Waste Management (ABF): Sebastian Gollnow, Marion Huber-Humer, Thomas Ladurner, Silvia Scherhaufer, Elisabeth Schmied, Julia Zeilinger,

Institute of Landscape Planning (ILAP): Doris Damyanovic, Gerda Schneider, Mirjam Stocker

Institute of Spatial Planning, Environmental Planning and Land Rearrangement (IRUB): Tatjana Fischer, Stefan Geier, Doris Österreicher, Gustav Puhr, Gernot Stöglehner

Institute of Chemical and Energy Engineering (IVET): Jan Kotík, Thomas Märzinger, Christoph Pfeifer

Institute of Sanitary Engineering and Water Pollution Control (SIG): Günter Langergraber

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CONTENT

1 MOTIVATION AND AIM

Urban environments increasingly face the challenges of rapidly growing populations and are at times confronted with a sudden need for short-term, cost-efficient housing due to diverse factors: e.g., increasing and unpredictable severity of natural disasters resulting in large number of displaced people; increase in the number of climate refugees; spontaneous migration due to insecure political circumstances, terror and war; the financial inability (particularly of developing countries) to provide sufficient infrastructure immediately in pace with rapid population growth; relevance of cities within national migration (education, job opportunities). Furthermore, the urgent (temporary) housing demand of people in a phase of transition or disaffiliation due to a disruption in their biography may also pose a significant challenge. Thus, an urgent need to find innovative, affordable, and flexible but at the same time sustainable and re-useable housing concepts that are easy to construct and quickly to implement is evident. Beside technical and environmental sustainability aspects, temporary housing also includes the process by which humans can begin to recover and re-integrate a sense of normality into their life.

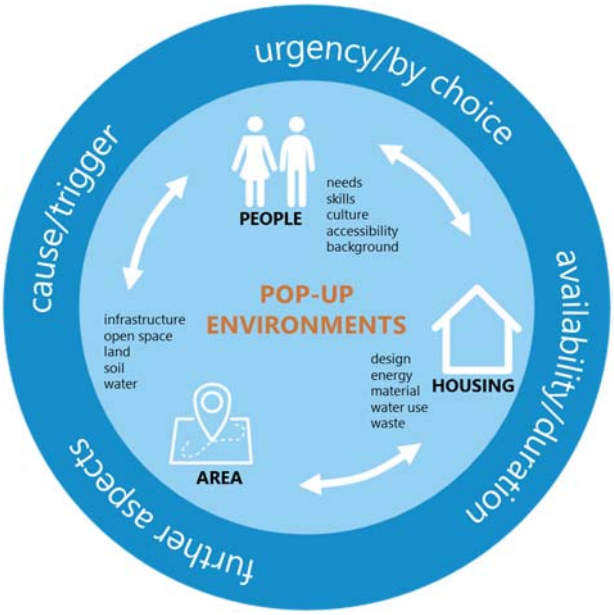


Figure 1: The three core elements of pop-up environments within this project and key impacting factors

Against this background and especially driven by the refugee crisis in the years 2015/16, an interdisciplinary team of scientists conceived the idea to work out a project proposal to systematically investigate and evaluate existing temporary housing options, and to create and assess innovative and sustainable models for pop-up living systems in urban environments regarding resource uptake as well as social aspects, which may serve as incubators for urban innovation. This proposal has been successfully submitted to the WWTF-Call “Environmental Systems Research 2017 – Urban Environments”. The project started on 1st April 2018 and ended in September 2021. The original duration of 36 months was extended by 6 months, mainly due to delays caused by the COVID-19 pandemic in 2020/21. In the project a wide range of disciplines worked closely together in an interdisciplinary manner.

Thus, the scientific aim was to expand our knowledge on how to design and evaluate sustainable temporary housing environments considering the complexity of factors influencing the mentioned three elements. The cross- and inter-disciplinary work in this project is based on a systematic survey of international temporary housing examples and their typologies, the development of scenarios (framework conditions) relevant for the City of Vienna as well as the design and comprehensive evaluation of six prototypical housing models, using a specifically developed indicator set. In addition, different innovation niche concepts were developed for these six housing models, which are intended to enable realised models to be used in the future as temporary spaces for experimentation and learning.

The research was guided by the following key-hypotheses (as stated in the project proposal):

- Temporary living spaces can provide one potential solution to rapidly increasing urban population by adapting “temporarily unused” urban land (H1)
- Temporary spaces can be highly sustainable in implementation and use throughout their whole life cycle (H2)
- Temporary spaces can create experimental areas allowing for an innovative learning environment, where sustainable practices can be developed and enhanced (H3)

On this basis, the project shall also provide structured and scientifically reflected information and guidance as a decision support for engineers, project developers and particularly for stakeholders and decision-makers of the City of Vienna.

The project deliverables (D1 – D6) are briefly outlined in Chapter 3. See Table 1 for an overview of deliverables and the relevant link to the webpage, where the deliverables are published.

The already published SCI papers can also be found on the project website. Additional publications are still in progress and/or in submission phase (status Oct. 2021). Information on the project and further outputs (e.g., presentations, conference proceedings) can similarly be found on the project webpage (See: https://popupenvironments.boku.ac.at/).

Table 1: Overview of Deliverables

WP No.	Del. No.	Deliverable Name (according to project proposal)
1	1	Description of interrelations of three elements
2	2	Checklist of requirements for suitable areas for relevant target groups and designation of potential model areas
3	3	Detailed description of scenarios and 6 pop-up housing models
4	4	6 scientifically evaluated models for pop-up housing in Vienna (“best knowledge guidance”)
4	5	Risk evaluation report
5	6	Transferability Concept

2 METHODOLOGICAL APPROACH AND APPLIED METHODS

Inter- and trans-disciplinary approaches were applied covering expertise related to the following research fields: urban and landscape planning, architecture and building systems technologies, natural-scientific/technical-based and resource-related disciplines focusing on energy optimization, sustainable resource and waste management, water supply and wastewater treatment as well as social and political sciences.

Methodologically, it required both the (deep) scientific expertise of specific disciplines to deliver a sound investigation and research base for each “element” as well as strong systematic interrelation of the diverse research fields to develop integrated urban pop-up concepts and applicable evaluation and decision tools.

The close interdisciplinary collaboration has been supported by a correspondingly suitable setting and internal organization, which was ensured by intensive professional exchange and cooperation in various interlinked groupings: Two-day plenary workshops, internal project meetings, specific senior- and PI-meetings, and, as the main working structure of the project, the six-student PhD group from different disciplines, worked on specific research questions directly with each other. The student PhD group met face-to-face at least 1-2 times per week in the beginning of the project, only when the lockdown was imposed due to the pandemic these meetings switched to an online mode, which significantly complicated the interdisciplinary working process. The project meetings, as well as the working group meetings of the PhD students, were comprehensively recorded and documented, since it turned out, that it was quite challenging and time-consuming to come up with an interdisciplinary “common language” and a common understanding of the research subject and research questions. The joint learning process within the interdisciplinary project team was complemented by transdisciplinary exchange in workshops with various external stakeholders (from Vienna).

For the “common understanding and language” following key terms have been defined within the project:

- **Pop-up housing:** non-permanent (temporary), reusable, physical shelter
- **Pop-up housing environment**: non-permanent (temporary), reusable, physical shelter (enclosed space) including the surrounding (private) open space
- **Temporary:** ranging from several days to 5 years (in exceptional cases max. 10 years)
- **Temporary living:** temporary living is to inhabit an area or structure (which can be temporary or permanent) for a specific period to bridge a phase of transition or disaffiliation (synonym: temporary accommodation; see Felix et al. 2014, p. 685). Temporary living includes temporary housing and temporary occupancy and has been categorized the terms in the project according to Figure 2.
    a. Temporary housing: temporarily present structure for residential use or repurposed permanent structure for temporary residential use;
    b. Temporary occupancy: changing occupants in permanent buildings. The duration of occupancy is intended to be minimum 1 day or night and maximum 5 years (up to 10 years).

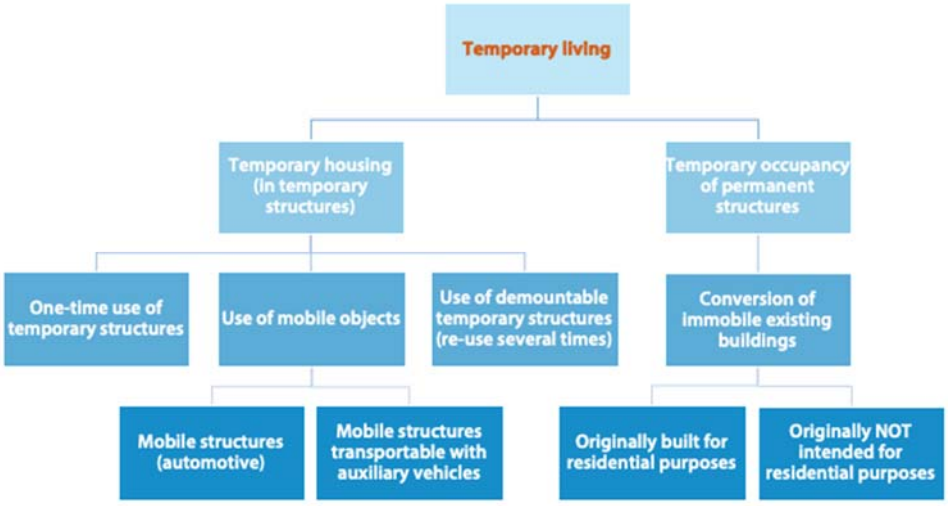


Figure 2: Categorized overview on used terms of temporary living options

- **Target/user group:** in general, people with an urgent housing demand, in a phase of transition or disaffiliation (disruption in biography due to diverse reasons)
- **Local innovation system:** space where innovative forms of living, collaboration, and learning, as well as technical, infrastructural and resource orientated innovation can occur
- **Scenario:** theoretical but generally conceivable and plausible application cases for temporary housing environments in Vienna; referring to frame conditions in which temporary housing environments might be needed and are suitable for application (providing information on where the temporary housing environment would be located, who would be residing there, expected/recommended duration of inhabitation etc.)
- **Housing model:** for each scenario concrete housing models are developed ("theoretic concretization"). Thus, a housing model is a special “theoretical case study” for a scenario. In the models, specific conditions are defined in detail (number of users, architectural design, selection of applied materials and technologies, etc.) to such a level that the models could be used as basis for the application of the evaluation and assessment methods (e.g., life cycle assessment process) and to test the developed indicator set.

The project team applied a “mixed methods” approach to elucidate and study the diverse aspects related to temporary urban housing options from different perspectives and ensure a cross-disciplinary analysis. Therefore, international literature and existing secondary data (e.g., screening meta-strategies and plans of the city of Vienna, descriptive research on technical reports and information from websites regarding existing temporary housing options) were systematically reviewed and evaluated, qualitative methods (e.g. interviews and workshops with relevant stakeholders, indicator-based risks assessment) and quantitative methods and tools (e.g., life cycle assessment tools, energy modelling using numerical assessment and simulation tools such as ArchiPhysik) were applied, as well as visualization methods (e.g., 3-D-modelling using ArchiCAD) used. The whole research process and

primarily used methods are briefly outlined in Figure 3. The applied methodological approach and the applied methods are described in detail in Deliverables D1 to D6.

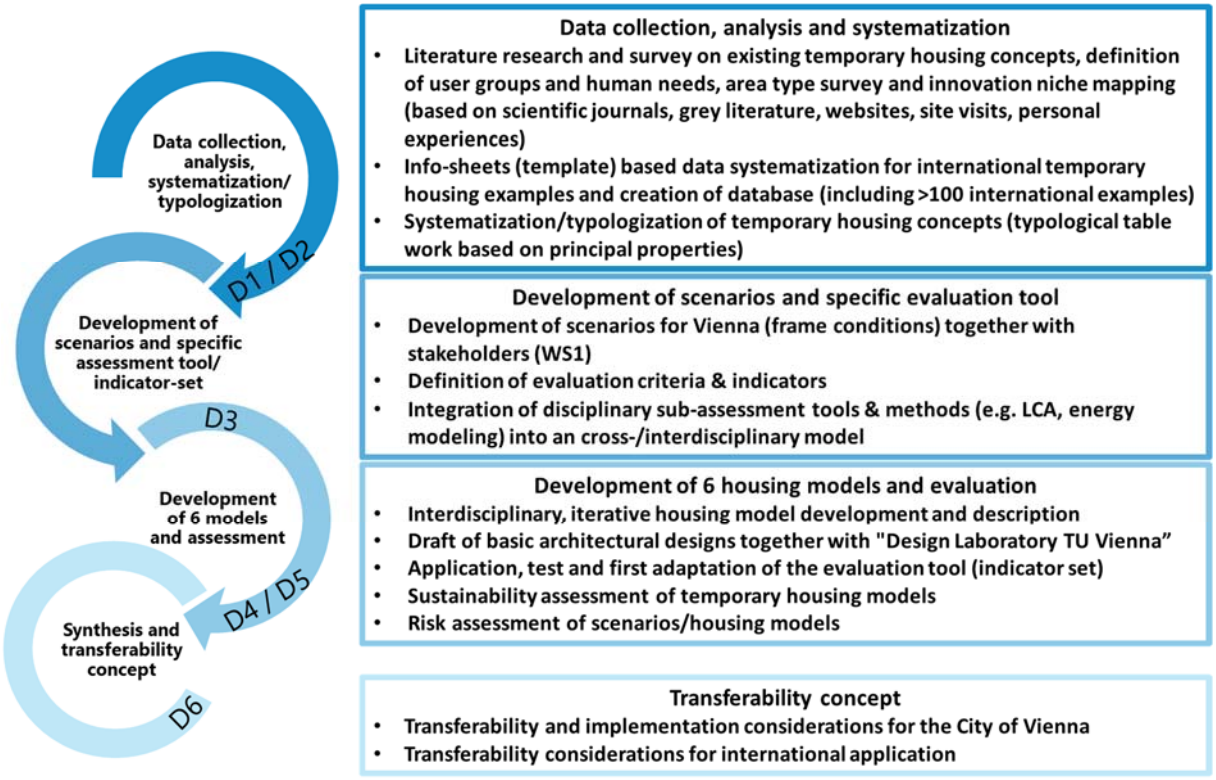


Figure 3: Overview of the methodological approach (WS1= workshop 1; D1 – D6: Deliverables D1 to D6)

An overview on the project and the time sequence represented in working packages with the relevant pending deliverables are shown in Figure 4.

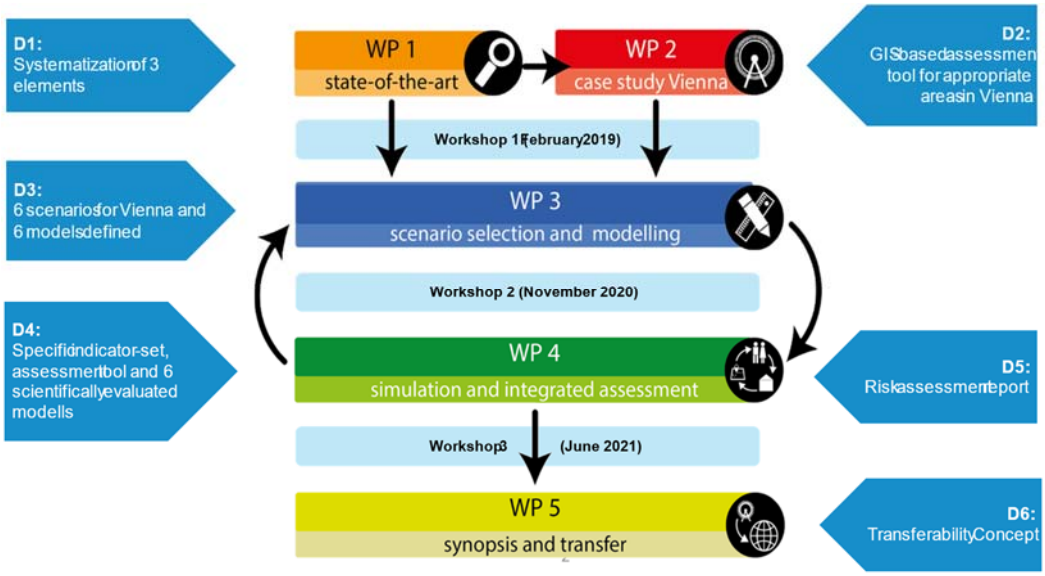


Figure 4: Overview on project working packages, stakeholder workshops and deliverables

The methodological approach involved several methods and practices, which are explained in the following four steps:

Step 1 - Data collection, analysis and systematisation of international housing examples, user groups and proper areas for Vienna (approach for **Deliverable D1 and D2**):

The main task of the first methodological step (mainly during the first project year) was to collect international examples of urban temporary housing environments and to systemise those empirical cases in a consistent form (using info-sheets) in a database (currently containing >100 examples). The examples were searched in peer-reviewed literature, grey literature, websites dedicated to the case studies (operated by, e.g., architects, NGOs, companies), articles on webpages dedicated to fields such as architecture or sustainability research, personal recollection, newsletter articles or TV reports, as well as a few on-site visits in Austria and Germany. Based on these examples a typological tabulation approach (adapted from a methodology well established in landscape planning) was applied to compare all housing examples in a systematic way and to develop a classification table (see also D1). The applied table method originally derives from phytosociology (cf. Haber, 1981), and is commonly used in landscape planning to compare built and open space structures based on principal properties.

In parallel, the land use of the city of Vienna has been analysed based on spatial and statistical data and a meta-analysis (a structured content analysis) has been conducted regarding the significance of temporary housing in existing strategy papers of the City of Vienna and its consideration in current Viennese urban planning. In-depth analysis of studies and strategies of the City of Vienna as well as legal matters in connection with "pop-up structures" were carried out, including over 1.000 documents produced in the period 1990-2018. The methodological approach of the document analysis and the results found were presented and reflected at the second stakeholder workshop in November 2020. The methodical approach was critically assessed by the group of stakeholders and seen as an important contribution to the novel and in-depth discussion of the topic "temporary uses/temporary housing" in Vienna. Potential area types have been identified and classified based on their characteristics related to the suitability of potential temporary use. A GIS-based assessment methodology has been elaborated to conduct specific queries on suitable areas for temporary housing applications in Vienna.

The third main task within this step was to characterize and classify potential user groups of temporary housing concepts according to their needs and demands. From the project perspective of temporary housing, the systematisation of needs defined by Max-Neef et al. (1991) turned out to serve as a promising starting point for identifying the interrelations between human needs, housing services and area requirements, when regarded in combination with Sen and Nussbaum's Capabilities approach (Nussbaum, 2009). Thus, these concepts served as a basis for the construction of abstracted "User Profiles" (see details in D1). To build a systematisation of users for the temporary housing context, which could then serve to provide information on the resulting demands on housing and area, the project team began by starting a broad collection of user groups with a temporary demand for housing,

mainly based on user groups identified within the international case studies on temporary housing documented in the project's own data pool. Based on these user groups, so called "user profiles" were abstracted. The objective of the "user profiles" was to develop a manageable number of profiles which are clearly distinct from each other regarding the requirements of the housing and the area. The resulting outcome of this approach is shown in Table 1 in Chapter 3 as well as in detail in Deliverable D1.

Moreover, international literature was examined concerning niche experiments and socio-technical innovations, with 6 existing conceptualizations being identified (niche experiments, bounded socio-technical experiments, grassroots experiments, transition experiments, sustainability experiments, urban living labs). To conduct the innovation niche mapping for Vienna, a google-search was conducted using the identified terms. Through this method around a dozen examples of ongoing and recently finished niche experiments were collected, including bottom-up initiatives (see Deliverable D2). The programme-based projects were indicative for important funding schemes relevant for Vienna with experimental character. These funding programmes were then systematically examined in greater detail. The collection of projects was thus expanded, with one-pagers being collected which contain the project name, topic, funding programme, source of financing, project team, project duration, budget, project webpage and an excerpt from the official project description. Over 90 projects were collected in this manner, with no claim to completeness. Of these cases, only around 25 were implementation projects, with the rest serving as exploratory projects or "entry" projects, laying the groundwork for possible future implementation projects.

A stakeholder workshop in February 2019 (WS1) marked the end of the first step (first year) of the research project. The project team appreciated this opportunity to discuss and work together with 11 representatives of various Viennese organizations, institutions, and companies, who shared their experiences and insights of their work with temporary living and housing and respective user groups. The aim of the workshop was to develop relevant scenario building blocks for temporary living in Vienna together with stakeholders from various backgrounds, to gather expertise regarding the "elements" people, housing and areas. In subsequent discussions, several success factors and obstacles to temporary living in Vienna were identified. The results then were fed into the next approach step: scenario framing and model development.

Step 2 – Development of **scenarios for the city of Vienna** and of a **specific assessment tool/indicator-set for sustainability assessment** for temporary housing models (approach to achieve Deliverable D3 and D4):

Based on detailed research of the first project step and the results of the stakeholder workshop from February 2019, six different scenarios were created, which subsequently offered the framework conditions for the development of the temporary housing models. The creation of pop-up housing scenarios was a multi-stage, inter- and transdisciplinary process, which started with the first stakeholder workshop (WS1). The workshop allowed for the first of several feedback loops that were implemented in the process of the scenario development. The interaction with the stakeholders at the workshop on the one hand represented a "reality check"

for the research findings derived from the “desk-research” in step 1, and on the other hand also opened new perspectives for the next process steps. Relevant framework conditions for Vienna and "building blocks" as basis for temporary housing scenario were drafted. Different scenario ideas were developed in three small groups (3-4 persons) with participants from different professional and disciplinary backgrounds and moderated by internal project team members. One important guiding principle for developing ideas and suggestions for pop-up housing scenarios was the relevance for Vienna – derived from the professional assessment background of the participants. To better structure the ideas and compare them later, different scenario building blocks were elaborated in a template (a similar, but more detailed information sheet was used to collect and characterise existing international examples of temporary housing for the data pool in step 1).

Based on the output of WS1, in April 2019, an internal 2-day project retreat (with the interdisciplinary project team) took place to (1) revise and improve the scenario drafts from WS1, (2) further develop and specify scenario drafts, and (3) assess and select six pop-up housing scenarios for further consideration in the project. To develop a diverse range of scenario drafts, some guiding criteria for scenario development/selection had to be taken into consideration by the task-groups at the retreat:

- Scenario drafts must be relevant for the City of Vienna
- Scenario drafts must follow an internal logic and be consistent
- Scenario drafts should consider different framework conditions (e.g., various building and area types)
- Scenario drafts must include some new or innovative aspects
- A minimum of 3 scenario drafts had to be developed by each task-group at the retreat and should consider two additional conditions to ensure the widest possible range of scenarios:
    a. At least one scenario draft should include the adaption or refurbishment of an existing building, at least one scenario draft should include new constructions.
    b. Three degrees of freedom (“Freiheitsgrade”) regarding land use and application of building codes (“Bauordnung”) were predefined. The scenario drafts should address those degrees of freedom.

The different ideas for scenarios from the task groups were presented, discussed, adapted, and analysed within the project team. This represents a second important feedback loop, as it opened the floor for all project team members to improve and streamline the scenario drafts. Finally, the scenario proposals were voted on by all project team members in an open setting.

Generally, it was an objective of the scenario development to generate creative and innovative new ideas, without having to take the existing legal and planning constraints (e.g., regarding building codes) too literally in a first step. Thus, the developed scenarios vary in their required degrees of freedom (“Freiheitsgrade”), which means to say that there is a range from scenarios which can easily be realized under the given framework conditions in Vienna (e.g., by falling fully within the existing building regulations), to those which are more radical in their approaches and require flexible experimental spaces where new options can be explored.

The entire scenario development and selection process is described in detail and presented as a process flow chart in Deliverable D3.

In parallel to the scenario development the methodology for a cross-disciplinary assessment (evaluation) tool specifically for temporary housing concepts was elaborated. Based on the approach shown in Figure 5, a set of specific indicators has been compiled based on existing sustainability indicators/criteria in the literature (mainly from the building sector) as well as newly adapted and created indicators by the project team, and then classified into the criteria categories "ecological quality", "technical quality", "site quality" and "social aspects and residential quality". At the beginning of this process, around 80 indicators were considered and examined in more detail, and then iteratively condensed to an indicator-set of 51 indicators. Most of the indicators were defined from scratch, adapted to the case of temporary housing. An overview is presented in Figure 8 (Chapter 3) and more details are given in Deliverable D4.

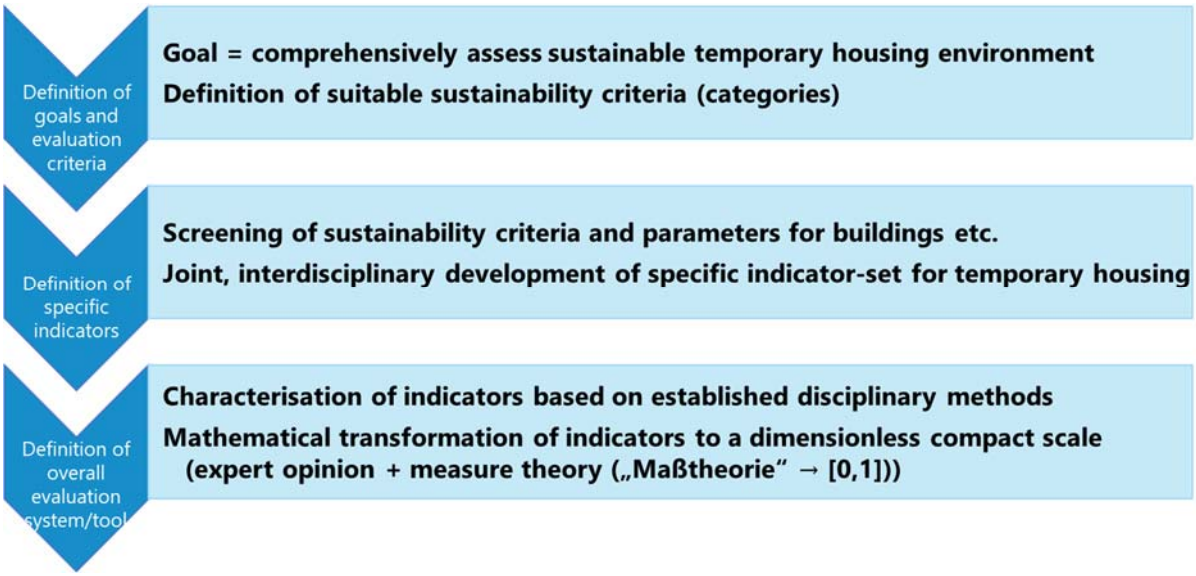


Figure 5: Approach for the definition of the indicator set and the cross-disciplinary (mathematical) transformation model

These very diverse indicators (quantitative and qualitative; from different disciplines) were then parameterized with mathematical equations, to make them comparable and assessable on the same level, each indicator can take an empirical value between 0 and 1. The cross-disciplinary assessment model comprises evaluation steps on an “object-level” (e.g., regarding material and technical aspects of housing), on a site-level (e.g., neighbourhood, infrastructure) and a general evaluation level (e.g. emissions, well-being). It combines and provides interlinkages of established methods and tools of the involved disciplines, such as Life Cycle Assessment (LCA) using the GaBi 10 Software and ecoinvent 3.7.1. LCI databases; standards for the construction sector (e.g., EN 15978, EN 15804); energy and emission modelling using thermal simulation tools such as ArchiPhysik.

The indicators and the cross-disciplinary tool in general were tested interactively using the 6 temporary housing models as case studies, and both the indicators and the housing models were adapted in several interdisciplinary feedback loops (see also step 3 in methodological

approach). The overall process took about 2 years. Detailed description of the methodological framework approach, particularly with respect to the mathematical transformation can be found in Deliverable D4. For each indicator a specific indicator-sheet has been compiled, describing the background considerations, instructions regarding data collection and measurement, the mathematical implementation, and the scaling in detail. The compiled indicator-sheets can be found in the annex of Deliverable D4.

Step 3 – Development and detailed description of six housing models, iterative sustainability assessment and risk assessment (approaches to finalize **Deliverables D3, D4 and D5**):

For each of the developed Viennese scenarios one housing model was drafted and designed. The housing models were developed and described to such a level of detail that it was possible to use them as “theoretical case studies” for testing the application of and adapting the cross-disciplinary assessment tool. Furthermore, the housing models could now be used as a basis for initial implementation and pilot-projects in the city of Vienna. The development of pop-up housing models was a multi-stage and deeply interdisciplinary process that took almost 2 years.

In cooperation with JASEC at the Vienna University of Technology (TU Wien), within the course for architecture students, "Pop-Up Shelter - Design Studio", the selected pop-up housing scenarios for Vienna were elaborated into concrete model design drafts. To achieve this task, the students were provided with a short description of each scenario and relevant framework conditions that had to be considered in the design proposals. The architecture students provided two to four model design drafts for each scenario. This generated a wide variety of implementation ideas and approaches, but ultimately a single housing model design had to be provided for each scenario. Thus, a selection and optimization process including further specification and development steps (e.g., material selection and estimation of quantities of building materials, number of users per living unit, energy supply, open space design, etc.) had to be conducted within the project team in an interdisciplinary and iterative manner in several revisions and adaptation loops.

Detailed architectural plans, including floor plans, were generated using ArchiCad software. Together with the whole project team the architectural models were further improved through feedback and suggested revisions. Then planning regarding all involved disciplines started, resulting in a higher level of detail. Bills of materials were defined, as well as open spaces within and in the surrounding of the pop-up housing models. Energy, water and waste concepts were developed as well as considerations regarding organisation and co-living of different user groups, etc. Those different disciplinary concepts and approaches were reflected in an interdisciplinary setting by the other project team members on a regular basis and revised according to these feedback loops, to achieve an overall balanced and consistent pop-up housing model. If no consensus between all disciplines could be achieved on details of the models, this was documented in the internal protocols of the meetings.

The project-internal selection and adaptation process for the six pop-up housing models is described in detail in Deliverable D3.

The housing models were used in parallel as “theoretical case studies” for testing the indicators and the further development and optimisation of the cross-disciplinary assessment tool, which was also done in a strong interdisciplinary setting (description of detailed process see also Deliverable D3 and D4).

The finalized housing models were then subjected to an interdisciplinary SWOT-analysis (see Deliverable D3) and based on that to a risk assessment, which was carried out in accordance with an appropriate method set based on standard risk assessment approaches and risk evaluation methods (hazard analysis, risk matrix methods, risk landscape, etc.) following international standards (e.g., ISO 31000/ONR 49000).

Step 4 – Synthesis and transferability concept (approach for Deliverable D6):

The final step of the entire approach was to bring all findings together, to extract main issues and to summarize considerations for a transfer of the theoretically developed housing models to the real world and potential implementation in the City of Vienna as well as on an international level in comparable urban settings.

A second (online) workshop in November 2020 was defined with the goal to discuss the status quo of addressing the topic of temporary housing in political strategy papers of the City of Vienna in the form of a transdisciplinary stakeholder dialogue. For this purpose, the results of the topic-centred analysis of Vienna-related policy documents were presented during the workshop, and then discussed along guiding questions together with the participants - including participants of Workshop 1 as well as employees of the City of Vienna, but also experts who deal with target groups living temporarily in Vienna in the broadest sense. The discussion with the stakeholders focussed on how temporary housing is dealt with in political strategy papers (inhibiting factors, promoting aspects).

The subsequent final workshop had the aim to present the project results to the participants of workshops 1 and/or 2, as well as to other stakeholders and to gain further insights for the transferability of the project results into practice (urban policy/urban planning). This online event took place in June 2021 under the theme "Temporary housing models as niche experiments in Vienna" and focused on the scenarios and models on temporary housing developed within the project. After the presentation and explanation of the developed scenarios and models, these were discussed together with the stakeholders. Special attention was paid to the potential of the models as innovation niches. Afterwards there was also the opportunity to discuss the topic of tiny houses as a model for temporary living in the city together with an invited expert. Based on these inputs a concept for a fictional meeting with representatives of the City of Vienna has been elaborated to provide concrete next steps in the transfer of the findings to stakeholders and decision makers in the City of Vienna. The details of this transferability concept, worked out as table documents for a fictional (future) meeting can be found in Deliverable D6.

To check the international applicability of the developed scenarios/housing models, interactive questionnaire sessions were conducted with international experts in a specialized session on an international conference, namely the 2020 Closed Cycles and Circular Society Symposium, hosted by the Zurich University of Applied Science ZHAW and the International Ecological

Engineering Society IEES on 2nd - 4th September 2020. The symposium was planned to be held in Zurich (Switzerland) but due to COVID-19 it was held online. The purpose of the questionnaire sessions was to gain feedback on the pop-up housing scenarios developed within the research project and to gather information about their applicability for the local contexts of the experts, examining possible drivers and barriers. The participants and target groups were experts and practitioners, such as scientists, planners, architects, and engineers, who are interested in the transition towards a circular society and the related international discussion.

The questionnaire session, lasting an hour and a half, was structured in a way which allowed a continuous exchange with the participants, following an introductory input from the presenter. The polling app “Slido" was utilized, an easy-to-use Q&A and polling platform. Within the questionnaire session participants answered in a synchronous manner during the session, with the results being transferred instantly. This format allowed respondents to ask questions of understanding before entering their answers and engage in brief exchanges surrounding the questionnaire topics. The questionnaire consisted of 7 parts, with an alternance between the presentation (e.g., including the description of the 6 temporary housing scenarios) and the questionnaire, with space for discussion between the parts.

After the positive experience with the interactive online questionnaires at the 2020 Closed Cycles and Circular Society Symposium, the session was repeated with interested experts who were selected and invited by the project team, chosen specifically to represent a broader range of countries and to represent varying fields of knowledge and expertise according to their occupation. In a total of 5 sessions, 18 experts participated, representing 11 different countries from 4 continents.

The detailed description of the used methodological approach is given in Deliverable D6.

3 KEY-OUTPUTS AND HIGHLIGHTED FINDINGS

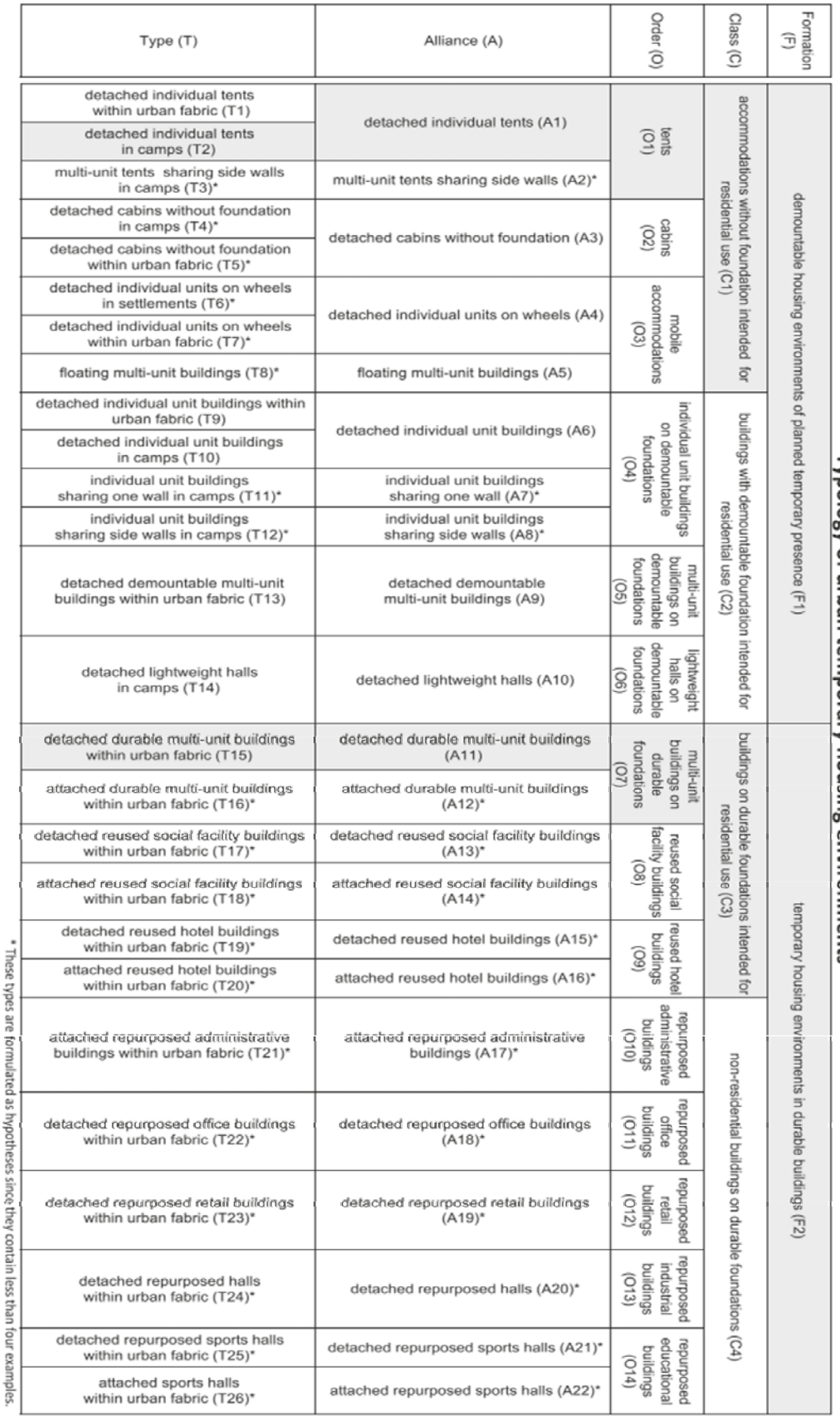
This chapter provides an overview of the key-outputs and most important findings, which are described in detail in the respective deliverables and scientific publications (see webpage). This chapter is thus intended to serve as a guide and orientation for the detailed results in the specific reports on the Deliverables D1 to D6.

3.1 DATA POOL ON INTERNATIONAL IMPLEMENTATION EXAMPLES OF TEMPORARY HOUSING ENVIRONMENTS

A structured, info-sheet-based data pool currently including over 100 diverse international examples of temporary housing concepts served as a basis for the systematisation and typologies for temporary houses (shelters) and is available at the project webpage (status Sept. 2021). The data pool includes information (in varying degrees of detail depending on availability) on the housing unit (size, materials, usage duration, resource concept, including water and energy supply, as well as sanitation system and solid waste management, etc.), location and environment, particularities, the user groups, and the publication source/designer/owner. The overall data pool is regarded as a working document, where new examples and additional information could be added. The data pool can be accessed at the project webpage: https://popupenvironments.boku.ac.at/

3.2 CLASSIFICATION TABLE (SYSTEMATIZATION AND TYPOLOGIES OF TEMPORARY HOUSING UNITS (PART OF DELIVERABLE D1))

66 selected examples from the above-mentioned international data pool (selection criteria based on completeness of the available datasets) served as a basis for the systematisation and typologies of the housing units according to the typological tabulation approach. The systematic comparison led to a typology that classifies the housing environments according to their qualities on different levels. A first draft (status March 2019) of the created classification table is included in the report (Deliverable D1), the final classification table (as well as the methodological approach) has been published in *Stocker, M; Schneider, G; Zeilinger, J; Rose, G; Damyanovic, D; and Huber-Humer, M (2020): Urban temporary housing environments – from a systematic comparison towards an integrated typology. Journal of Housing & Built Environment; https://doi.org/10.1007/s10901-020-09812-x,* and can be seen in Figure 6, which presents the first published comprehensive typology for temporary housing units based on a scientific tabulation process. Comparing this typology with other published typologies, it can be seen that structural-spatial characteristics are well suited to structure the variety of temporary accommodations. The suggested terminology and typology provide a common basis to further research and involved persons of different backgrounds, promoting communication, understanding, and learning among different disciplines. The typology is not a rigid structure: the systematic comparison via tabulation allows the integration of further examples and criteria. Continuing the process started here, extensions (new types) as well as more specific differentiation of the classification (sub-types/variations) can be achieved. The method also opens the possibility for in-depth investigations on examples and/or types, about which there is still a lot to learn.



Typology of urban temporary housing environments

Type (T)	Alliance (A)	Order (O)	Class (C)	Formation (F)
detached individual tents within urban fabric (T1)	detached individual tents (A1)	tents (O1)	accommodations without foundation intended for residential use (C1)	demountable housing environments of planned temporary presence (F1)
detached individual tents in camps (T2)				
multi-unit tents sharing side walls in camps (T3)*	multi-unit tents sharing side walls (A2)*			
detached cabins without foundation in camps (T4)*	detached cabins without foundation (A3)	cabins (O2)		
detached cabins without foundation within urban fabric (T5)*				
detached individual units on wheels in settlements (T6)*	detached individual units on wheels (A4)	mobile accommodations (O3)		
detached individual units on wheels within urban fabric (T7)*				
floating multi-unit buildings (T8)*	floating multi-unit buildings (A5)			
detached individual unit buildings within urban fabric (T9)	detached individual unit buildings (A6)	individual unit buildings on demountable foundations (O4)	buildings with demountable foundation intended for residential use (C2)	
detached individual unit buildings in camps (T10)				
individual unit buildings sharing one wall in camps (T11)*	individual unit buildings sharing one wall (A7)*			
individual unit buildings sharing side walls in camps (T12)*	individual unit buildings sharing side walls (A8)*			
detached demountable multi-unit buildings within urban fabric (T13)	detached demountable multi-unit buildings (A9)	multi-unit buildings on demountable foundations (O5)		
detached lightweight halls in camps (T14)	detached lightweight halls (A10)	lightweight halls on demountable foundations (O6)		
detached durable multi-unit buildings within urban fabric (T15)	detached durable multi-unit buildings (A11)	multi-unit buildings on durable foundations (O7)	buildings on durable foundations intended for residential use (C3)	temporary housing environments in durable buildings (F2)
attached durable multi-unit buildings within urban fabric (T16)*	attached durable multi-unit buildings (A12)*			
detached reused social facility buildings within urban fabric (T17)*	detached reused social facility buildings (A13)*	reused social facility buildings (O8)		
attached reused social facility buildings within urban fabric (T18)*	attached reused social facility buildings (A14)*			
detached reused hotel buildings within urban fabric (T19)*	detached reused hotel buildings (A15)*	reused hotel buildings (O9)		
attached reused hotel buildings within urban fabric (T20)*	attached reused hotel buildings (A16)*			
attached repurposed administrative buildings within urban fabric (T21)*	attached repurposed administrative buildings (A17)*	repurposed administrative buildings (O10)	non-residential buildings on durable foundations (C4)	
detached repurposed office buildings within urban fabric (T22)*	detached repurposed office buildings (A18)*	repurposed office buildings (O11)		
detached repurposed retail buildings within urban fabric (T23)*	detached repurposed retail buildings (A19)*	repurposed retail buildings (O12)		
detached repurposed halls within urban fabric (T24)*	detached repurposed halls (A20)*	repurposed industrial buildings (O13)		
detached repurposed sports halls within urban fabric (T25)*	detached repurposed sports halls (A21)*	repurposed educational buildings (O14)		
attached sports halls within urban fabric (T26)*	attached repurposed sports halls (A22)*			

* These types are formulated as hypotheses since they contain less than four examples.

Figure 6: Classification table (typology) for temporary housing units (published within this project in Stocker et al., 2020); Abbreviations according to the examples in the data pool

In parallel a different, mathematical approach was applied to cluster the international examples. The methodological approach and first results are described in the manuscript *"Märzinger, T.; Kotík, J.; Pfeifer, C. (2021). Application of Hierarchical Agglomerative Clustering (HAC) for Systemic Classification of Pop-Up Housing (PUH) Environments. Appl. Sci. 2021, 11, 11122."*

3.3 ABSTRACTED USER PROFILES FOR TEMPORARY LIVING (PART OF DELIVERABLE D1)

For the exercise of identifying interrelations of the elements "people", "housing" and "areas" a new categorization of users, so called "user profiles", was developed on the basis of the user groups identified and specified within the international case studies on temporary housing documented in the data pool (e.g., people affected by disasters, people fleeing without refugee status, asylum-seekers, people in training or education (e.g. students), people affected by homelessness, people with temporary working contracts, participants, employees and visitors of festivals, sporting events, etc.). The objective of the "user profiles" was to develop a manageable number of profiles which are distinct from each other regarding the requirements of the housing and area. The goal was to assign each user group to one of the more abstract and general user profiles. The resulting outcome of this approach is shown in Table 2 (and in more details described in Deliverable D1 and D3).

Table 2: User Profiles systematised according to urgency and ability

Profile A	Profile B	Profile C
Urgency **high** (city perspective): sudden & unexpected increase in demand in a short period of time	Urgency **low** (city perspective): no unexpected change in temporary housing demand	Urgency **low** (city perspective): no unexpected change in temporary housing demand
Urgency **high** (individual perspective): no safe alternatives	Urgency **high** (individual perspective): no safe alternatives	Urgency **low** (individual perspective): alternatives are given but there is still a need for affordable housing
In given circumstances, individuals of this profile cannot meet many needs in a self-organized manner	Depending on the circumstances, individuals of this profile may require outside support to satisfy some of their needs	Individuals of this profile can meet their needs in a self-organized manner
Example: Individuals affected by disasters	*Example: Individuals affected by homelessness or precarious living*	*Example: Individuals in training or higher education*

The user profiles represent different modes of urgency (perspectives city and individual) and different abilities to self-organize human needs. Profile A describes individuals with an urgent demand for temporary housing. In this context urgent describes a sudden and unexpected increase of demand with a very limited timeframe for preparation and reaction. Profile B describes individuals with low urgency in terms of there being no sudden unforeseen changes in housing demand (perspective: city), but high urgency in terms of there being lacking or unsecure alternatives (perspective: individual). Profile C describes individuals with low urgency

in terms of there being no sudden unforeseen changes in housing demand (perspective: city) and medium urgency in terms of there being existing alternatives (perspective: individual), albeit not to a satisfactory degree in terms of quantity or affordability.

This abstracted systematisation can be used as a scientifically sound basis for further research in the field of user groups and their human needs in the context to temporary housing.

3.4 GIS-BASED ASSESSMENT TOOL TO IDENTIFY POTENTIAL AREAS FOR TEMPORARY HOUSING IN VIENNA (DELIVERABLE D2)

A dynamic analysis approach was chosen for the preparation of the assessment of potential areas for the city of Vienna. For this purpose, a self-programmed GIS-based assessment tool was developed, which was implemented using open-source software QGIS (QGIS 3.16 - https://qgis.org/de/site/). The required input data is based exclusively on freely available data (Open Government data of the City of Vienna and OpenStreetMap). This ensures good traceability and transparency as well as adaptability and expandability.

The GIS tool allows to vary the main input parameters and to adapt the analysis of potentially suitable areas regarding the requirements of the respective scenarios, occasions, user groups and technical requirements. For this purpose, the indicators that were selected for Deliverable D4 and which refer to site quality (accessibility of central facilities, noise pollution, ecological land use, slope gradient, quality of public transport supply and active mobility, accessibility for construction, operation, and dismantling) can be adapted in terms of their input parameters and weighted according to the requirements. For each indicator, adapted calculation modules were created for data preparation, pre-processing or aggregation, and evaluation (see Figure 7).

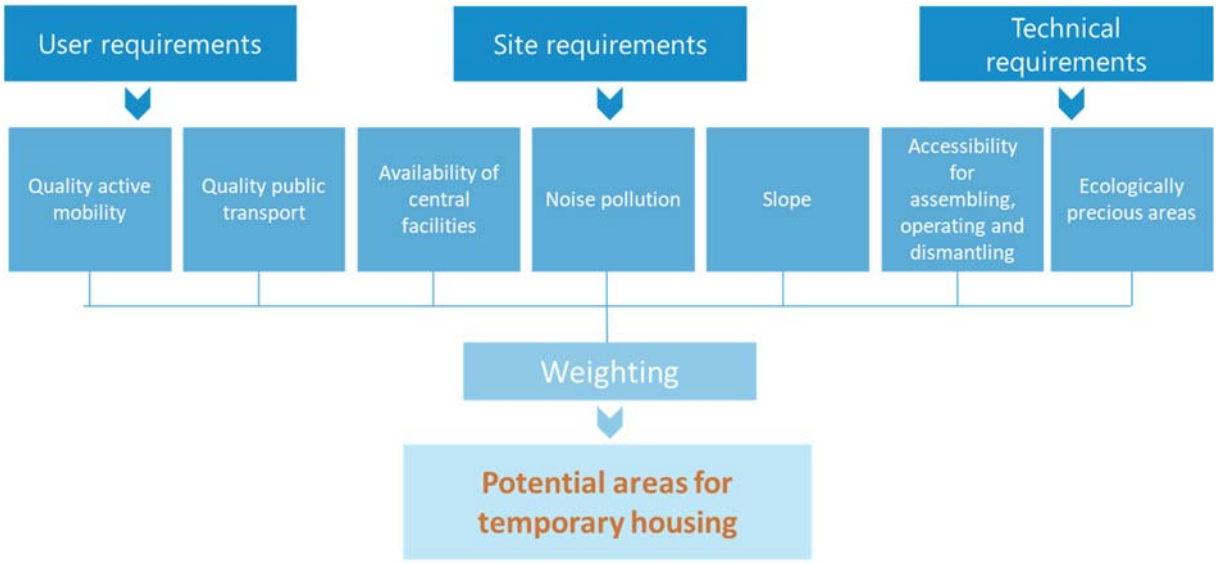


Figure 7: Framework conditions for the identification of potential areas for temporary housing

Since suitable values regarding the selected indicators for temporary housing needs are largely missing in the technical and planning literature, this approach enables an iterative

elaboration of characteristic values. Existing values which originate from the environment of long-term urban development and planning or from the field of disaster management, were selected as possible reference points or orientation values. However, these characteristic values are only conditionally applicable to the methodological approach chosen here, which allows the integration of temporary housing needs into established urban planning processes with a high demand on planning methodology and quality.

In programming the data preparation, pre-processing and aggregation modules, care was taken to prepare the basic data in such a way as to ensure an optimum between data and complexity reduction while maintaining the highest possible level of detail and analysis capabilities. As a result, the computing time for the analyses was considerably reduced. This allows the tool to be used in workshops with experts and decision makers to deepen the understanding of the individual indicators and their key input parameters. In addition, this can be used to support a negotiation process to determine characteristic values and appropriate areas. The tool can be used for an evaluation of existing areas (site assessment) as well as for an area search. More details can be found in Deliverable D2.

3.5 SIX THEORETICAL POP-UP HOUSING MODELS FOR THE CITY OF VIENNA (DELIVERABLES D3 AND D4)

In the project, six clearly differing scenarios relevant for the city of Vienna were developed in an inter- and transdisciplinary process, which represent current and possible future (e.g., dealing with heat waves in the city) framework conditions for temporary housing (see Table 3). Based on this, tangible pop-up housing models were designed in an interdisciplinary multi-stage process and scientifically evaluated regarding their sustainability. These evaluated housing models are now available as a basis for further discussion and elaboration and for possible implementation in pilot projects or niche experiments in the city of Vienna. The detailed description of the housing models including a SWOT-analysis is given in Deliverable D3 and their main properties are briefly summarized in factsheets (one for each housing-model), which can be found in the Annex. The results of the sustainability appraisal of the housing models can be found in Deliverable D4.

Table 3: Overview and summary of main characteristics of the six transdisciplinary developed scenarios (frame conditions for housing models) for the City of Vienna (Scenarios 1-3)

	Beat the Heat	Life Sharing to go	Gap Module
User group	People vulnerable to heat waves, e.g., elderly people, pregnant women, families with babies / young children	User mix: people interested in communal living, people with limited housing options, persons eligible for asylum	User mix: people interested in communal living, people with limited housing options, persons eligible for asylum
Usage Time	Several days to weeks (duration of a heat wave)	Up to one year per resident	2-5 years
Building characteristics and open spaces	Newly constructed buildings using recycled construction elements (EUR-pallets) and sustainable raw materials. Natural cooling Private terrace and communal space for recreation	Temporary living in halls of vacant (factory, garage, market, …) buildings in small living modules. Reduced private living space, generous communal spaces and multifunctional areas	Building based on modular components and prefabricated elements, Private loggias, Generous communal spaces and multifunctional areas at ground floor level
Site characteristics	Well ventilated open areas with high potential for natural cooling, Flat area (<5%)	Site of vacant factory/building not in disrepair (no health hazards, no danger of building collapse, no site contamination)	Vacant building lots, brownfields in urban areas
Resources	Power supply via grid connection, natural ventilation and cooling with sun sails and water mist sprays, on-site elevated water tanks and dry toilets	Power and water supply via grid connection, centralized sewage connection, wood chip heating, PV	Power and water supply via grid connection, centralized sewage connection
Neighbourhood characteristics	Connection to public transport, connection to social infrastructure	Active involvement of the neighbourhood Connection to public transport, connection to social infrastructure	Active involvement of the neighbourhood Connection to public transport, connection to social infrastructure
Special features	Rapid deployment in crisis situations (heat waves)	Repurposed building envelope, only indoor living modules are newly constructed. Living modules are easily dismountable and reusable	Communal rooms at ground floor level suitable as neighbourhood centre (for storage, meetings etc.)

Table 4: Overview and summary of main characteristics of the six transdisciplinary developed scenarios (frame conditions for housing models) for the City of Vienna (Scenarios 4-6)

	Life on track(s)	Flat-Pack	DonAutonom
User group	Flexible: ranging from people with sudden housing needs to short-term stays	Individuals / families with temporary housing needs, e.g., expats	People interested in sustainable and resource autonomous living
Usage Time	Several days to weeks	6-24 months	flexible; several months to 3 years
Building characteristics and open spaces	Fully equipped mobile housing unit on railway wagons Repurposed ISO shipping container as a tiny house hinged private terrace mounted to housing container	Temporary living in vacant ground-floor retail space. Reusable, mobile living boxes („furniture in a box"), easy to adapt to different retail space layouts. Appropriation of inner courtyards or public areas in front of the retail premise	Temporary living in a vacant cargo ship in repurposed ISO shipping containers. Aiming for (partial) self-sufficiency and autonomy regarding Resource, energy and food supply. Private loggias and communal Roof terrace (gardening options)
Site characteristics	Railroad areas: Rails, tracks, disused stations and track systems	Vacant retail space on ground floor level (< 100m²)	River/water system with berth for ship
Resources	Power supply via grid connection, semi-centralized water and sanitation solution with storage tanks	Power and water supply via grid connection, centralized sewage connection	Circularity concepts: high degree of resource autonomy: PV, rainwater treatment, greywater system, nutrients
Neighbourhood characteristics	Varies, as the building scenario is mobile, connection to public transport connection to social infrastructure	Connection to public transport, connection to social infrastructure	Connection to public transport, connection to social infrastructure
Special features	Mobile building solution, can be transported to other locations or cities without dismantling	Mobile living boxes are reused and transported from one vacant retail space to the next after use	Partially autonomous resource supply

The process of designing the pop-up models was also based on the findings from an extensive literature survey and on the analysis of international case studies on temporary housing environments in urban spaces (data pool), from which key elements that define the framework conditions of urban planning strategies for temporary housing were extracted and analysed. These key-findings are published in the paper *Bertino, G.; Fischer, T.; Puhr, G.; Langergraber, G.; Österreicher, D.; Framework Conditions and Strategies for Pop-Up Environments in Urban Planning. Sustainability 2019, 11, 30, doi: 10.3390/su11247204.*

General findings for the design of demountable und re-useable pop-up housing models were also derived and abstracted from investigation of the case studies comprised in the data pool as well as the considerations on and the design process of the pop-up housing models. These results have been published here: *Bertino, G.; Kisser, J.; Zeilinger, J.; Langergraber, G.; Fischer, T.; Österreicher, D.; Fundamentals of Building Deconstruction as a Circular Economy Strategy for the Reuse of Construction Materials. Applied Sciences 2021, 11, 939, doi:10.3390/app11030939.*

Moreover, considerations and conclusions on the requirements of open spaces for temporary housing environments are presented in the manuscript *Stocker, M., Damyanovic D., Huber-Humer M., Schneider G.: Open spaces of formal temporary buildings: quality and requirements. submitted to the Journal "Cities" in August 2021.*

3.6 SPECIFIC SUSTAINABILITY INDICATOR-SET AND CROSS-DISCIPLINARY ASSESSMENT TOOL FOR TEMPORARY HOUSING ENVIRONMENTS (PART OF DELIVERABLE D4)

A compendium of 51 indicators grouped in the categories "ecological quality", "technical quality", "site quality" and "social aspects and residential quality (quality of life)" (see Figure 8) specifically selected, adapted and developed for the sustainability assessment of temporary housing environments has been generated in the project. Each indicator is described in detail in an indicator-sheet including information on background considerations, expressiveness, calculation, mathematical transformation (parameterisation) and scaling (see Deliverable D4). The indicator-set combined with the mathematical parameterisation and scaling process is the main part of the cross-disciplinary assessment tool for temporary housing concepts.

Figure 8: Set of indicators for the sustainability assessment of temporary housing environments

For the interdisciplinary evaluation and to answer the research hypotheses, an interdisciplinary method was needed in the project. Due to the lack of suitable existing methods, a new method for the evaluation of eco-site-socio-technical processes has been developed. During the

development it was important to find a quantitative method, which not only allows an evaluation, but also accompanies and supports the interdisciplinary cooperation in general. At the beginning of the project work, it was determined that, in addition to an interdisciplinary working language, the acceptance of individual solution approaches in the respective disciplines related to individual research questions. This circumstance can go so far that a partial aspect is regarded as supposedly ideal by one discipline and is not considered acceptable by another. This leads to a dilemma in the cooperation, which can be solved only with difficulty or not at all by means of a discussion.

Therefore, a mathematical solution space was defined in which the acceptance can be mapped, in the following called acceptance mapping. The used definition or ranking of acceptance and its characteristics was derived from Luke (1995). It was broken down into an acceptable range (which corresponds to an active endorsement), a tolerable range (which corresponds to a passive approval) and a range that can no longer be tolerated (which corresponds to an active rejection). For this purpose, in the first step, the essential properties or sub-processes of the solutions to be evaluated were identified. In the following, the indicators were constructed from these. When constructing the indicators, care was taken to ensure that they were as self-contained as possible and that their acceptance could be assessed as simply and with an interdisciplinary manner as possible. Care was also taken to ensure that no dilemma can occur in an indicator. To identify a possible dilemma, a later non-monotonic acceptance mapping was identified as a necessary condition, but whether this is also sufficient could not yet be clarified in the project. Likewise, in constructing the indicators, care was taken to ensure that a general view of a solution approach emerged from the indicators. Regarding pop-up housing environments, this means that rapidly changing characteristics (such as a change of location, a change of use or users) can be generated via a subsequent linkage of the pop-up housing environment assessment. The problem space thus found and spanned by the indicators was mapped into the interval [0,1] monotonically increasing or monotonically decreasing via the acceptance mapping developed for each indicator. Principles, methods, and definitions from the literature (Schmidt, 2009, Meintrup et al., 2005, Jänich, 2008, and Kovacevic, 2008) were used for this purpose. During the development, each indicator was considered equal. This should allow for a later definition of an operation to incorporate location, usage, or users, and possibly provide a basis for the development of an algebraic structure.

Figure 9 exemplarily shows the visualization of the interdisciplinary assessment using the housing model "Pallet Shelter" as a “case study”. All 51 indicators were normalized and scaled between 0 (low quality) and 1 (high quality) and grouped into four assessment plots by ecological, technical, site and social/residential quality. The closer the indicator is to "1”, the higher the quality. For the whole plot that means, if a larger area of the plot is covered, the higher the "sustainability" in these four categories. Overall, it can be concluded from the ratings of all six housing models that a higher social/residential quality usually corresponds with a lower technical and ecological quality. This can also be seen in the example "Pallet Shelter" (Figure 9).

In general, it must be said that the design of all six housing models was done within the Viennese context and the associated high housing standards. Thus, the housing/living quality was given a quite high priority, which required a higher technical and a more complex configuration (compared to other temporary forms of housing such as, e.g., tents or containers). This is reflected in the evaluation in the partly quite low ratings of some of the technical and ecological indicators (e.g., Lass/Ldisass, GWP).

As a special feature of the "Pallet Shelter" it has to be mentioned that the housing model itself can be built and dismantled quite easily and quickly (indicators "level of ease of assembly/disassembly" (Lass/Ldisass)), but in our specific scenario it was assumed that well ventilated, cooler but sealed areas serve as a location (in order not to occupy high-quality public green spaces) and this location would have to be greened and adapted extensively for a high living quality, which results in the low values of these two parameters. Another specific feature of this housing model is that the daylight quality (DLQ) resulted in poor values due to the extensive shading for natural cooling.

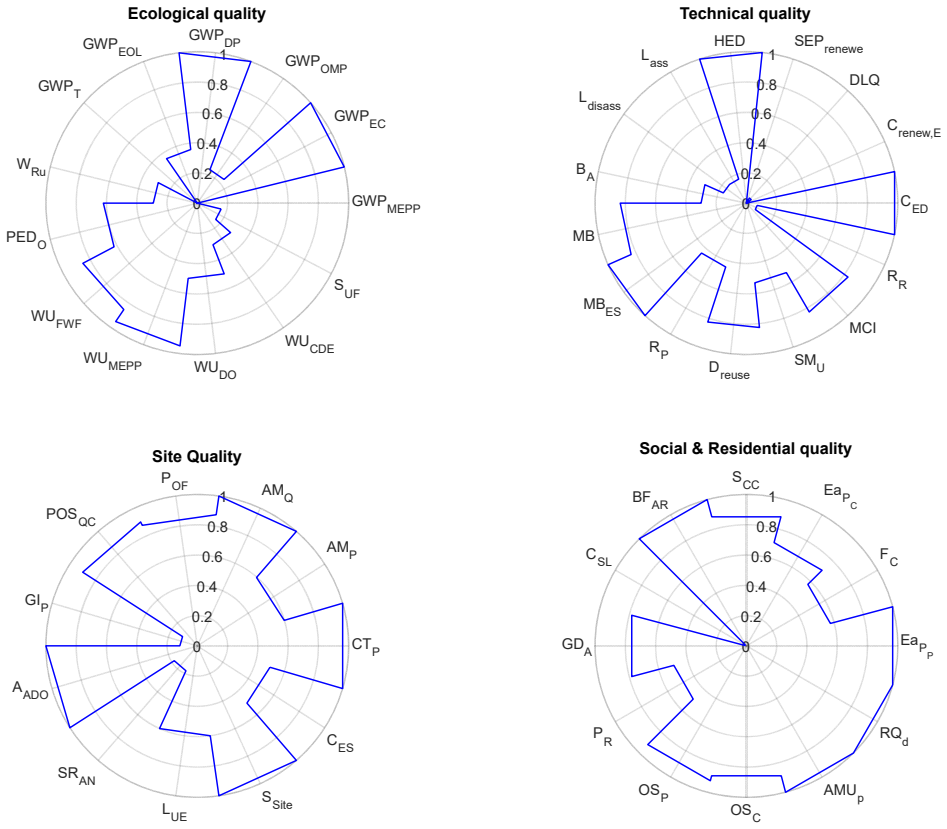


Figure 9: Exemplary assessment plots for the scenario "Beat the Heat" (model Pallet Shelter); all 51 indicators are normalized and scaled between 0 (low quality) and 1 (high quality)

This assessment tool has been iteratively adapted and tested using the housing models as "theoretical case studies", which show in general a high level of diversity, thus also demonstrating the quality of the assessment method, although a more in-depth sensitivity analysis has yet to be carried out, particularly regarding the scaling for each indicator, and the derivation and abstraction of general principles and interrelations between the assessment indicators (e.g., the investigation of the tolerance limits of the indicators as well as the analysis of the dependencies and influences among each indicator). However, the method can now serve as an adequate assessment approach for the sustainability evaluation and refinement of temporary housing options regarding technical, site, social and ecological aspects. Economic considerations are not covered in this approach so far but should be investigated in detail in the future and necessarily integrated at a later stage.

3.7 KEY-FINDINGS REGARDING TEMPORARY HOUSING MODELS AS EXPERIMENTAL INNOVATION NICHES (PART OF DELIVERABLE D3)

Each of the six temporary housing models should also be able to serve as micro innovation systems. Therefore, a tailor-made innovation model for each of the six housing models was conceptualized. A comprehensive literature analysis provided the basis for this research step. Based on the examined current literature, the following experimental designs were selected as suitable: niche experiments, urban living labs, bounded socio-technical experiments, transition experiments and grassroots experiments. In a next step these existing experimental designs in the field of sustainability transitions were compared to one another, detailing their strengths and weaknesses to highlight their differences and draw attention to their special features. A process for the selection of suitable experimental designs was then developed, addressing the question "What is a robust method when selecting between experimental designs for sustainability transitions"? The two-step method developed for this purpose is described in detail in this paper: "*Rose, G., Stocker, M., Ornetzeder, M. (2021). Temporary housing projects as experimental niches for sustainable innovation. In submission to the Journal „Cities", Elsevier" (Nov 2021).*

Table 5 gives an overview of the innovation foci proposed for the six models and the experimental designs which have been identified as suitable according to the developed selection method. The model in the Beat the Heat scenario, for example, is well-suited to test within a controlled experimental set-up if the objectives postulated in the scenario can be achieved, and was conceptualized as a niche experiment within the project. Depending on the main research questions pursued within the experiment, Beat the Heat could also be conceptualized as an urban living lab or bounded socio-technical experiment. Based on its framework conditions and objectives it is, however, not suited to serve as a transitions experiment or grassroots experiment. Other examples, such as Life Sharing to Go, demand a much more open design for learning and experimentation, with plenty of room for a variety of topics, so this scenario was planned as a hybrid between transition and grassroots experiments. Taking this as a basis, each of the six developed models for temporary housing

may be implemented as an urban experiment and can thus become an element of the local innovation system in the city of Vienna.

Table 5: Overview of six temporary housing scenarios/models and associated innovation systems for Vienna

Scenario	Beat the Heat	Life Sharing to go	Gap Module	Life on track(s)	Flat-Pack	Don Autonom
Model	**Pallet Shelter**	**InFactory**	**Gapsolutely fitting**	**TinyTainer**	**Shop Hopping Box**	**Binnen bleiben**
Innovation focus	Circular building concepts, low-tech solutions, rapid generation of green spaces	New forms of living and interaction, alternative pathways for sustainable and communal living, modular building	New forms of living and interaction, social integration, minimalism and collectivism as strategy for sustainability	Operational suitability for disaster contexts, on-site solutions (water and sanitation), electricity provision	Flexible and adaptable living spaces (modules, partitions)	Self-sufficiency and autonomy regarding reuse of resources, energy supply, food supply and internal governing structures
Suitable experimental designs	Niche experiment, (Urban Living Lab, Bounded socio-technical experiment)	Transition experiment, Grassroots experiment	Bounded socio-technical experiment, (Transition experiment)	Niche experiment, Urlan Living Lab	Niche experiment	Bounded socio-technical experiment, Urban Living Lab

3.8 RISK-ASSESSMENT REPORT OF THEORETICAL HOUSING MODELS (DELIVERABLE D5)

While still at a theoretical stage the introduced housing models were part of a standardised risk assessment. The main parameters for describing the models and the specific context they will be used in can roughly be assigned to the different management phases. In the early phases problem awareness and a certain preparedness to take a decision will be decisive. Additionally, the time needed to install a certain measurement might be of importance. Regarding the application phase, those parameters which will affect resources are the key factors which can endanger the employment of a certain model, i.e. the duration and the extent of a measurement. Finally, the persons who will inhabit a certain type of building will influence the risk assessment by their perceptions and social interactions. Therefore, parameters such as voluntariness, controllability and familiarity will play an important role.

A risk assessment according to ISO standard 31000/ÖNORM 4900, widely used in the field of organisational management, was carried out to evaluate the scenarios developed in this project. Even though only limited resources were available for this subsequent part of the

project, we expected its preliminary results would offer valuable insights into both the basic risk assessment of the models presented and their formulated scenarios as well as the applicability of this method in principle. An interesting methodological consideration in this project was that a risk assessment method that had been tested in practice was applied to objects that did not yet exist, i.e. ex ante. However, the risk assessment according to ON 4900 is both structured enough and sufficiently flexible, so that a corresponding adaptation was possible.

With regard to the models or scenarios, a distinction can be made between scenario-specific risks and non-scenario-specific, i.e. generic risks. While scenarios such as "Life on track(s)" (model "TinyTainer") or "DonAutonom" (model "Binnen bleiben") have risks that are caused by the potentially dangerous location (abandoned railway stations, river banks), other scenarios or the models derived from them involve risks that are either technical, urban planning or social. In the case of "GapModule", for example, the quite high planning and construction costs need to be mentioned, for other scenarios ("LifeSharingToGo") generally a quite long preparatory phase. "BeatTheHeat" also requires more coordination in advance, which also increases the preparation period for this scenario. Scenario-independent risks are first and foremost (1) the unwillingness of owners to make vacancies available for the construction of temporary forms of housing, (2) the tendency of residents - for obvious reasons - to settle permanently in the temporary environment provided and therefore to create a quasi-permanent residential relationship out of a temporary relationship of use, and that (3) in the case of an inhomogeneous group structure and a lack of integration into the social environment, potential sources of conflict are created at the local level, which can lead to an increased effort for order and control.

The interdisciplinary approach used in this project made it possible to build up new knowledge in cooperation and to evaluate it in a participatory, multi-stage process. For this reason, the approach is particularly suitable for emergent developments, such as the regulation of the use of new technologies or in crisis and disaster management.

3.9 TRANSFERABILITY CONCEPT (DELIVERABLE D6)

The transferability concept covers both the implementation of temporary housing environments, respectively the developed scenarios and housing models, in the City of Vienna as well as the wider diffusion of sustainable temporary housing in urban areas. In the national context for the City of Vienna these transferability considerations may serve as a sound basis to support the transfer of temporary housing ideas in concrete pilot projects and to stimulate the discussion with relevant stakeholders for the implementation in corresponding strategy papers and the creation of political-legal framework conditions.

As part of the local transferability concept, a script for a fictional meeting with representatives of the City of Vienna and decision-makers has been elaborated to provide concrete next steps, that could result from the project outcome. The framework scenario as well as the methodology for this potential meeting are elaborated in more detail in D6.

To explore drivers and barriers of the developed scenarios regarding the international transferability of the concepts, online questionnaire sessions were conducted with an international audience. The results obtained from the questionnaire sessions allow insight into the international perception of temporary pop-up environments and are presented in Deliverable D6 as well as in the paper *Bertino, G.; Rose G.; Kisser J.; Drivers and Barriers for Implementation and International Transferability of Sustainable Pop-up Living Systems. Springer Circular Economy and Sustainability, 2021, 31, doi 10.1007/s43615-021-00063-8.* It was observed that while the perceptions of what requirements temporary housing must fulfil to be sustainable are quite uniform among the experts, the identified barriers for implementation within different international contexts differed greatly. The designs of these temporary housing scenarios and models, which rely heavily on local resources and systems, are strongly interwoven with the fabric and conditions of the city they were conceptualised for. While this serves to promote the sustainability of these solutions, it poses a particular challenge for the international transferability, requiring extensive adaptation for other contexts, particularly with significant differences in local socio-cultural and climatic conditions. However, the key topics addressed by the Viennese scenarios, e.g. migration and refugees, homelessness and precarious living, affordability and flexibility of urban housing, climate change adaptations, are global issues, which merely differ in extent and expression, leading to strong resonance with the participants. The scenarios appear to be considered adaptable and flexible enough to be applied in numerous locations, requiring some fine-tuning for the specific local contexts, and being particularly well-suited for the European continent.

5 REFLECTION OF RESEARCH HYPOTHESES AND CONCLUSIONS

As mentioned in the introduction, the research within this project was guided by three main hypotheses. The generalized key findings and conclusions reflecting these hypotheses are briefly summarized below.

H1 Temporary living spaces can provide one potential solution to rapidly increasing urban population by adapting "temporarily unused" urban land:

- Temporary housing (seen from an international perspective) is a recently heavily debated topic in cities with growth dynamics, but not a solution for the growing mass and cannot be regarded as an alternative to permanent building structures. It is purposeful for specific uses and to address special "needs" ("niche solution"), however, it is primarily addressing and covering qualitative aspects and requirements, and not quantitative (see also Bertino et al. 2019). The theoretically developed pop-up housing models are therefore not to be understood as a general solution for Vienna (or any other urban area in Europe) but offer suggestions for specific cases and innovative niche implementations to increase the usage intensity of vacant spaces. Nevertheless, in large cities like Vienna there will always be temporary forms of housing, so it is important that the city administration and other relevant actors actively address this issue.
- The study of the legal materials (e.g., Building Code for Vienna) and strategic planning instruments (STEP and specialised strategic concepts) revealed following issues, which were also confirmed by the outcome of the two stakeholder workshops (WS 2 and 3):
    a. Temporary (residential) housing is not explicitly addressed and considered in the former and current Viennese planning strategies (e.g., STEP 2025) and it is currently not a relevant issue in the strategic orientation of the City of Vienna.
    b. There is currently limited room for action regarding the construction of affordable temporary housing options due to the high urban development standards and high-quality standards for housing. This tends to be independent of whether a corresponding dedication for a specific residential usage already exists.
    c. Disruptive events are not considered, the focus is on planning continuity and reacting to ongoing (development) trends, above all population growth due to positive external migration balance.
- A fundamental obstacle seems to be a lack of awareness to include temporary housing into greater planning frameworks, and particularly the general concerns of stakeholders that temporary structures may become permanent, which would cut across and interfere with longer-term urban development plans.

- Clear organisational and proper legal framework conditions are needed to implement (and abrogate) temporary housing easily and in a targeted and reasonable way, where it is required to quickly meet the needs of people and user groups and to foster sustainability in the city in terms of space and resource demands. From the literature survey it appeared that temporary housing environments clearly need additional features, such as connection to cultural issues, social learning or experimental work for their smooth implementation and usage.
- The spatial abstract thinking of "pop up environments" was quite difficult from the professional perspective of spatial and urban planning in the project, especially since every conversion of existing infrastructure or every change of use as well as “unused/undeveloped” areas has tangible (political) consequences that must be discussed for concrete examples (e.g., impact on specific neighbourhoods). This challenge was also reflected in the fact that the project was widely conceived as a basic research project, but it became apparent that a concretization of the target groups, the occasion leading to "pop-up environments" as well as the spatial context in which these temporary structures are placed was necessary. This specification and the spatial context of Vienna mainly impacted the character of the project as an application-oriented basic research, which became more and more apparent in the course of the processing.

H2 Temporary spaces can be highly sustainable in implementation and use throughout their whole life cycle.

- There is no internationally accepted definition of “sustainable temporary housing” in the scientific literature; and therefore, no systematic sustainability assessment of temporary housing options has been published so far; based on this reasoning a comprehensive indicator-set and assessment tool specifically for temporary housing environments was developed in this project.
- The application of pop-up housing environments is supposed to increase urban sustainability incorporating the entire material life cycle (Bertino et al., 2019). Key-aspects and main characteristics are:
    a. Flexibility (different uses and application) and modularity of components allowing easier assembly and disassembly operations that, in many cases, allow for the complete reversibility of the project.
    b. Prefabrication may lead to an environmentally friendly construction process (reduction of dust, waste and wastewater in construction process compared to traditional methods); the precision of pre-construction and the use of raw materials with low embodied energy (including recycled materials, construction and industrial waste, wood) lead to a higher resource-efficiency.
    c. Transformation of contemporary architecture, thanks to numerous construction advantages, summarised as lower costs, because the cost for prefabricated

materials and their assembling on site are usually much lower than traditional construction methods;

d. Time savings, because the time required to complete the structure can be considerably reduced.

- Some of the current international urban temporary housing concepts (reflecting a specific lifestyle) are based on tiny house concepts and other ideas that are more sustainable (e.g., use of alternative or recycled/reused materials) and flexible structures.
- Thus, key-aspects with respect to environmental impact and sustainable resource thinking are demountable materials and modules, that allow as many as possible high-quality re-use cycles.
- Connection to water and sanitation services is usually available in urban environments (especially in well-serviced cities such as Vienna), and appeared to be the simplest and most affordable solution with the least expenditure of resources for temporary housing, thus the question of autonomous infrastructure in temporary housing turned out to be not highly relevant and sometimes even difficult to implement due to a strict legal framework (e.g., regarding sanitation solutions); however, temporary living spaces at remote locations can be also equipped with on-site water supply and self-sustaining sanitation solutions if required. On-site water supply and sanitation solutions can be designed so that (re)using treated greywater and/or rainwater for non-potable use is anticipated.
- Key-conditions regarding energy supply solutions for pop-up housing environments are feasibility, return of investment and initial cost capacities/budget, however, no detailed economic analysis has been conducted in the project. Depending on these factors, a highly sustainable energy supply system could be installed on virtually every site for virtually any temporary environment. However, using existing technical (energy) infrastructure (e.g., grid connection) usually seems more feasible than installing autonomous or self-sufficient energy supply systems for temporary housing in the urban (Viennese) context. If suitable technical infrastructure is available on site, it should be used preferentially for temporary housing options. Of course, temporary living spaces can be equipped with autonomous energy supply systems; however, their installation is highly dependent on the duration of use and its degree of remoteness in respect to existing (energy) infrastructure like grid connection.
- Turning temporarily unused urban spaces (particularly old vacant industry buildings, gaps between buildings connected to infrastructure, etc.) into temporary housing options is highly sustainable from a spatial resource perspective, and thus, helps to slow down the rapid soil sealing and land consumption of high-quality green areas.
- (Green) Open spaces in the immediate housing environment or on the plot, are immensely important since they offer free space to all dwellers, including user groups with reduced mobility, time, and financial resources. This is particularly true for

temporary housing environments, since (private) indoor living space is usually limited due to construction features. However, well-designed, and equally distributed communal and public open and green spaces can counteract but not compensate for the lack of private open space (Stocker et al. 2021, in submission).

- The six housing models developed in the project are mostly based on sustainable materials and demountable and reusable components. They were mainly designed for a potential implementation in the City of Vienna and thus with a high living standard in mind. This resulted in technically quite complex configurations (compared to common temporary housing options like tents or containers), providing high social/residential qualities, but relatively low technical and environmental ratings regarding sustainability in the assessment. Further adjustment and optimization steps are going on and will be addressed in a paper that is currently (Nov.2021) in preparation.

H3 Temporary spaces can create experimental areas allowing for an innovative learning environment, where sustainable practices can be developed and enhanced.

- Temporary housing models can be designed as sustainability experiments. These experiments can be used to further develop certain aspects of these models in a real-world setting and/or to test new technologies and practices with sustainability potential in the real world and derive general learning experiences from them.
- The different types of temporary housing developed in this project each offer specific potentials for the development of urban sustainability ideas. Some may have a social focus from the outset (e.g., social integration of immigrants, relationship between private and communal space), others may have more ecological and technical aspects (e.g. recycling of building materials, reuse of housing elements, tiny housing character – less resource use) that can be explored further.
- The engagement with and development of sustainable temporary housing models in this project led to incremental improvements rather than ideas for radical system-transforming innovations. However, if actual implementation projects are realised as thematically open experiments, room for manoeuvring could be created to encourage more radical approaches.
- Temporary living spaces can create experimental spaces in terms of implementing solutions for (re)using treated greywater and/or rainwater and dry toilets. These solutions could be a showcase for water saving solutions in urban areas.
- Temporary living spaces can also create experimental spaces for new and highly innovative autonomous energy systems since they provide suitable framework conditions for technical ‘sandbox’ solutions and can lead to new and highly efficient energy supply systems which can be tested/implemented at different sites/building areas.

- The experimental designs studied feature specific characteristics. They can be controlled politically/administratively to varying degrees and offer a range of learning and experimentation opportunities. Some are very well suited for the development of practical solutions, while others offer a platform to challenge prevailing social patterns and practices.
- Individual experiments that are connected to a pilot project, for example, do not yet constitute an innovation niche. This would require a series of further measures and stable framework conditions (e.g., timely horizon, financial resources, research activities, thematic coherence). However, temporary housing projects can be linked to thematically appropriate niche activities (e.g., circular economy) as experiments with particularly favourable conditions for practical testing.

6 OUTLOOK

In this project, the basic elements of temporary housing have been systematically analyzed and linked in theoretical housing models. In next steps, the project findings and theoretical housing models should be transferred into practice (see also considerations in D6). This concerns both the strategic level (with respect to urban planning and development, innovation research, resource management and circular economy) as well as the implementation level, e.g. demonstration in pilot projects.

In addition, an economic analysis of the housing models is currently missing. Due to the as yet unspecific prototypical level of the housing model development, an economic evaluation did not appear to be expedient at this stage. However, an economic analysis should be addressed, for example, in the form of a feasibility study for potential (pilot) implementations of the models.

Application of the project outputs and results at the strategic level

Focus on urban planning and development

The project results can be integrated into urban development considering temporary uses in the course of planning processes (basic principles, evaluation models, etc.) to a greater extent; particularly regarding the integration in STEP 2025 as well as in the Smart City Strategy of the City of Vienna. The project has shown that temporary housing can be provided in a sustainable way. As temporary housing is also happening in Vienna, it is important to deal with this issue in a responsible and well-planned manner.

Focus on innovation research

Temporary housing offers a suitable framework to explore the future of sustainable urban living. The project laid the foundations for the conception of urban experimental and learning spaces, which could be of interest, e.g., to the City of Vienna, the Vienna Business Agency or private investors. In further projects, even more radical approaches could be explored within the framework of temporary forms of housing. The thematic focus could extend far beyond the actual topic of housing. In temporary and spatially limited social experiments, the future of the city could be explored. The experimental character would make it possible for such experiments to fail, but the lessons that can be learned in the process would be documented and evaluated.

The idea of thematically connected urban real-world experiments, discussed here for the first time (final workshop), could also be further developed. Such an approach would go far beyond the topic of housing and would focus more on experimentation and learning covering a broader range of topics. Especially when it comes to exploring radical and potentially disruptive sustainable innovations, it is not enough to conduct a few isolated experiments. However, networks of interconnected experiments could help to take more risks and question existing practices and technologies more strongly.

Focus on resource, sustainability, and circular economy aspects

Some project outputs, e.g., those which concern the dismantlability and reusability of building components or entire units, could be used as supporting materials for further steps of the Circular Economy Strategy 2021, which is currently being developed by the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK), and which shall become the national answer to the EU Circular Economy Package and to specific issues in the Green Deal. Moreover, the project results could be of high relevance, when such national strategies must be allocated to the City of Vienna (e.g., within the Smart City or the Sustainable Development Strategy of the City of Vienna (MA22) or the Viennese Waste Management Plan/Waste Prevention Program (MA48)).

Since the building sector has a significant impact on the environment (high resource and energy demand, waste generation, greenhouse gas emissions[1]), the EU is launching a new comprehensive strategy for a sustainable built environment based on the program of the Green Deal, which should promote circular economy principles throughout the life cycle of buildings by, for example, enhancing measures to improve the durability and adaptability of buildings in line with circular economy principles for building design. Therefore, some of our project results and outputs (e.g., the developed assessment approach and the deliverables on the sustainable housing models) could become highly relevant for circular building considerations in Vienna.

Application of the project outputs and results at the implementation level (experimental space)

The future potential of the developed housing models lies in the scalability, deconstructability and storage capability of the individual units. In a future project, real-life experiments could be undertaken to design such entities. Thus, one of the next important steps would be to transfer the theoretically developed and evaluated housing models into practice and to use instruments of innovation research, such as niche experiments, etc. to support and reflect the activities scientifically. The provided (theoretical) project outputs can support the direct implementation of (selected) models in a concrete pilot project. Open questions regarding construction, optimization in operation, dismantlability and storage as well as after-use concepts, resource aspects, extension of use, reuse and recycling of building materials and components should be analysed in the pilot scale application. Temporary forms of housing could be also explored in real laboratories and provide an experimental space for urban sustainability. Questions regarding content orientation, conceptual implementation, organizational implementation, accompanying research and duration can be specified. Projects that generally deal with the development of sustainable solutions for the city can also benefit from the project results (concept development).

[1] Building sector requires enormous resources and is responsible for about 50% of total raw material extraction, and construction accounts for over 35 % of the total waste generated in the EU. Greenhouse gas emissions from raw material extraction to construction / renovation of buildings are estimated at 5-12% of total national greenhouse gas emissions (European Union, 2020).

Further research needs on scientific methodological approaches

Within the project, an assessment tool with indicators specifically designed to evaluate the sustainability of temporary housing has been developed and tested on the six theoretical housing models. However, this methodological process is still under development and needs further application examples for evaluation (sensitivity analyses of indicators) and fine-tuning. The method and the underlying concept could principally be transferred to other areas, it could be, e.g., adapted for the evaluation of permanent forms of living.

The data pool of international examples of temporary housing created in the course of the project could also be expanded, and the developed typology of temporary housing forms should be reviewed and adapted if necessary. An expanded database with national and international examples could be used as input for new research projects. This would allow various secondary analyses to be carried out on follow-up research questions.

The GIS model developed for assessing the potential of areas for temporary housing in the City of Vienna should be expanded, optimised, and validated for its application suitability in practice. Again, the project created a foundation that allows for further development for other use cases.

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8 FIGURES AND TABLES

9 ANNEX

9.1 LIST OF INDICATORS

9.1.1 Ecological quality

Table 6: List of ecological indicators

Type of quality	No.	Abbreviation	Indicator Name
Ecological	1	GWP_{MEPP}	Global warming potential material extraction and production phase
	2	GWP_{EC}	Global warming potential construction phase
	3	GWP_{OMP}	Global warming potential operational phase and maintenance
	4	GWP_{DP}	Global warming potential deconstruction phase
	5	GWP_{EOL}	Global warming potential end of life phase
	6	GWP_{T}	Global warming potential emissions total
	7	W_Ru	Water reuse
	8	PED_{O}	Primary energy demand - operation
	9	W_{FP}	Full water footprint
	10	WP_{FP}	Product water footprint of materials used in building
	11	WU_{DO}	Water use during operation
	12	WU_{CD}	Water use during construction and disassembly
	13	S_{UF}	Stock usage factor

9.1.2 Technical quality

Table 7: List of technical indicators

Type of quality	No.	Abbreviation	Indicator Name
Technical	1	C_{ED}	Energy demand - cooling
	2	$C_{RENEWE,E}$	Coverage energy - electrical
	3	DLW	Daylight quality
	4	$SEP_{RENEWE,E}$	Share energy production renewable
	5	HED	Energy demand – heating
	6	L_{ASS}	Level of ease of assembly
	7	B_{A}	Level of building control
	8	MB	Maintenance building
	9	MB_{ES}	Maintenance building engineering services
	10	R_{P}	Recycling potential
	11	D_{REUSE}	Reuse potential (end of life)
	12	L_{DISASS}	Level of ease of disassembly

	13	SM_U	Secondary material utilization
	14	MCI	Material circularity indicator
	15	R_R	Realizable recycling factor

9.1.3 Site quality

Table 8: List of site indicators

Type of quality	No.	Abbreviation	Indicator Name
Site	1	CT_P	Connection to public transport
	2	AM_P	Active mobility on the plot
	3	AM_Q	Active mobility in the quarter
	4	P_{OF}	Proximity to use-specific objects and facilities
	5	POS_{QC}	Access to public opens spaces in the quarter and city
	6	GI_P	Green infrastructure on the plot
	7	A_{ADO}	Accessibility for assembly, dismantling and operating phase
	8	SR_{AN}	Suitability for residential use depending on ambient noise
	9	L_{UE}	Land use efficiency
	10	S_{SITE}	Suitability of site
	11	C_{ES}	Consumption of ecologically sensitive areas

9.1.4 Social aspects and residential quality (quality of life)

Table 9: List of social and residential quality indicators

Type of quality	No.	Abbreviation	Indicator Name
Social and quality of life	1	Ea_{PP}	Effective area per person
	2	F_C	Facility category
	3	Ea_{PC}	Effective area per person (community)
	4	S_{CC}	Spaces conducive to communication
	5	BF_{AR}	Barrier-free accessible rooms
	6	C_{SL}	Changeability of the room size and layout
	7	GD_A	Gender+ and diversity aspects of built and open space structures
	8	P_R	Empowerment and type of participation
	9	OS_P	Private open spaces
	10	OS_C	Communal open spaces
	11	AMU_P	Open spaces of areas with mixed use
	12	RQ_d	High residential quality in the districts

9.2 FACT SHEETS

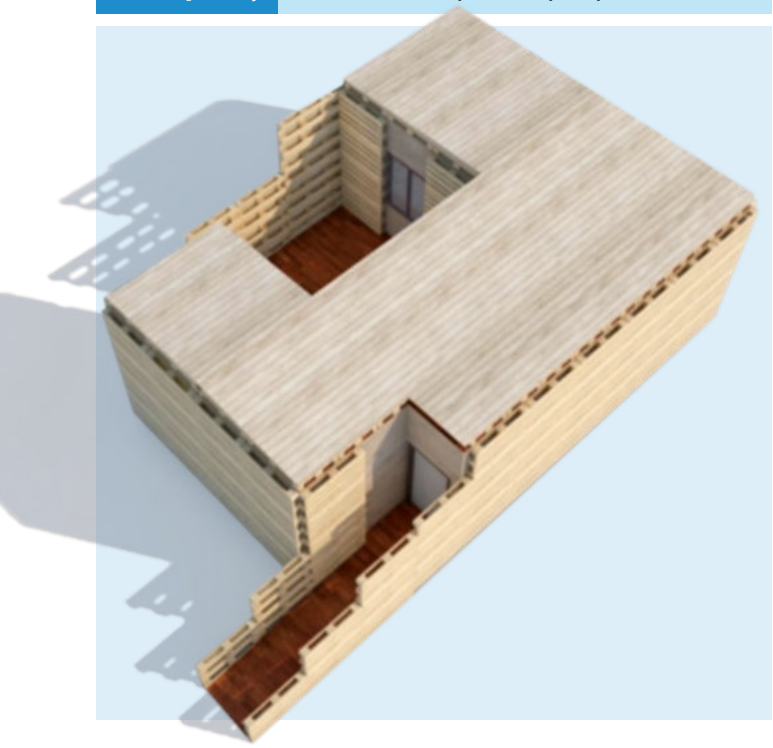
Beat the Heat / Pallet Shelter
Life Sharing to go / InFactory
Gap Module / Gapsolutely fitting
Life on track(s) / TinyTainer
Flat-Pack / Shop Hopping Box
Don Autonom / Binnen bleiben

Urban pop-up housing environments and their potential as local innovation systems

BEAT THE HEAT
PALLET SHELTER

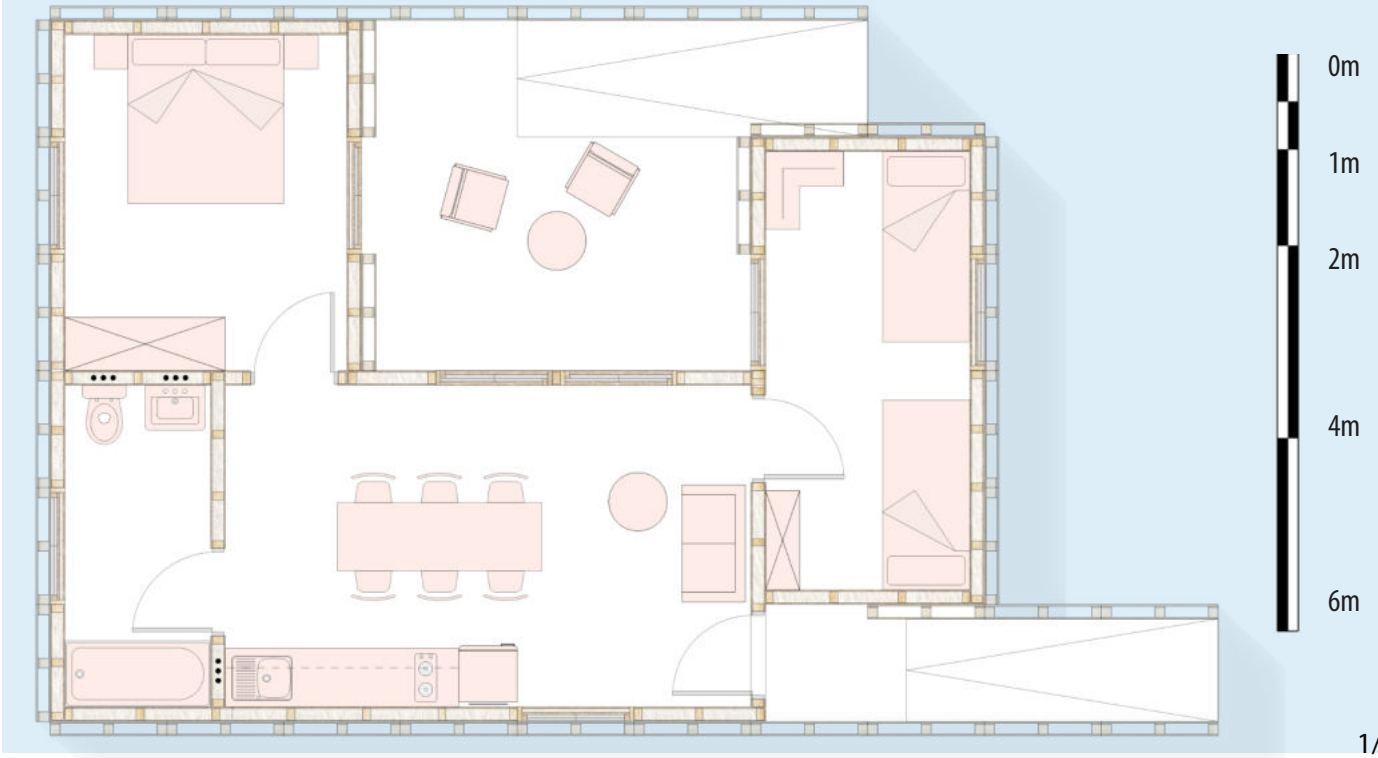
APPROACH

Purpose	Temporary housing during heat waves
User group	People vulnerable to heat waves
Usage time	Several days to weeks
Lifetime	Several years
Capacity	Scenario for up to 48 people



BUILDING

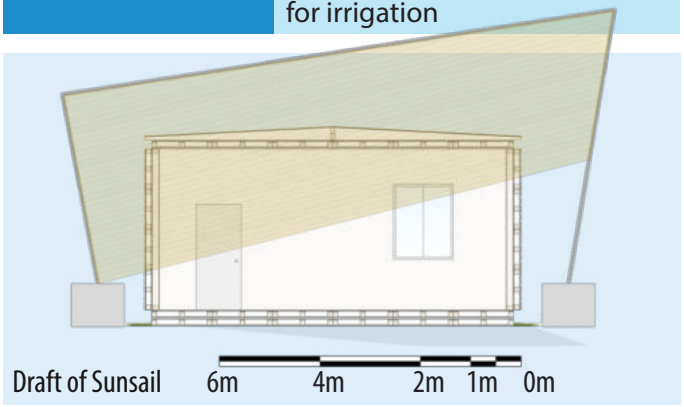
Characteristics Design	Based on natural cooling principles Recycled construction elements Sustainable raw materials Minimal transport costs Easy and quick assembly Reusable and easy to store Completely shaded by sun sail
Main Materials	Standardized EUR-pallets Oriented strand board panels Straw insulation Wooden laminate Wooden beams
Size	Building 50 m^2, Terrace 10 m^2 Up to 4 people per housing unit

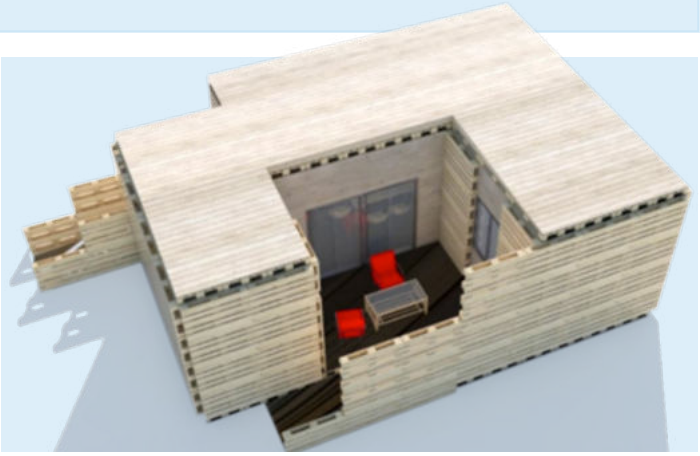


BEAT THE HEAT PALLET SHELTER

RESOURCES

Power supply	Grid connection
Electric installation	Conventional
Heating	None required
Cooling	Sun sails, water mist sprays
Ventilation	Natural ventilation
Water supply	On-site elevated water tank
Water heating	Instantaneous water heaters at tapping points
Outdoor lighting	LED mounted on the buildings
Wastewater	Percolation/infiltration
Sanitation system	Dry toilets, greywater system for irrigation





SITE

Preconditions	High potential for natural cooling systems Accessibility of public transport Accessibility of social infrastructure Flat area (slope <5%)
Open space	Private: terrace, garden and cultivation area Communal: space for recreation and circulation Wheelchair-accessible Communal used bike storage

Adapted from the original design of Barbero Duràn and Cuesta Urquia

PROJECT PARTNERS

The project ESR17-010 has been funded by the Vienna Science and Technology Fund (WWTF).

Urban pop-up housing environments and their potential as local innovation systems

APPROACH

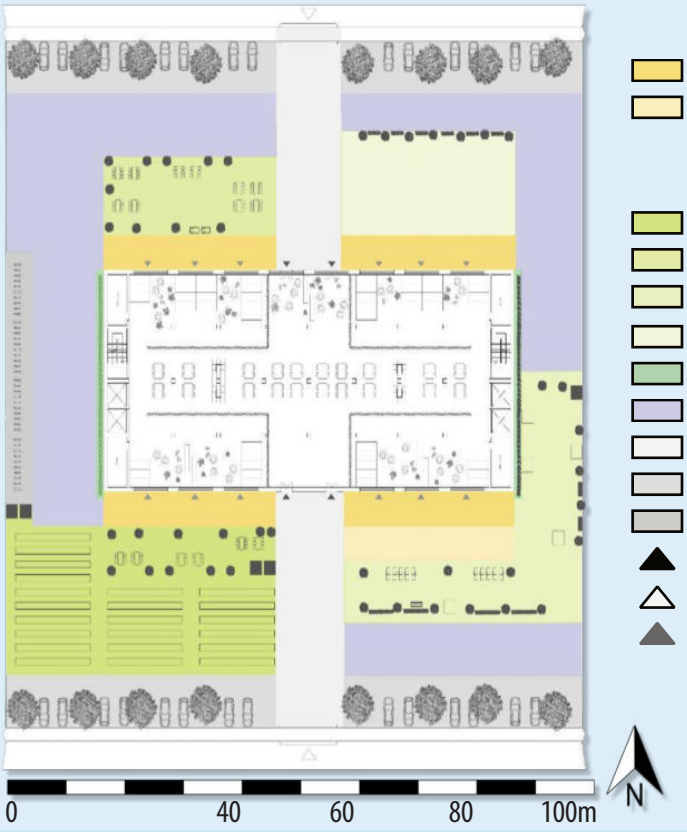
Purpose	Temporary living in halls of vacant (factory) buildings
User group	User mix – people interested in communal living and people with limited housing options
Usage time	Up to one year per resident
Lifetime	Until new permanent use of building
Capacity	Scenario for up to 78 people

LIFE SHARING TO GO
INFACTORY

BUILDING

Characteristics	Based on exploring communal ways of living and fostering exchange between people with different backgrounds
Design	Interconnectable modules (3.6x1.2m) Different module configurations Floating floor with heating system
Main Materials	Frame: structural steel Insulation: straw Walls: timber wood Simple joints
Size	1 to 4 people per housing unit

LIFE SHARING TO GO INFACTORY

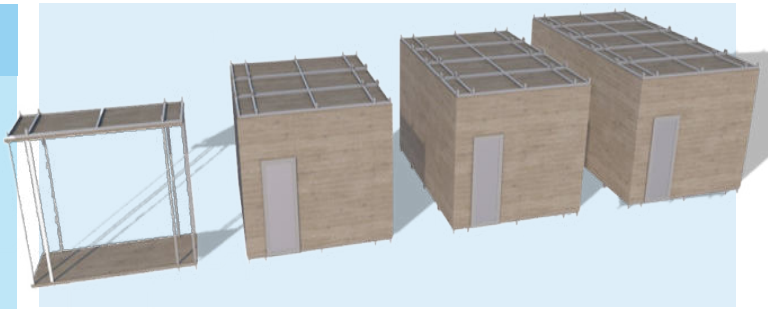


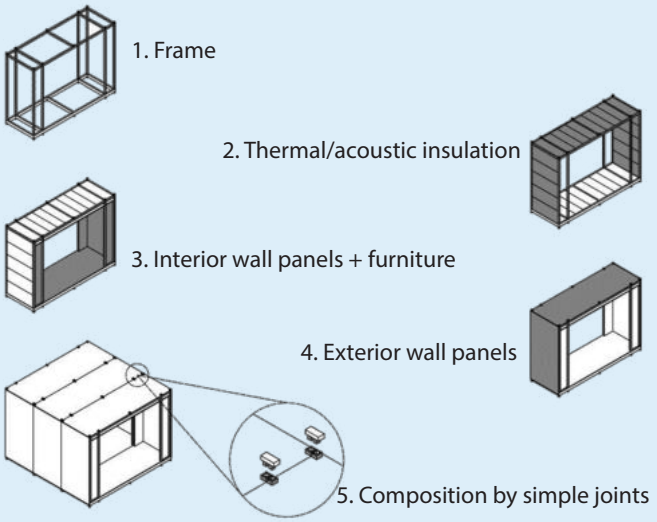
Area suitable for appropriation
- Appropriateable by adjacent residential units
- Area for domestic activities (laundry drying, etc.)

Comunal open space
- Area for cultivation: high raised beds
- Area for gathering
- Silent area
- Play area
- Facade greening
- Multifuncional area open for different uses
- Access area
- Car parking
- Bike parking (roofed)
- Building access
- Access to housing environment
- Informal acces to appropriatable open space residential units

RESOURCES

Power supply	Grid connection
Electric installation	Building management system
Heating	Wood chip plant
Ventilation	Natural ventilation
Water supply	Public water network
Water heating	Wood chip plant/PV
Sanitation system	Sewage connection





SITE

Preconditions	Accessibility of public transport
	Accessibility of social infrastructure
	Site is not in disrepair (health hazards, danger of collapse, site contamination)
Open space	No private open space
	Communal: cultivation area
	Area for gathering
	Silent area
	Play area
	Multifunctional area
	Bike parking
	Trees in buffer zone
	Access area

Adapted from the original design of Tasevska and Dimitrov

PROJECT PARTNERS

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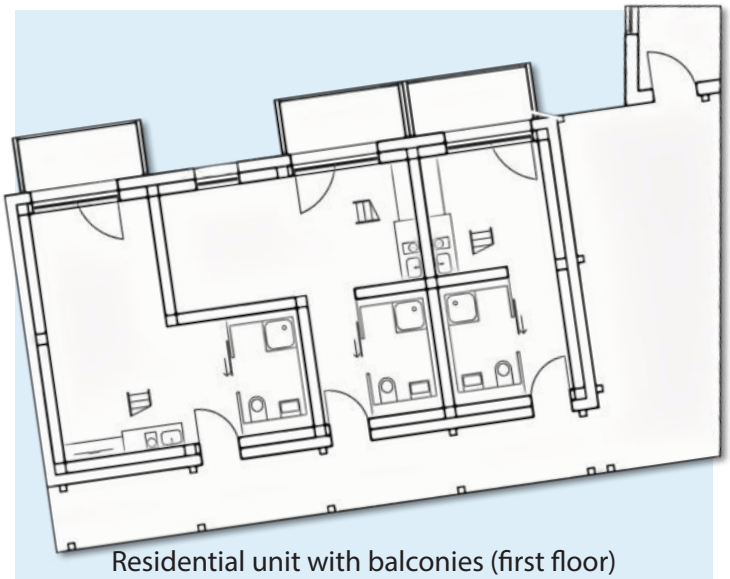
Urban pop-up housing environments and their potential as local innovation systems

GAP MODULE
GAPSOLUTELY FITTING

APPROACH

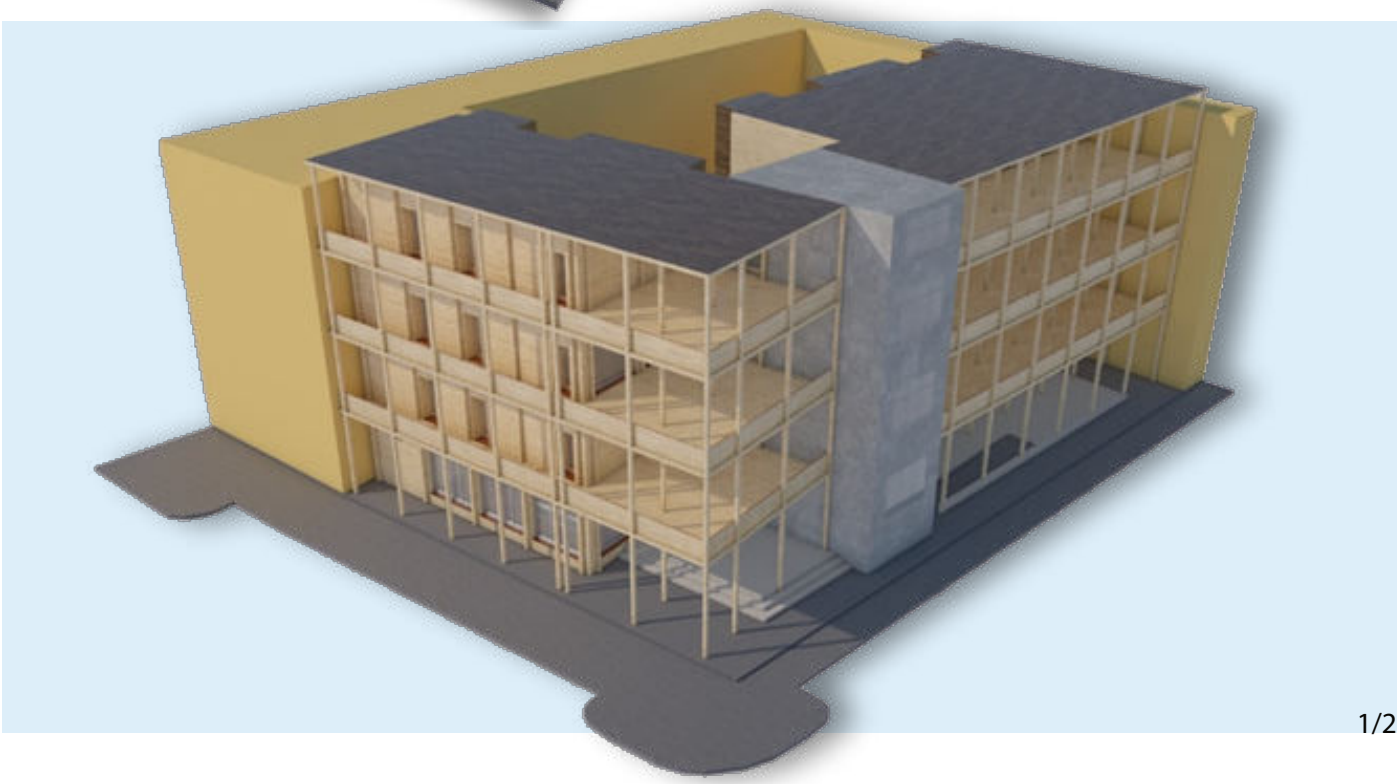
Purpose	Temporary housing in vacant lots
User group	User mix – people interested in communal living and people with limited housing options
Usage time	Two to five years
Lifetime	Multiple assembly and disassembly phases
Capacity	Scenario for up to 31 people



Residential unit with balconies (first floor)

BUILDING

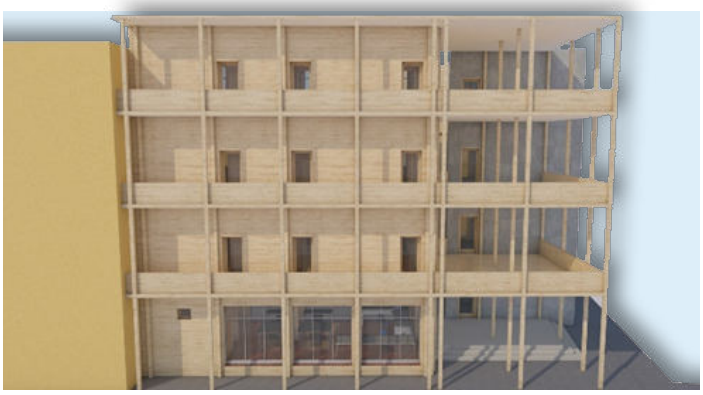
Characteristics	Based on modular components consisting of prefabricated elements
Design	Easy transport Reusable modules Deconstruction with low wear and tear Allows different living constellations
Main Materials	Wooden columns Cross-laminated timber Nut and bolt fixation Reinforced concrete
Size	1 to 6 people per housing unit



GAP MODULE GAPSOLUTELY FITTING

RESOURCES

Power supply	Grid connection/Photovoltaics
Electric installation	Building management system
Heating	Air-water heat pump (AWHP)
Ventilation	System with heat exchanger
Water supply	Public water network
Water heating	AWHP/elect. heating cartridge
Sanitation system	Sewage connection



SITE

Preconditions	Accessibility of public transport Accessibility of social infrastructure Vacant lot free of preexisting structures
Open space	Private: loggias towards inner courtyard Communal: terrace Green area, cultivation area Access area, graveled path Bike storage room Involvement of the neighborhood is encouraged by communal open space concept

Adapted from the original design of Friedwagner and Prömpers

PROJECT PARTNERS

WWTF VIENNA SCIENCE AND TECHNOLOGY FUND

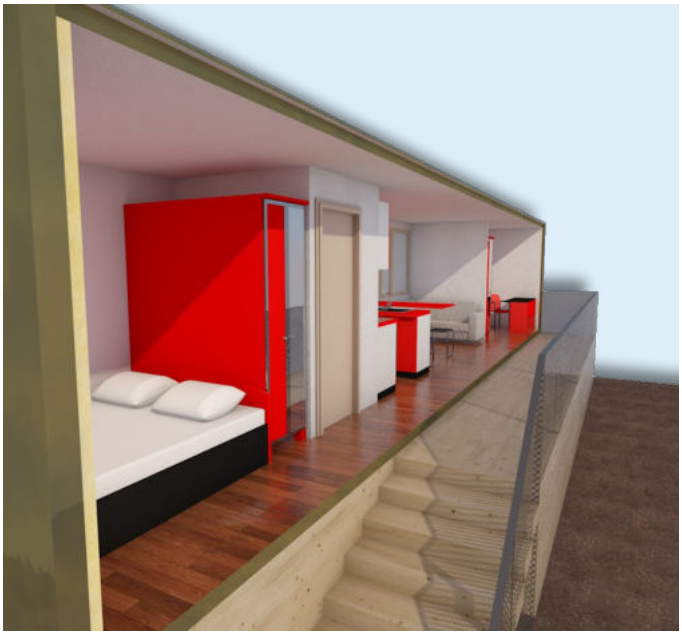
The project ESR17-010 has been funded by the Vienna Science and Technology Fund (WWTF).

Urban pop-up housing environments and their potential as local innovation systems

LIFE ON TRACK(S)
TINYTAINER

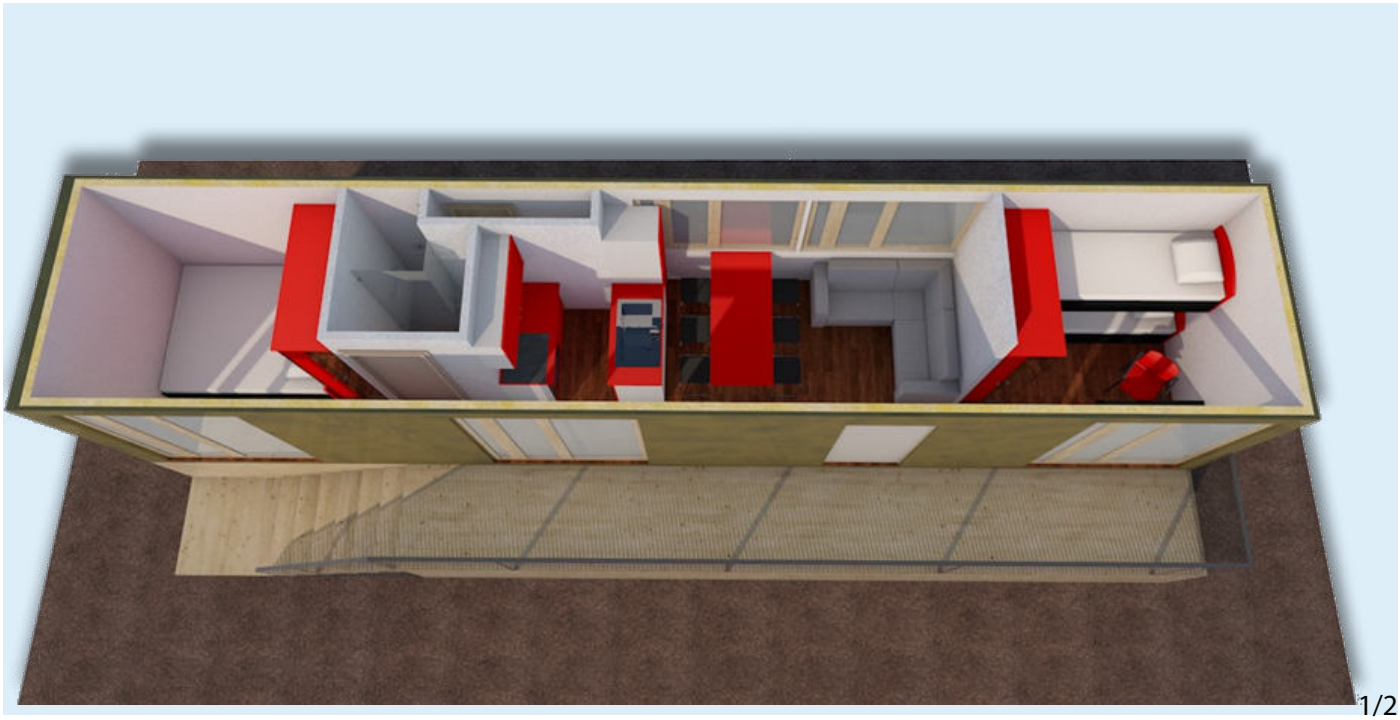
APPROACH

Purpose	Flexible – ranging from disaster response to event hostels
User group	Flexible – ranging from people with sudden housing needs to short-terms stays
Usage time	Several days to weeks
Lifetime	High durability
Capacity	Scenario for up to 40 people

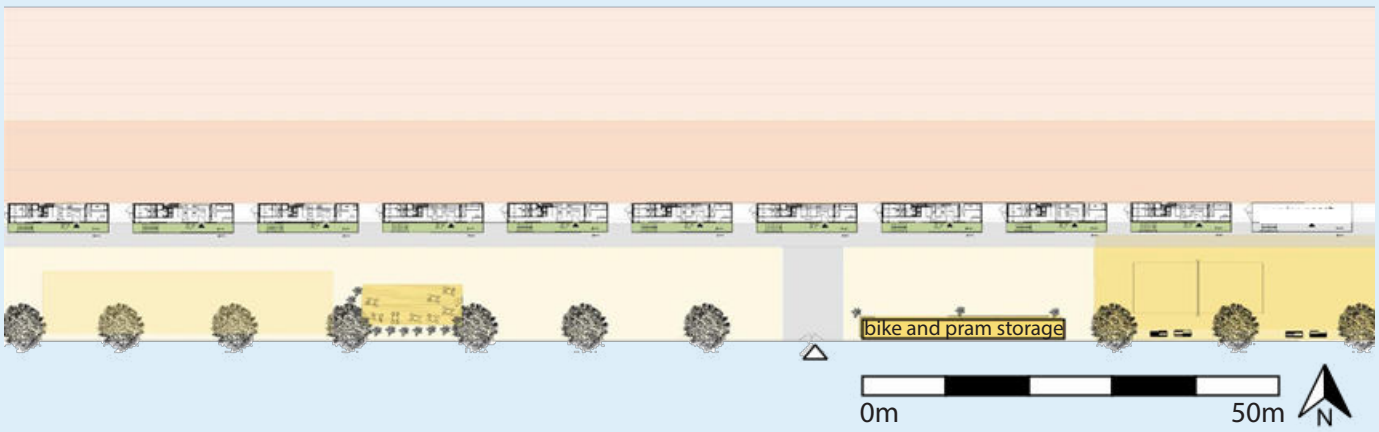


BUILDING

Characteristics	Quickly deployable housing solution with a wide range of possible usages
Design	Fully equipped mobile housing unit on railway Transportable without dismantling to intended location along railways
Main Materials	Repurposed ISO (shipping) containers Corrugated steel Plywood flooring Straw insulation
Size	Up to 4 people per housing unit



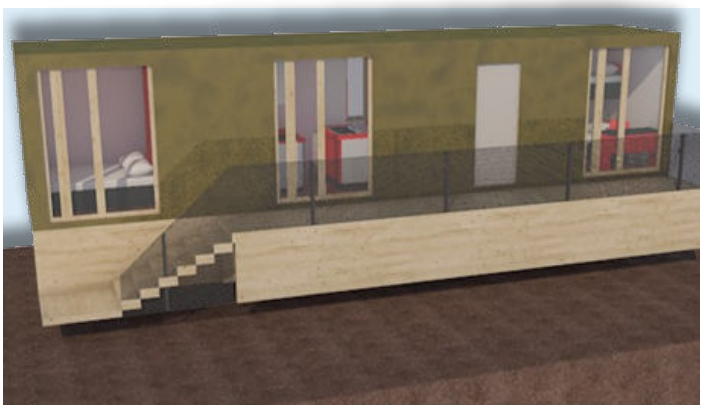
LIFE ON TRACK(S) TINYTAINER



- Open space private to residential unit
- Access area
- Buffer area (tracks)
- Tracks used for other uses
- Communal used open space open to appropriation
- Communal used open space: potential gardening area
- Communal used open space: play zone
- Communal used open space: terrace with seating
- Communal bike storage (roofed)

RESOURCES

Power supply	Grid connection
Heating	Infrared panels
Ventilation	Integrated in window frame
Water supply	Public water network
Water heating	Electric flow heaters
Sanitation system	Sewage connection



SITE

Preconditions	Non-frequented tracks Delimitation to operational rail lines Low noise exposure Accessiblity of social infrastructure Accessibility of public transport
Open space	Private: terrace mounted on container and folded in for transport Communal: terrace Access area Multifunctional area (cultivation, play zone, etc.) Bike storage

Adapted from the original design of Neudeck and Werni

PROJECT PARTNERS

The project ESR17-010 has been funded by the Vienna Science and Technology Fund (WWTF).

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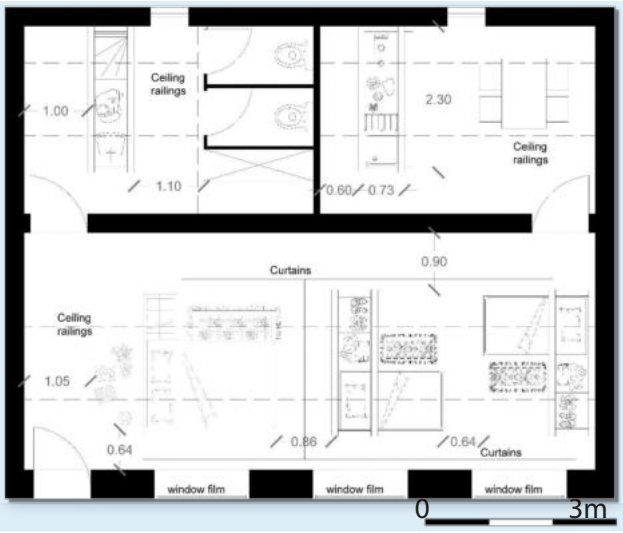
APPROACH

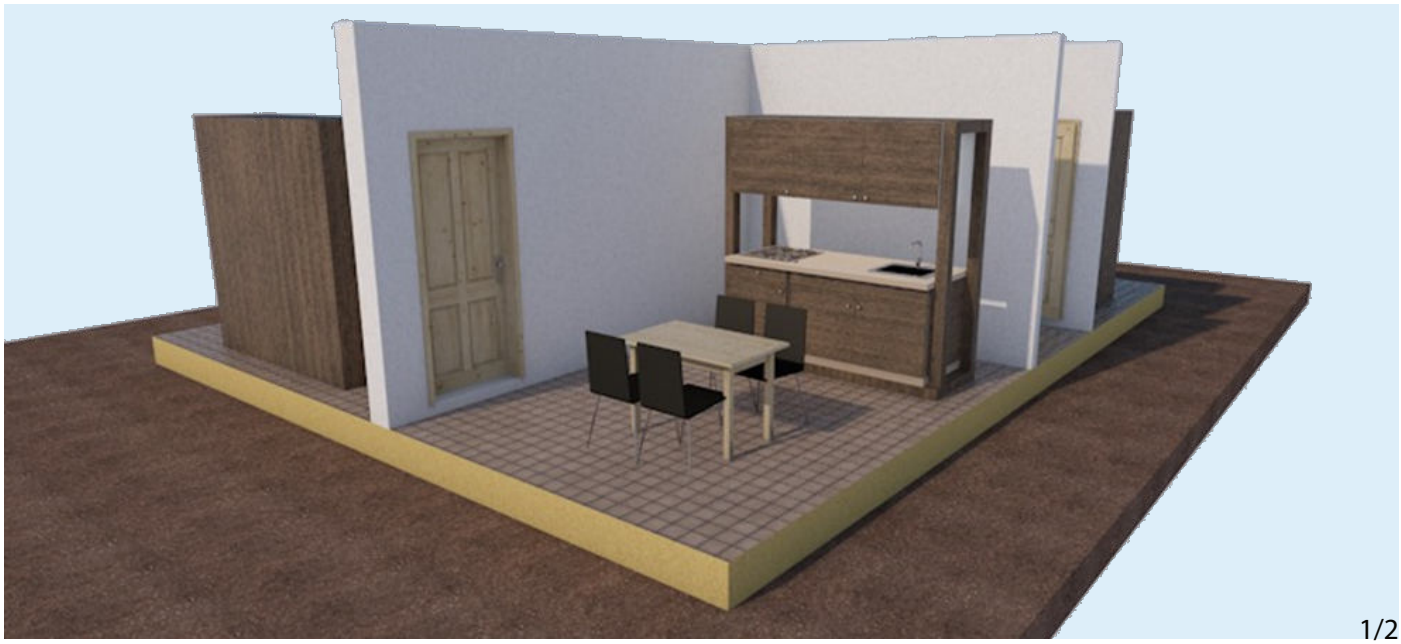
Purpose	Temporary living in vacant ground floor retail space
User group	Inviduals/families with temporary housing needs, e.g. expats
Usage time	Six to 24 months
Lifetime	Multiple assembly and disassembly phases
Capacity	Scenario for up to 4 people

FLAT-PACK
SHOP HOPPING BOX

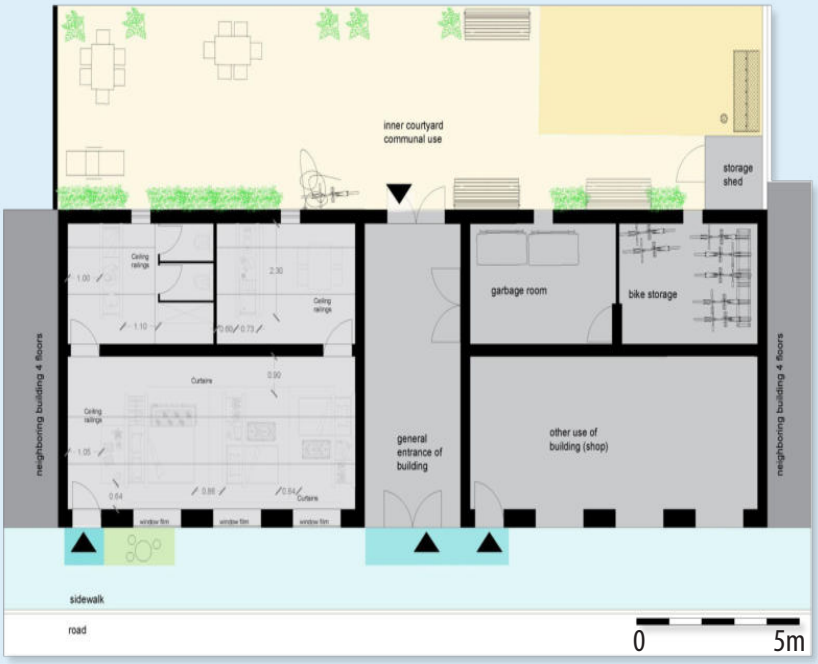


BUILDING

Characteristics	Reusable, mobile living boxes ("furniture in a box"), easy to adapt to different retail space layouts
	Flexible room layout through sliding modules on rails and fold-up beds
Design	Individual living units
	No structural adaptions
	Sliding modules on rails
	Kitchen and shower module available
	Durability and ease of repair
Main Materials	Wooden modules
	Guiding metal rails
	Textile curtains
Size	Case-dependent on available floor plan of retail space



FLAT-PACK SHOP HOPPING BOX



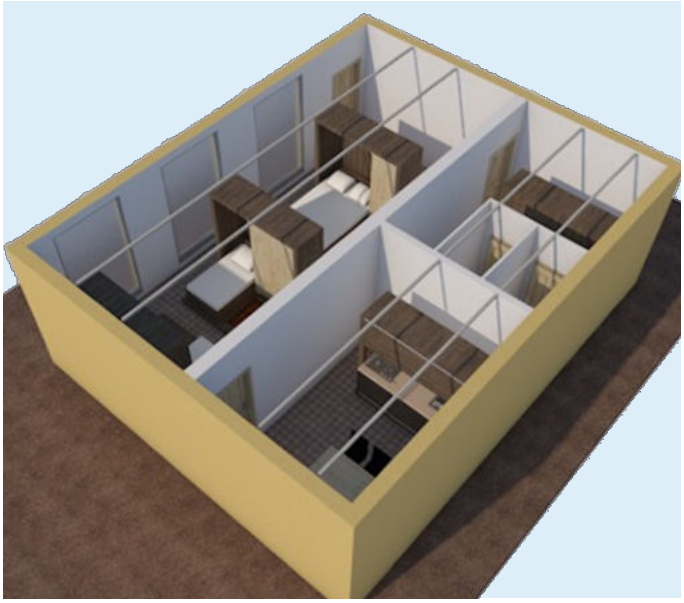
Buildings
- Neighboring buildings
- Part of building of other or communal use
- Housing environment

Public open space
- Access area of housing environment
- Access area of building
- Public open space able to be appropriated by residents

Open space - communal used by building's residents
- Inner courtyard with seating, open for different uses
- Inner courtyard used as play area
- Facade greening

RESOURCES

Power supply	Grid connection
Electric installation	Current system in place
Heating	Current system in place
Ventilation	Current system in place
Water supply	Public water network
Water heating	Current system in place
Sanitation system	Sewage connection



SITE

Preconditions	Small vacant ground-floor retail space Toilet available in retail space Location in main streets of the city
Open space	No private open space Communal: Inner courtyard Short-term appropriation of sidewalks (e.g. Parklets)

Adapted from the original design of Verdugo Pelaez and Rodriguez

PROJECT PARTNERS

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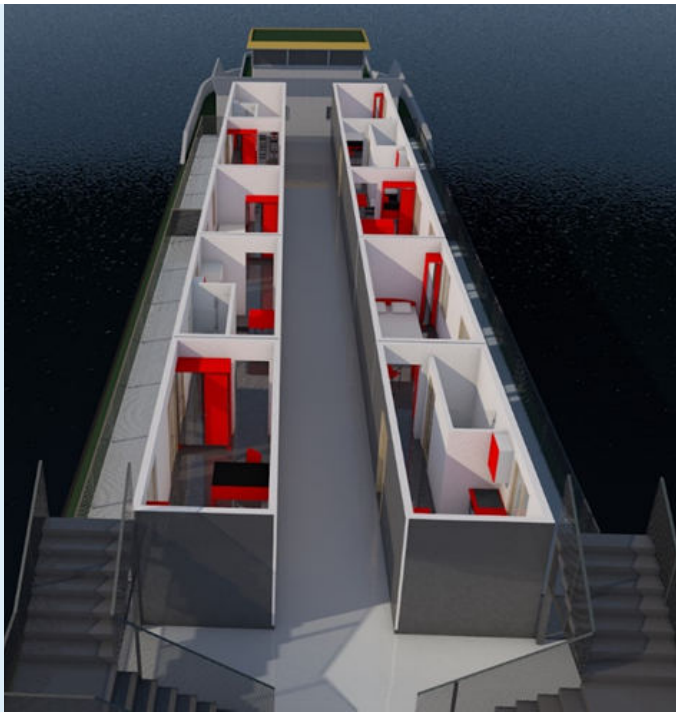
DONAUTONOM
BINNEN BLEIBEN

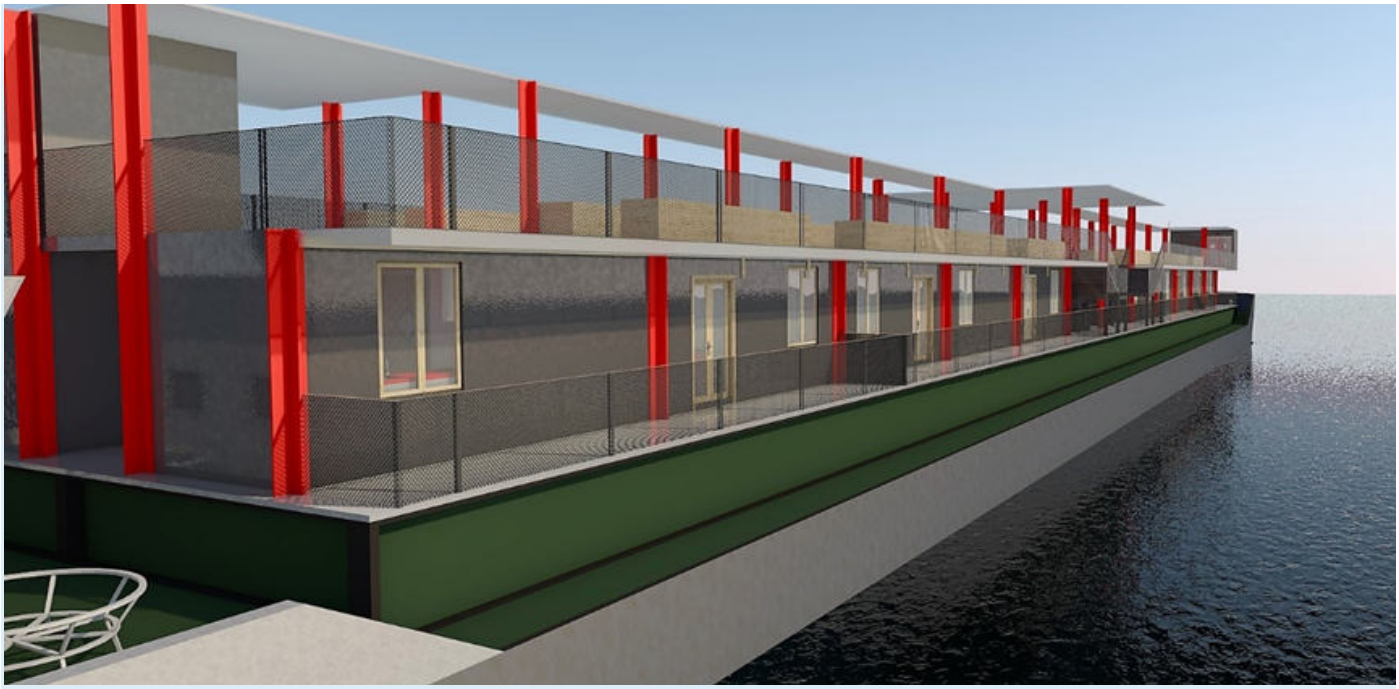
APPROACH

Purpose	Temporary living in cargo ship
User group	People interested in sustainable and resource autonomous living
Usage time	Up to three months per resident
Lifetime	Up to three years moored
Capacity	Scenario for up to 20 people

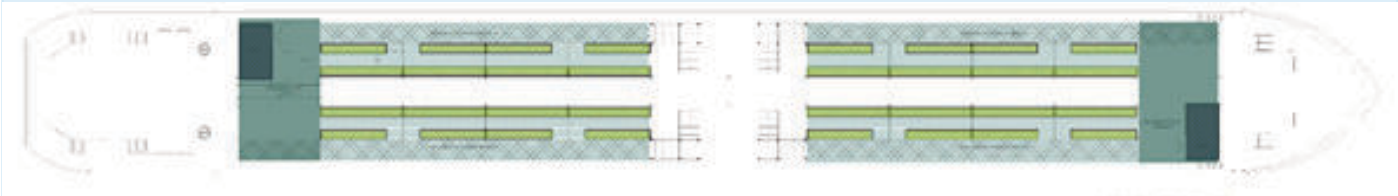


BUILDING

Characteristics	Aiming for self-sufficiency and autonomy regarding resources, energy and food supply
Design	Efficient utilization of the limited space
Main Materials	Repurposed ISO (shipping) containers Sliding doors Sliding wall segments
Size	Two or three containers per unit 1 to 4 people per housing unit

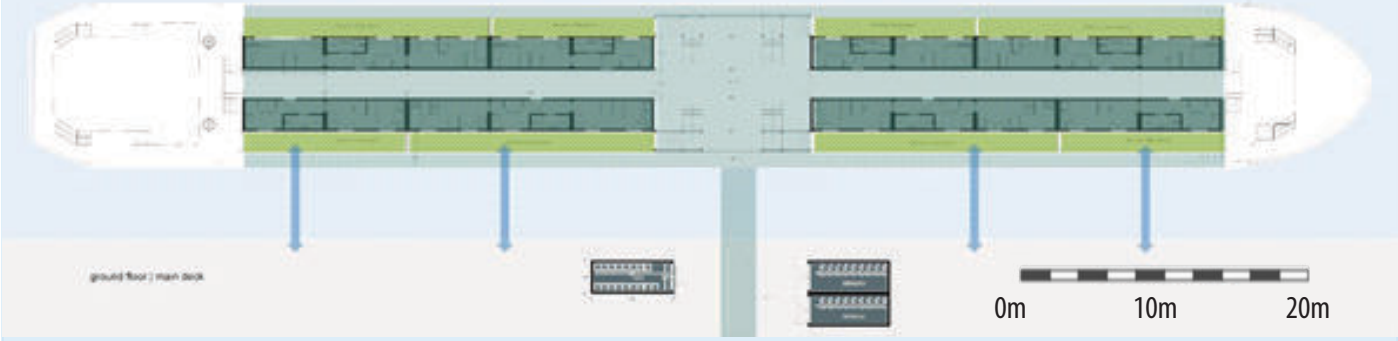


DONAUTONOM BINNEN BLEIBEN



1st floor | raised beds

- Productive area (high raised beds; approx. 73 m²)
- Communal area for gatherings (approx. 100 m²)
- Access area (approx. 300 m²)
- Shed (approx. 20 m²)



Ground floor | main deck

- Private semi-open space: loggia (18- 27m²)
- Private units for 2-3 users
- Access area (approx. 325m²) and landing stage
- Public open space (quay)
- Bike Storage and garbage facilities
- Possible conflicts (private-public)

RESOURCES

Power supply	Photovoltaics on the ship
Electric installation	Building management system
Heating	Water heat pump
Ventilation	Integrated into window frame
Water supply	Water treatment unit for river water and collected rain water/external water supply
Water heating	Electric flow heaters
Sanitation system	Greywater and blackwater system operated with river or rain water

SITE

Preconditions	Berth for ship Accessibility of public transport Accessibility of social infrastructure
Open space	Private: loggia – 18-27m²/apartment Communal: Area for gatherings (roof terrace) Productive area (high raised beds) Access area

Adapted from the original design of Dembski and Woessner

PROJECT PARTNERS

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