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SOVIET-ERA DETACHED SINGLE-FAMILY HOUSE - A TYPOLOGY FRAMEWORK FOR RENOVATION WAVE STRATEGY IN ESTONIA

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AUTHOR´S DECLARATION

I hereby declare, that I have written this thesis independently.
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PREFACE

The topic of this thesis was formed out of a practical need for insight into the characteristics and properties of Estonia´s detached housing stock in all aspects concerning the renovation wave.

Data for this study was collected from both archival material and modern sources.

I would like to thank my supervisors, Kimmo Lylykangas and Targo Kalamees, for assisting me in keeping my balance during the writing of this thesis, as well as my colleagues at the Estonian Open Air Museum, who provided advice with challenging questions. Last but not least, I would like to thank my friends and family for all their support.

ABSTRACT

Building typologies have been used in both architectural design and implementing renovation strategies as a method of imposing order onto a diverse whole. To fulfill the year 2050 goal of carbon neutrality within the European Union, renovation volumes will need to be increased in Estonia, meaning that renovation processes will need to become as efficient as possible.

Typologies function on the basis that certain groups of buildings share more charactertistics than others, meaning that additional properties may be extrapolated by knowing a building´s type. Previous typology examples have correlated a building type´s morphology, year of construction and construction method, organized into either a matrix or decision tree, that can be used for estimating a building´s energy performance or conducting energy advice. These typologies are developed on the basis of either expert knowledge or statistical data collected from various databases.

This study aimed to develop a multifunctional typology of soviet-era detached single-family houses in Estonia, that can be used as input for both energy modeling and developing renovation solutions that respect the building´s original architecture. The method entailed studying soviet-era construction practice and standard project albums for establishing a typology, primarily based on the division of heated space within the building volume. This typology system was then verified and studied further by analyzing three towns in different counties in Estonia, where data was collected from online maps and archival files to study each building type's architectural characteristics, as well as correlations between building type, construction type and project approval year.

All three towns displayed a somewhat different proportion of building types, altough the traditional gable house type was found to be most common across Estonia. Some building types were found to be more diverse in architectural form than others. Possible construction types were found to be diverse during the period as well, including timber and brick structures, although by the mid 1970's, a simultaneous shift towards aerated concrete takes place in all three towns. Correlating a specific building type with construction method was unlikely with the amount of data available in the study. Therefore a statistical top-down method of energy modeling is proposed, where construction types are assigned proportionally according to known statistics of construction type prevalence among each building type and construction year.

This verified typology presents a framework for future studies concerning detached houses in Estonia.

KOKKUVÕTE

Hoonete tüpoloogiaid kui süsteemi loomise meetodit keerukates andmekogudes on kasutatud nii arhitektuursel projekteerimisel kui ka renoveerimisstrateegiate rakendamisel. Euroopa Liidu 2050. aasta süsinikuneutraalsuse eesmärgi täitmiseks tuleb Eestis suurendada renoveerimismahtusid, seega renoveerimisprotsessid peavad muutuma võimalikult tõhusaks.

Tüpoloogiad toimivad printsiibil, et teatud hoonegruppidel on rohkem ühiseid omadusi kui teistel, seega teades hoone tüüpi on võimalik teatud täpsusega ekstrapoleerida täiendavaid hoone ehituslikke omadusi. Varasemad näited tüpoloogiatest on loonud seoseid hoonetüübi ehitusliku vormi, ehitusaasta ja konstruktsiooni vahel, mis on omakorda organiseeritud kas maatriksiks või otsustuspuuks, mida saab kasutada hoone energiatõhususe hindamiseks või renoveerimisalase nõu andmiseks. Need tüpoloogiad on välja töötatud kas eksperthinnagute või erinevatest andmebaasidest kogutud statistiliste andmete baasil.

Selle uuringu eesmärk oli välja töötada Eesti nõukogudeaegsete eramute tüpoloogia, mida saab kasutada nii sisendina energiatõhususe modelleerimisel kui ka hoone arhitektuuri arvestavate renoveerimislahenduste väljatöötamisel. Meetod tüpoloogia loomiseks hõlmas nõukogudeaegse ehituspraktika ja tüüpprojektide albumite uurimist, mis põhines eelkõige köetava pinna paiknemisel hoonemahus. Loodud tüpoloogia struktuuri kontrolliti ja arendati edasi kolme alevi analüüsimisel erinevatest Eesti maakondadest. Andmeid koguti veebikaartidelt ja arhiividest, et selgitada välja iga hoonetüübi arhitektuursed omapärad, ning seosed hoonetüübi, konstruktsiooni ja projekti koostamise aasta vahel.

Kõigis kolmes alevis oli hoonetüüpide osakaal mõnevõrra erinev, kuigi üle Eesti kõige levinumaks hoonetüübiks kerkis traditsiooniline viilmaja. Leiti, et mõned hoonetüübid on arhitektuuriliselt mitmekesisemad kui teised. Võimalikud konstruktsioonitüübid olid esialgu peamiselt puit- ja telliskonstruktsioonid, kuid 1970. aastate keskpaigas toimub kõigis kolmes alevis üleminek betoonplokk-konstruktsioonidele. Konkreetse hoonetüübi seostamine kindla konstruktsiooniga oli uuringus kasutatud andmete põhjal ebatõenäoline. Seetõttu valiti statistiline „top-down" energiamodelleerimise meetod, kus konstruktsioonitüübid määratakse proportsionaalselt vastavalt teadaolevale konstruktsioonide leviku statistikale iga hoonetüübi ja ehitusaasta lõikes.

Lõputöö tulemusena loodud tüpoloogia annab raamistiku tulevasteks uuringuteks Eesti eramute omaduste väljaselgitamiseks.

1 INTRODUCTION

The European Union is committed to decarbonizing its building stock by 2050, as buildings are currently the largest energy consumer in Europe. To meet this goal, Estonia has created its Long-term strategy for building renovation, which entails the full renovation of all buildings erected before the year 2000. This means reaching the minimum required energy performance level of class C. According to the strategy, yearly renovation volumes will need to increase five times by year 2040 (Taltech & MKM, 2020).

The largest section of the Estonian building stock by number of buildings is detached single-family housing, most of which has been built during the soviet occupation from 1945 to 1991. Approximately 105 000 detached single-family homes in Estonia will need to reach energy class C by 2050. In the case of detached housing, the volumes will need to increase 20 times when compared to current renovation volumes and practice (Taltech & MKM, 2020). This means that all renovation processes will need to become considerably more efficient and that less time can be allocated for auditing or examining buildings on an individual basis and a standardized approach is needed.

Renovation is a multifaceted enterprise, involving in general the following aspects:

- improvements to energy efficiency;
- extending the building´s life cycle;
- maintaining or improving the architectural quality of the living environment;
- improving comfort of residents.

For efficient planning, having established the strategic goal, the initial situation will need to be defined and specified in an adequate manner. Building typologies could serve as a tool for both describing and extrapolating information about a building's properties on the basis that certain groups of buildings are more homogenous in nature than others. This would serve as a basis for the development of standardized renovation solutions and renovation strategies.

In this study, a typology framework of soviet-era detached single-family houses is proposed, that would both illustrate the baseline properties of the existing housing stock, as well as provide input for planning future renovation works through energy modeling and developing adequate renovation solutions. The proposed typology is based on historical data, which was then verified and studied further with building information from three towns in Estonia.

Research questions:

- How to divide the housing stock into building types and which architectural characteristics define each building type?
- What is the estimated prevalence of each building type?
- What are their likely physical constructive properties?
- How can this typology serve as a tool for preserving characteristic features of buildings during the renovation wave?
- Which energy modeling technique is the most promising based on the findings related to the questions above?

All photographs used as illustrations have been obtained from Google Maps, unless stated otherwise. All archival documents either referenced within the text or used as illustrations have their corresponding archive identification code referenced in Appendices 1 to 3 according to the address of the dwelling. All archival material from Pärnu-Jaagupi was kindly supplied by L. Kruusa.

2 LITERATURE REVIEW

The literature review will provide an overview of national renovation goals for Estonia, current renovation practice and potential strategies to be implemented in increasing renovation volumes. Typologies are explained as useful tools in the renovation wave along with case studies, after which the object of the study, the soviet-era detached single family house, is introduced.

2.1 Climate goals of the EU

Buildings are the single largest energy consumer in Europe, with heating, cooling and domestic hot water accounting for 80 % of all energy consumed by citizens. At present, approximately 35 % of the EU's buildings are over 50 years old and almost 75 % of the building stock is energy inefficient (European Commission, n.d.-a). According to Directive (EU) 2018/844 of the European Parliament and of the Council, the Union is committed to developing a sustainable, competitive, secure and decarbonised energy system by the year 2050. This includes decarbonising the building stock, which is responsible for approximately 36% of all CO_2 emissions in the Union (Directive 2018/844, 2018). All of these measures are directed towards achieving the European Green Deal, with the vision of becoming the first climate-neutral continent in the world (European Commission, n.d.-b). To fulfill this goal, Estonia completed its Long-term strategy for building renovation (REKS) in year 2020, which aims at full renovation of all buildings erected before the year 2000. The depth of full renovation is reflected in the minimum required energy performance of a building after a major renovation, which, according to the Estonian energy performance regulations, currently is class C (Taltech & MKM, 2020). Achieving sustainability, however, is expressed in more dimensions than simply minimizing energy consumption. As set forth by the New European Bauhaus, an interdisciplinary creative initiative with the goal of connecting the European Green Deal to the quality of living spaces and the spatial experiences of citizens, the Renovation Wave has the potential to not only reduce our carbon footprint, but also improve our living environment in terms of visual quality. For this reason, the Estonian Strategy for Long-Term renovation has also included quality of public space as part of its five central principles (Directive 2018/844, 2018):

- cost-effective application of energy efficiency requirements, as well as environmentally conscious construction materials and processes;
- regional balance between functional regions and second-tier centers;
- quality of living and working environment, as well as public space;

- technological development of renovation solutions and technologies;
- climate change mitigation and adaptation.

2.2 Challenges of the renovation wave

According to the year 2021 national census, there are 266 475 residential buildings in Estonia. 77,5 % (206 529) of these are single-family homes (Statistikaamet, 2021). According to the Long-Term Renovation Strategy, the thermal conductivity of building envelopes of houses constructed in Estonia after the year 2000 is significantly lower than that of those constructed before the year 1990 (Taltech & MKM, 2020). Therefore, the former are unlikely to require full renovation and are not included in the renovation strategy. The number of single-family homes built before year 2000 is approximately 155 000, and considering the percentage of already renovated buildings and the projected numbers of buildings falling out of use, the total number of private single-family homes requiring renovation ranges at 105 000, covering a total floor area of around 14 000 000 m^2 (Taltech & MKM, 2020).

Detached houses offer the least potential in terms of energy-savings per building when compared to apartment buildings and non-residential buildings, with 18 000 000 m^2 spread out across ~14,000 apartment buildings and 22 000 000 m^2 across ~27,000 non-residential buildings (Taltech & MKM, 2020). This means that renovating a single apartment building will produce on average 1300 m^2 of renovated space, while renovating a single detached house produces approximately 140 m^2 of renovated space. Looking at the total number of buildings, however, detached houses are in the overwhelming majority.

By age and numbers, the largest section of the detached housing stock is from the second period of the soviet occupation in Estonia from years 1945 to 1991. This number ranges between 69 000 and 71 000 dwellings according to REKS (Figure 2.1) (Taltech & MKM, 2020) and national census data (Figure 2.2) (Statistikaamet, 2021).

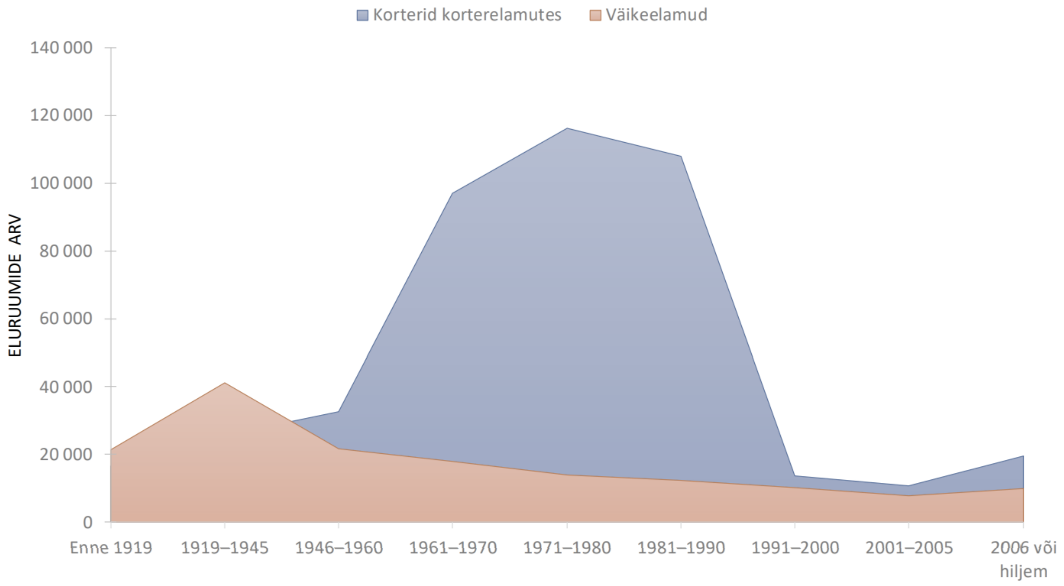


Figure 2.1 *Correlations between construction period and number of living spaces (Taltech & MKM, 2020)*

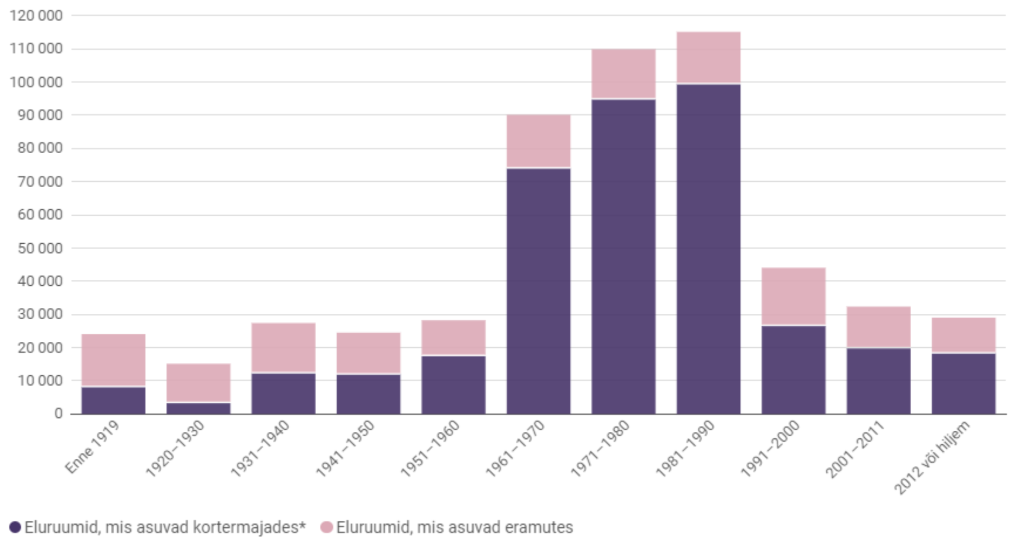


Figure 2.2 *Number of living spaces according to construction year and building type (Statistikaamet, 2021)*

2.2.1 Renovation volumes and speed

In order to meet the year 2050 goals set out by the Estonian long-term strategy for renovation, national renovation volumes across all building types will need to be increased five-fold by years 2035 to 2040 (2 400 000 m^2) when compared to volumes in year 2020 (500 000 m^2) (Figure 2.3). Detached housing, however, will need to be multiplied by twenty times by year 2045, from 40 000 m^2 per year to 800 000 m^2 per year (Taltech & MKM, 2020).

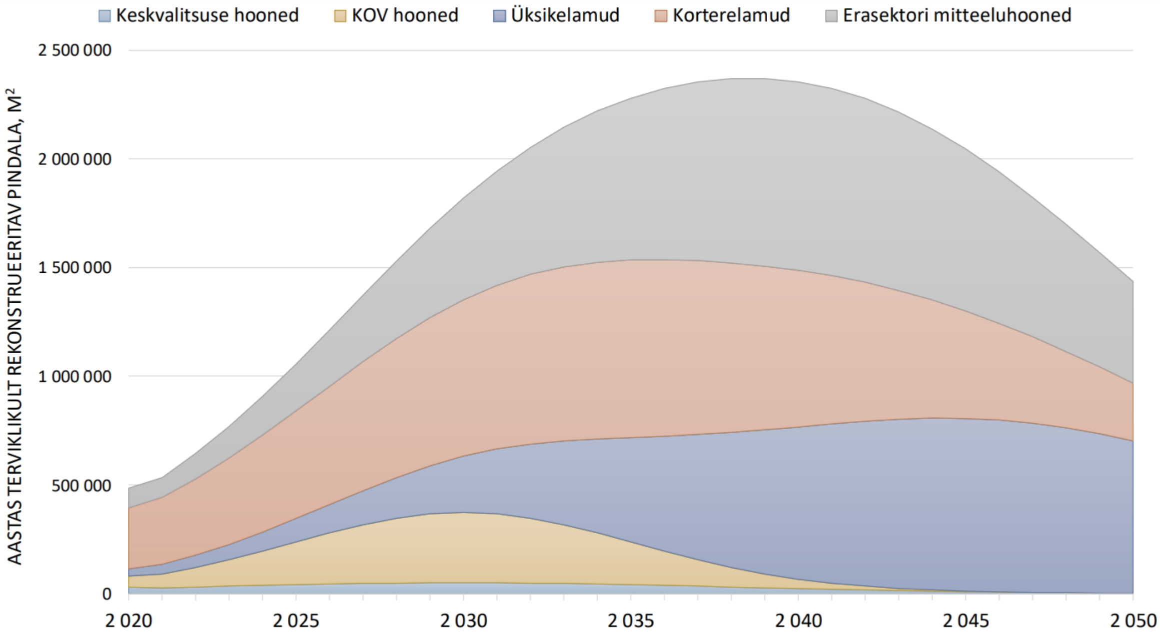


Figure 2.3 *Prognosed cumulative renovation volumes (m^2) by year and building type (Taltech & MKM, 2020)*

2.2.2 Challenges for home-owners and policy makers

Homeowners in Estonia are today largely responsible for renovating their buildings themselves. In order to achieve energy-class C, possible renovation measures include insulating the facades and roof, switching out energy-inefficient windows, improving the heating and ventilation system and installing solar panels (KredEx, 2019). The reasons are numerous, however, for a homeowner to undertake renovation works in their building, other than improving energy efficiency. Some of these include visual improvements, added sections for expanding functional space, improving indoor climate, etc., which can all be regarded as alternative reasons and can cause the risk of ignoring measures for energy efficiency (Taltech & MKM, 2020).

The average cost of fully renovating an average-sized (150 m^2) detached dwelling in Estonia is estimated to be approximately 60 000 euros per dwelling (Taltech & MKM, 2020). As many homeowners lack knowledge, financial means and even will to undertake full renovation works, basic repairs remain the general norm (Taltech, 2023). The lack of knowledge concerning proper renovation practice can be an especially concerning issue, as this can lead to situations, where a home-owner has spent their budget on renovation measures that might not have been as effective as they could have been (little to no insulation behind new facade or roof, no improved heating system, etc.), meaning that for this particular dwelling, any further improvements in energy-efficiency have been “locked out” for an unknown number of years, depending on the willingness of the owner to allocate further financial means into re-doing the previous renovation measures.

Predicting necessary renovation volumes is essential for planning renovation strategies, but the current physical state of Estonia´s detached housing stock may be somewhat difficult to estimate, since in many cases, building owners do not provide local governments with legally required information about construction and renovation works being carried out in their dwellings (Taltech, 2023), either due to lack of interest or will to deal with the bureaucratic processes.

2.3 Renovation strategies and measures

In order to meet the renovation volumes necessary for reaching the year 2050 goal, renovation processes will need to become substantially more efficient. This means applying regional renovation strategies, conducting high quality but en-masse renovation advice, estimating the energy performance of existing buildings and potential renovation measures with software tools, etc. - in general, any activity that would save time, energy and resources for both home-owners, construction engineers, builders or decision-makers.

2.3.1 Subsidies

One of the primary measures to meet renovation volumes is allocating grants and subsidies to support home-owners during the renovation process. As the average net-income per member of household in Estonia was approximately 1000 euros in year 2021, finding funds for full renovation works is likely a common issue among homeowners (Statistikaamet, 2021). The KredEx foundation, set up by the Ministry of Economic Affairs and Communication, acts as the primary source of subsidies and grants for renovating residential buildings in Estonia. The grants available to detached home owners are for the sole purpose of achieving energy efficiency, better indoor climate, and facilitating the adoption of renewable energy sources (KredEx, n.d.).

2.3.2 Access to renovation knowledge and raising awareness

Access to high quality renovation knowledge for home-owners is critical, yet somewhat limited in Estonia. Aside from academic publications and various handbooks and pamphlets, the average homeowner has no single comprehensive go-to information source for all questions regarding the renovation process as a whole. To remedy this problem across all member states, the European Commission has introduced the concept of a renovation passport to be developed for each member state (Directive 2018/844, 2018).

A renovation passport is a document outlining the long-term renovation roadmap to achieve deep renovation for each building, supporting owners with personalized advice on recommended renovation measures and stages (BPIE, 2017). These renovation solutions will all need to take into account achieving full renovation, meaning that even when renovation works are done step-by-step over a longer period of time, renovation measures applied in the present cannot hinder renovation measures that are to be applied in the future.

2.3.3 Industrial solutions

In order to meet renovation goals, innovations in the building sector are needed. One possible solution is industrially prefabricated elements, which entails the design and manufacturing of structural building components in a factory setting, to be then installed rather than constructed on site. This solution has proven that in some cases construction time was decreased between 20 % to 50 % (BPIE, 2022). The most promising opportunities for industrially optimized renovation solutions, which can be used repeatedly, are offered by standardized buildings (Csoknyai et al., 2016). In Estonia, many apartment buildings built before the 1990's time period follow standardized projects from industrially pre-manufactured elements, making it likely that standardized building elements for renovation may be developed as well (Puustusmaa, 2020). No such solutions have been discussed for detached housing, however.

2.3.4 Regional renovation strategies

Continuation of the current practice of renovating buildings one-by-one is unlikely to guarantee the necessary renovation volumes or speed to meet the year 2050 goals. Therefore, community and district approaches are recommended by the European Commission in order to develop zero-energy or even positive energy regions, where energy consumption is optimized across all buildings (European Commission, 2020).

2.3.5 Building stock modeling

Forecasting the long-term changes and developments in energy use within building stocks is key in making informed policy decisions, as the major effects resulting from energy efficiency improvements may take years if not decades to be realized (Tuominen et.al., 2014). Making these forecasts wouldrequire appropriate tools. Building stock models offer a way of making assessments concerning energy demands of building stocks, as well as evaluating their environmental impacts. With this knowledge, pathways and strategies towards reducing energy demand and greenhouse gas emissions may be developed, evaluated and compared (Nägeli et. al., 2018).

2.4 Architectural effects of the renovation wave

In addition to energy efficiency, the question of preserving the architectural quality of Estonia’s detached housing stock is relevant as well. When improving the thermal properties of a building´s boundary surfaces, generally three main variations of insulation solutions are possible: adding external insulation (1), adding internal insulation (2) or replacing existing insulation materials with more efficient ones (3). The suitability of each option depends on both the structure of the building and other variables, such as heritage-protection. Currently in Estonia, energy efficiency measures do not apply directly to buildings under heritage protection or in milieu-valuable areas. Restoration or renovation works need to be coordinated with the Estonian National Heritage Board (Talk, 2018). Information material concerning the maintenance and restoration of some more established and studied building types with respect towards their architecture has been published in Estonia, for example the “*Sõjajärgne individuaalelamu*” (Tallinna Kultuuriväärtuste Amet & Aavik, 2014), the “*Funktsionalistlik maja*” (Tallinna Kultuuriväärtuste Amet & Eensalu, 2013), the “*Lenderi maja*” (Tallinna Kultuuriväärtuste Amet & Martin, 2011) to name a few. The Renovation Handbook is another set of instructional materials concerning heritage buildings published by the Estonian National Heritage Board, available as both online and printed form (Muinsuskaitseamet, n.d.). The renovation process of traditional rural dwellings has also been explored in the “*Vana Maamaja käsiraamat*” (Metslang, 2013). All other building types of detached housing in Estonia are generally unexplored in terms of establishing renovation guidelines or measures that respect the architectural character and potential heritage value of the building. This is a sensitive situation however, as even buildings not under heritage protection still define the visual identity and architectural character of Estonia´s streets, neighborhoods, housing districts and towns. All buildings define the living environment, both urban and rural, and its identity. In order to preserve this identity and maintain a connection to the past, or instead improve this identity by redefining a new vision for the future, it is necessary to remain conscious of the potential impacts of renovation measures.

At a public discussion held on November 22nd 2022 at the Estonian Museum of Architecture, titled “*(h)arutus*”, panel members reflected on the long-lasting visual, as well as technical legacy of the upcoming renovation wave, as there is great potential to both improve the spatial quality of Estonia´s living space and damage it. The role of the architect was greatly emphasized, as someone acting on the “front-line” alongside construction engineers to ensure that buildings undergoing renovation don't end up looking or being perceived by residents as worse than before. In view of the author, current prominently noticable renovation practice of replacing older windows with more efficient, yet plain-looking designs, as well as adding external insulation around the facade without architecturally compensating or imitating the original characteristic wall-finishing may lead to a noticeable loss of character and individuality within the Estonian building stock (Figure 2.4).

Figure 2.4 *Example of a renovated building in Germany, where the original characteristic facade has been covered with a newer, yet plain design (Wikipedia contributors, 2023)*

This loss of character is not only a question of visual quality but of lengthening the life-cycle of the building as well. An example in Tallinn, Estonia can be highlighted, where a historic building (Kotzebue tn 2/1) (Figure 2.5) had been renovated in the past (Figure 2.6) and then allowed to be demolished (Figure 2.7) in year 2023 due to the renovation measures not accounting for the architectural details and character of the building. Therefore the value of the building had been diminished and its life-cycle cut short directly due to the application of architecturally non-appropriate renovation measures.

Figure 2.5 *View of Kotzebue 2/1 in approximately 1966. (Tallinna Linnamuuseum, n.d.)*

Figure 2.6 *View of Kotzebue 2/1 in 2019*

Figure 2.7 *View of Kotzebue 2/1 in 2023 (ERR, 2023)*

The topic of life-cycles also leads to the question of defining the differences between sustainability and energy efficiency, and whether they can be regarded as synonyms or different sides to a more complicated matter. The question arises, whether it would be appropriate to compare all buildings based only on their current state of energy efficiency with little-to-no regard towards the age and existing life-cycle of the building. Tying a buildings required performance to its age was also discussed during the aforementioned public discussion, whether it is realistic to expect the same energy performance from a 100-year-old building as from a 20-year-old building, since it does not take into account the environmental impacts of a building´s construction, life cycle and total carbon footprint as a whole. As architect C. Elefante eloquently puts it: "The most sustainable building is the one that is already built" (Elefante, n.d.).

2.5 Typology case studies

2.5.1 Typologies in architecture

The subject of typologies and types in architecture may be considered and defined in numerous ways. Aside from being a form of knowledge that can be applied directly to the design process (Martinez, 2003), typologies and types can define classification and listing methods as a projection of order to a diverse whole (Moles & Rohmer, 1990). The type may be configured as a schema, reduced to a common base following the reduction of specific characteristics. Therefore the type can be presented as a basic common form among a variety of possible designs (Martinez, 2003).

Typologies assist in the classification of groups of buildings based on common base characteristics. The definition and nature of these characteristics depend on the function of the typology. They can be based on building function, massing, layout distribution, orientation, architectural style, number of floors, footprint shape, facade composition, roof shape, etc. - basically any characteristic that may be used to define a building, either morphological or stylistic (Figure 2.8).

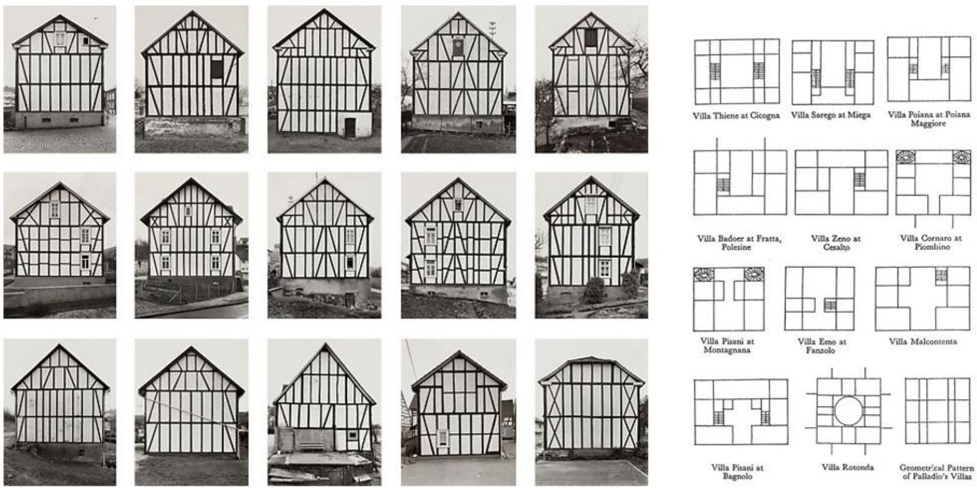


Figure 2.8 *Left to right: Framework Houses (Becher, n.d.); Schematized plans of eleven of Palladio's villas (Wittkower, 1967)*

In order to maintain a building's character, this character needs to be defined. Examples of typologies have been developed and used as tools for this exact purpose in establishing guidelines for heritage protection measures. These typologies can have different levels of detail, describing types based on either visually determined characteristics, like location on site plan, roof shape, number of floors and facade composition. Others describe more precise parameters like division of layout and living spaces, dimensions of building sections and various construction details, exact construction types with approximate thermal properties, etc. This knowledge can improve the decision-making processes concerning heritage protection and assist in standardizing intervention proposals that are appropriate in a historic or otherwise architecturally valuable area (Ayyildiz et at., 2017) (Pozas & González, 2018).

2.5.2 Typologies in renovation practice

Typologies have been proven to be useful in renovation strategy in numerous ways. Some concentrate on providing information material and conducting energy advice (Kragh & Wittchen, 2014). Other examples are used for a better understanding of the energy performance of building portfolios on different levels: from the strategic planning of housing companies up to the evaluation of national policies and measures in the building sector (Loga & Diefenbach, 2010). The order, effect and magnitude of applied energy efficiency measures need to be analyzed and prognosed, as limited economic means are bound to delay the renovation speed and general progress in most EU countries, making it critical that the established strategies and measures are verified to be in the correct direction (Kragh & Wittchen, 2014).

2.5.3 Typologies as communication tools

Providing advice on energy efficiency measures entails a certain level of structure in order for the home-owner to receive the necessary information in as clear and concise a manner as possible. An effective approach would be to communicate renovation measures through a typology of building types, where the owner would be able to receive tailored renovation advice based on the type of home they own. For example, the Danish Energy Agency has compiled a Building Guide (Bygningsguiden), where knowledge about the most common building types in Denmark have been gathered into a typology, each with an appropriate collection of recommended energy-efficiency measures that respect both the architecture of the dwelling and the financial means of the homeowner (Figure 2.9) (Energistyrelsen, n.d.). The previously mentioned maintenance and restoration guides for certain building types published in Estonia are also examples of tailoring and communicating renovation measures through a building type.

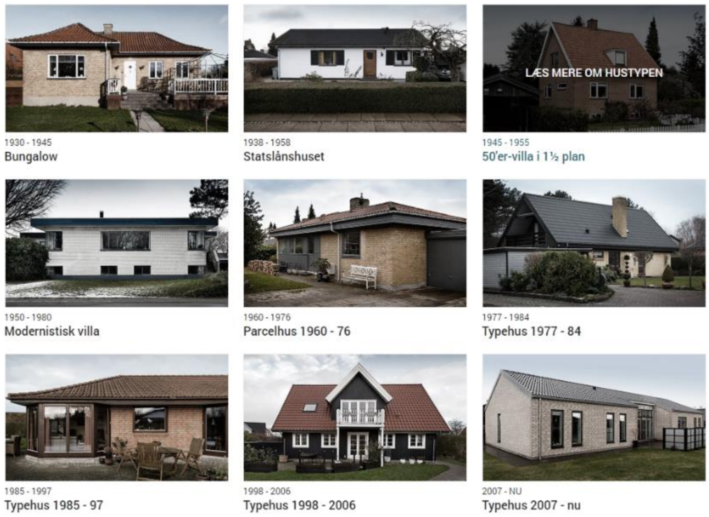


Figure 2.9 *Danish Building Guide (Bygningsguiden) interface (Energistyrelsen, n.d.)*

2.5.4 Typologies in energy modeling

Understanding the energy performance of building portfolios in designing renovation strategies entails a level of estimation based on building stock models.

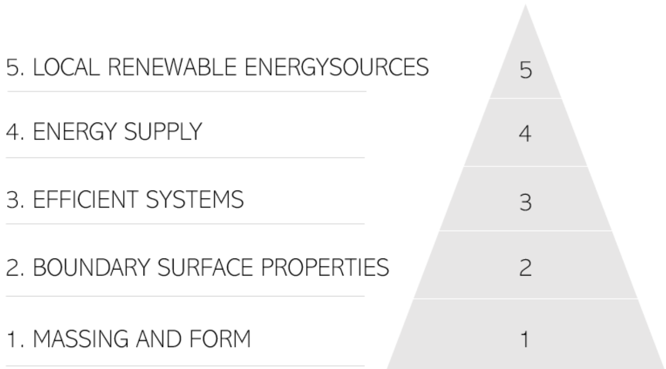


Figure 2.10 *Impact of building parameter on energy efficiency (KredEx, 2017)*

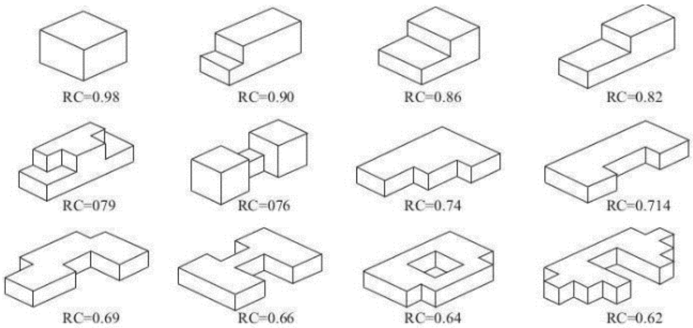


Figure 2.11 *Relative compactness of a variety of volumes (Catalina, Virgone & Iordache, 2011)*

As demonstrated in Figure 2.10, a building's form is one of the most defining aspects in determining its level of energy efficiency (KredEx, 2017), as this affects the cost of energy required to heat or cool an occupied space (Catalina, Virgone & Iordache, 2011). A way of evaluating a building's form and massing with regard to heat loss surfaces is done through parameterslike shape factor and relative compactness, which are ratios calculated between a building's volume and surface area (Figure 2.11) (Catalina, Virgone & Iordache, 2011). Generally, buildings with a higher shape factor or relative compactness can be described as more efficient concerning heat loss. To achieve a higher relative compactness, heated space ought to be stacked vertically rather than laid out horizontally, with as few breaks in massing as possible. The footprint of the building ought to remain simple, with as few corners as possible, and compact, with a proportion closer to a square rather than a rectangle.

The second most defining aspect of a building in terms of heat loss concerns the properties of its boundary surfaces (KredEx, 2017). The thermal properties of a structural boundary surface is characterized by its thermal transmittance or U-value ($W/(m^2K)$), which expresses the amount of heat (W) transferred through the structure through an area of 1 m^2 with a temperature difference of one degree (K). U-values depend on the material properties, composition of materials within the structure and overall thickness of the boundary wall (Masso, 2012).

Different energy modeling techniques are mainly divided into bottom-up and top-down approaches. Each technique relies on different levels of input information, different calculation or simulation techniques, and provides results with different applicability (Swan & Ugursal, 2009). The top-down approach is characterized by a more macroeconomic view of energy consumption, factoring in relationships between the energy sector and other sections of the economy, and is more applicable for national strategies, unfit for calculations on the level of individual buildings (Lim & Zhai, 2017). The bottom-up approach uses less generalized data rooting from buildings, like individual houses or even groups of houses (Swan & Ugursal, 2009). Bottom-up models typically estimate the energy demand of buildings proven to be representative for the building stock and aggregate the results to the stock level. Therefore they can be considered as useful instruments in scenario analysis for providing assessments of the effectiveness of energy policies (Ballarini & Corrado, 2017). This bottom-up approach can be also divided into two sub-methods: statistical and engineering; with the first relying on measured historical data and types of regression analysis; and the second relying on building physics and representative buildings in terms of archetype or sample buildings. Using both archetype and sample buildings, often titled reference buildings, in building stock modeling make it possible to conduct analysis even with limited data availability (Nägeli et al., 2018).

Depending on their methodology, reference buildings can be either real buildings, or hypothetical buildings. (de Vasconcelos, Pinheiro, Manso & Cabaço, 2014). Four main subtypes of reference buildings may be highlighted.

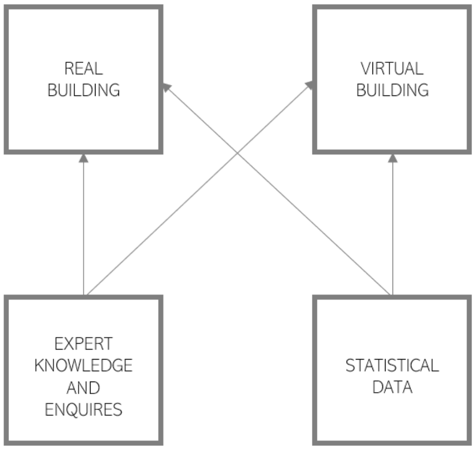


Figure 2.12 *Combinations of obtaining reference buildings*

As illustrated in figure 2.12, real buildings can be chosen as a reference building either by expert knowledge and other relevant sources of information, or by using statistical data to locate a building with statistically representative physical parameters, like commonly used systems or construction materials. Hypothetical reference buildings are in a sense virtual buildings, for which each relevant parameter is also determined and combined together either through expert knowledge or by using statistical data (de Vasconcelos, Pinheiro, Manso & Cabaço, 2014) (Schaefer & Ghisi, 2016).

One method of gathering statistical data of a building stock is through a census, which includes data at local, national or international scales. Another method is through a survey which involves sampling of individual buildings within a defined section of the building stock (Ali et al., 2020). Energy performance certificates have so far been used to develop building stock databases but generally they have not been proven to be representative (Pasichnyi et.al., 2019). Any interpretations and conclusions drawn from the data need to account for the possible limitations concerning data source and sample size (Tuominen et al., 2014), as building stock models are affected by several aspects of uncertainty. Using reference buildings in energy modeling presents restrictions in representing heterogeneity within the building stock as any grouping of buildings based on common characteristics will inevitably miss a certain level of variety within the building stock. The issues of random variations, insufficient knowledge and unpredictable user behavior are additional factors in accounting for uncertainties (Booth, Choudhary & Spiegelhalter, 2012). Therefore bottom-up engineering modeling approaches are sensitive to assumptions made from buildings deemed to be representative, as any minor error in their description is multiplied in the modeling process (Nägeli et. al., 2018). A balance between accuracy and complexity needs to be often found (Booth, Choudhary & Spiegelhalter, 2012).

2.5.5 IEE TABULA

The most distinguished example of a typology-based energy modeling structure is the IEE Project TABULA (Typology Approach for Building Stock Energy Assessment), which aimed to develop a cohesive structure of residential building typologies across thirteen european countries to provide a basis for analyzing national building stocks for strategy and scenario calculations (Figure 2.13) (IEE TABULA, n.d.-a).

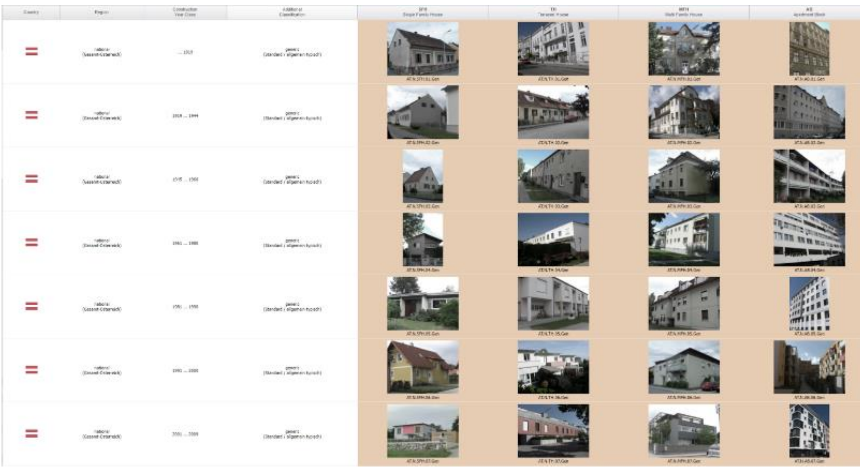


Figure 2.13 *Austrian typology matrix within TABULA Webtool (TABULA Webtool, n.d.)*

The primary division between building types in this system was based on building size and morphology, which was either detached, terraced, multi-family or apartment housing. The second point of division was the date of construction or construction period, which was relevant for factoring in common construction methods, changes in building regulations, performance standards, and innovations affecting energy performance (insulation, heating systems etc). It is notable however, that no overlap occurred between building type construction periods, meaning that according to this system, a single reference building represents the entire part of the building stock for its chosen period. Some typologies also took into account climatic zones, as larger EU countries may have different climatic zones within their borders, leading to different number of heating days for example. Each building type was then described by its frequency within the building stock, its size, number of floors, boundary surface construction types, heat supply system, etc. in its original state, along with recommended renovation measures for improved energy performance (IEE TABULA, n.d.-b).

Common sources of data for developing these building types across all participating countries were national statistics and census data, polls and surveys, national subsidy and energy audits, registries of buildings, energy performance certificate databases, etc (Loga, Diefenbach, 2010).

2.5.6 RESTO project and stone apartment building typology

At the beginning of year 2022, the pilot project RESTO was launched in Estonia in cooperation with the city of Võru, FinEst Smart City Center of Excellence, TalTech Department of Civil Engineering and Architecture, and the Department of Software Science in order to create a digital tool for local governments to prepare regional building renovation strategies. The concept is to calculate the likely energy performance of all buildings in a chosen region by combining data from the Estonian Building Register, the Estonian digital twin and archetypical reference buildings from results of building stock studies. These results would then be compared with the energy performance of best known renovated examples of the same building type to establish the most appropriate renovation measures for each building, with regard to energy saving targets with optimal costs for building owners (TalTech, 2023).

A typology for bottom-up energy modeling utilizing the engineering approach of archetypes was developed for Estonian apartment buildings as part of this project. 417 projects of renovated apartment buildings co-funded by KredEx were obtained for data analysis, during which correlations between a buildings construction type, massing (number of floors and staircases) and year of construction were established. A decision tree of apartment building types was generated with both statistical data and expert knowledge, to be used with Estonia's Building Register and digital twin data to estimate an apartment building's energy performance (Figure 2.14). For this reason, accuracy of Building Register data was analyzed as well and it was concluded that the data quality concerning certain building parameters, especially construction types was generally problematic and did not provide enirely accurate descriptions. Methods of data verification were developed, yet the system remains generally reliant on data accuracy of the Building Register, which the author also recommends to systematically improve in the future (Iliste, 2022).

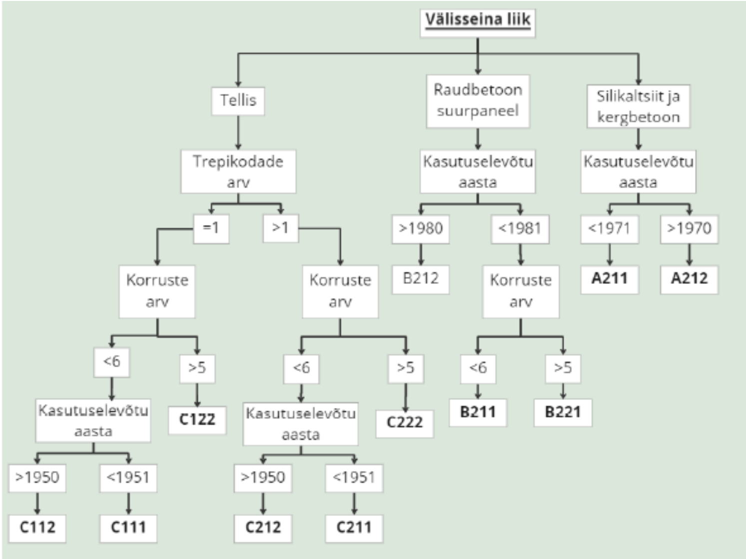


Figure 2.14 *Decision tree for determining stone apartment building types (Iliste, 2022)*

2.6 Defining the soviet-era detached single-family house

2.6.1 Previous studies into soviet-era detached house typology

A comprehensive inventory and analysis of the soviet-era individual dwellings in the Nõmme area of Tallinn was conducted by M. Aavik, which was later developed into the previously mentioned "Sõjajärgne individuaalelamu" publication aimed at conserving the architectural heritage of these dwellings (Tallinna Kultuuriväärtuste Amet & Aavik, 2013). The general division of dwelling types was between 3 groups, depending on the architectural character of their upper floors: dwelling with high-pitched gable roof and attic floor (1), dwelling with full-height upper floor (2) and dwelling with no upper floor (3).

Another period of detached housing architecture, which has been studied by T. Reidla, is the postmodern era. In her work she has analyzed the architectural form and details of detached houses built during the prevalence of postmodern architecture in five areas in Estonia. Her focus was primarily on the general plans, construction practice, stylistic developments, as well as the reputation and perception of the period among historians and the general public (Reidla, 2019). Therefore, no concrete typology structure apart from a stylistic one can be highlighted.

Another study into the architectural typology of Estonia´s detached housing, which also included insight into the soviet period, was done by A. Allikmaa. His work mainly focused on statistical analysis of building data from Estonia´s Building Register (EHR), from which five statistically representative dwelling profiles were extracted to represent all detached houses in Estonia. These building profiles were then matched with five real building projects, for which renovation scenarios were presented (Allikmaa, 2013). However, this typology system, while being statistically representative, is based only on data concerning the building´s year of construction, area, construction type, heating system and other miscellaneous data available in the Building Register; with little regard towards the variety of architectural form and massing. The division of the whole detached housing stock into five categories is questionable as well in terms of expressing the architectural variety of dwellings in Estonia.

An inventory of the individual dwellings in the town of Pärnu-Jaagupi in Estonia was done by L. Kruusa, with the goal to provide an architectural overview of the region, presented through a typology. In her work, she highlights dwellings with either a high-pitched roof (1) or a low roof (2), further divided into two- or single-floored dwellings (Kruusa, 2020).

2.6.2 Soviet housing policy and individual construction

The first soviet occupation beginning in year 1940 affected all aspects of life in Estonia, including housing. According to paragraph 6 of the constitution of the ESSR, all property, including land, natural resources production enterprises, banks, utility companies, the urban housing stock, etc., were all declared property of the state. Many principles and state institutions founded during this time remained in effect until the dissolution of the soviet union (Kõre, Ainsaar & Hendrikson, 1996).

As state construction efforts were not able to meet the demand for housing after the destruction caused by the Second World War, it was decided to allow citizens to construct their own dwellings. These private single-family homes were titled "individual dwellings'', or *individuchkas* during the soviet period. By typology, these dwellings could be either detached houses, semi-detached houses or row houses. Although contradictory to the soviet ideal of collective habitation, these dwellings were accepted as a kind of necessary evil in alleviating the post-war housing crisis (Kalm, 2013a). Certain supportive measures were even established by the state to create "more favorable conditions compared to pre-war times" for builders wishing to construct their own homes. These supportive measures included a free plot of land, state loans, guaranteed access to construction materials, etc (Aarmann, 1956). Construction work however, would need to be done by the builder themselves or with unofficial help, as constuction firms were as a rule employed on state projects (Aavik, 2010).

2.6.3 Obtaining the plot

The first step towards building an individual dwelling was acquiring the plot, which was regulated in terms of size. In urban areas, the size of the plot was to be between 300 m^2 and 600 m^2, while in rural areas the limitation was between 700 m^2 and 1200 m^2 (Veski, 1969). The locations and size of individual dwelling neighborhoods were pre-approved with district- or city-level general plans and therefore, the individual builder could not apply for a plot at random locations (Veski, Aarmann & Niine, 1959). The application was to be then submitted to the local executive committee. After approval was granted, a topographical plan of the plot was prepared by the local design office (*tootmisgrupp*) employed by the department of architecture under the executive committee. The design task (*arhitektuur-planeerimise ülesanne* or *APÜ*) was issued to the builder as well, either by the same local design office or by the district chief-architect (Masso, 1990), which regulated the location on the plot, the general size of dwelling, number of floors, roof shape etc., which were occasionally already set in place by general plans. After this, it was time to submit an appropriate project.

2.6.4 Project types and size norms

Each project was mainly characterized by two parameters: livable space (1) and general or usable space (2). Livable space defined the living room, dining room or nook, bedrooms, office and children´s room. General or usable space defined livable space combined with secondary spaces like the kitchen, bathroom, WC, halls, corridors and wall cabinets. Auxiliary or utility spaces defined the utility laundry kitchen, garage, furnace room, storage spaces, workrooms, etc. (Veski, Aarmann & Niine, 1959).

From year 1948 onwards, the number of floors and number of livable rooms per dwelling were limited to two and five respectively (Karro, 1959). In year 1957, the decree "Concerning housing development in the USSR" sought to achieve the ambitious goal of eliminating all housing shortage in the union in 12 years. The very next year, an amendment to the 1948 decree was announced in 1958, which briefly stated that livable space was not to exceed 60 m^2 in any future individual dwelling projects (Villa & ENSV Kohaliku Majanduse Ministeerium, 1960). This was likely a reaction to the year 1957 decree, as individual housing was not as efficient in resolving the housing shortage compared to industrially constructed apartment buildings. By year 1967, general or usable space had also been limited to 110 m^2, although the exact year of implementation cannot be verified in historical sources. There is no mention of this limitation in a collection of housing laws published in 1960 (Villa & ENSV Kohaliku Majanduse Ministeerium, 1960), yet by 1967, an article references the "new general space limitation" as being established in 1966 (Roopalu, 1967), although this has not been corroborated by any other historical source. In year 1980, H. Parmas stated that from 1978 onwards, the regulations concerning dwelling size were relaxed, allowing for up to six rooms and 127 m^2 of general space. Differences between urban and rural areas were mentioned as well (Parmas, 1980). By year 1986, an instructional booklet of architectural design norms and regulations describes only a general space limitation, which was 130 m^2 (ENSV Riiklik Ehituskomitee, 1986). Whether the limitation of living space and number of rooms was still in effect or not, is not stated.

There were three types of projects available to the individual builder: standardized (1), recommended for repeat-use (2) and individual (3) (Veski, Aarmann & Niine, 1959). Standardized projects and projects recommended for repeat-use were often compiled from either architectural competitions or town archives and were then published into albums and booklets with certain design improvements. These projects were propagated as being efficient and of verified quality, which would lead to no difficulty in the bureaucratic approval process (Aarmann, 1956). Individual projects were mostly drawn privately by architects or construction engineers according to the wishes of the builder, although for some time up to the late 1950's, the builder was potentially allowed to design the project as well (Veski, 1969).

The proportion between standardized or recommended projects and individual projects in soviet individual dwelling construction practice is so far unknown. In year 1964, A. Peterson reports that 35 % of individual dwellings have so far been constructed using standardized projects according to national statistics, with all other dwellings implementing either individual or greatly altered standardized projects (Peterson, 1964).

2.6.5 Standard and recommended for repeat-use project albums

The very first standard projects are known to have been published as early as year 1946 (Vendach, 1946). By year 1954, the first known albums of standard and repeat-use projects were published in two parts by the state design firm "Estonprojekt" (VPI Estonprojekt, 1954). In year 1956, a third part continuing the album series was published (RPI Estongiprogorstroi, 1956). Another project album specifically tailored to rural collective farm dwellers was published in year 1954 as well, containing projects from an architectural competition held in 1953 with the goal of alleviating the lack of suitable standardized projects for rural areas (ENSV Põllumajanduse Ministeerium, 1954). In year 1958, the first set of 19 projects titled "E-series" was published (ENSV Põllumajanduse Ministeerium, 1958). The following set of 23 projects were published in 1959 (ENSV MN Riiklik Ehituse ja Arhitektuuri Komitee, 1959). In year 1965, a fourth addition to the previous album series was introduced (RPI Estonprojekt, 1965). This album published projects from an architectural competition held in 1960 (Kammal, 1966). No other albums were published until year 1976 (Berends & Dobrõš, 1976), which contained projects from an architectural competition held in 1974, and from other miscellaneous sources (Toss, 1974). However from this point onwards, while the previously mentioned albums were generally vague in terms of suitability to urban or rural environments, only albums aimed at rural areas have been identified. The first, published in year 1977, contained both individual dwelling projects, as well as other building typologies (RPI Eesti Maaehitusprojekt, 1977). Two more albums containing exclusively individual projects for rural areas were published during the 1980's, one in 1981 (Asszonyi & Amjärv, 1981) and another in 1983 (Amjärv, 1983).

Another parallel series of standard projects and albums were developed and published by the collective farm design firm *PI EKE Projekt* (Kalm, 2001), at times in collaboration with *RPI Eesti Maaehitusprojekt* under the *EKE Külatare* initiative from the second half of the 1960's up until the 1980's (Kolk, 2005).

Figure 2.15 *Selection of standard project albums and pamphlets from the period*

2.6.6 Individual construction practice

A variety of construction methods were used in individual dwelling construction during the soviet period. Over the nearly 50-year period of soviet occupation in Estonia, numerous construction handbooks aimed towards individual dwelling builders were published. These handbooks contained basic, yet concise knowledge about almost everything concerning the construction process from laying foundations to installing the roof and plumbing. Five main handbooks can be highlighted: "*Abiks individuaalelamute ehitajaile*" (Tamm & Jomm, 1949), "*Elamuehitus 1*" (Jürgenson, 1949), "*Individuaalehitaja käsiraamat*" (Veski, Aarmann & Niine, 1959), "*Individuaalelamute ehitamine*" (Veski, 1969) and "*Väikemajad*" (Masso, 1990) (Figure 2.16). Quality of the construction and finishings however, depended on the budget and skills of the owner and the availability of materials and working hands. It was also not uncommon for the construction process to last up to 10 or more years in some cases (Masso, 1990). Changes to layout and other details implemented during construction were not uncommon either (Peterson, 1964). The dwelling was regarded as finished by the local government, if works had been completed on the external finishing, streetside fence, on one livable room, the kitchen and WC (Villa & ENSV Kohaliku Majanduse Ministeerium, 1960).

Figure 2.16 *Selection of construction handbooks from the period (left to right:* : "*Abiks individuaalelamute ehitajaile*" (Tamm & Jomm, 1949), "*Elamuehitus 1*" (Jürgenson, 1949), "*Individuaalehitaja käsiraamat*" (Veski, Aarmann & Niine, 1959), "*Individuaalelamute ehitamine*" (Veski, 1969) and "*Väikemajad*" (Masso, *1990))*

A parallel method of obtaining housing was an industrially constructed dwelling (Masso, 1990). Co-operatives and collective farms were an alternative source of individual dwelling construction, utilizing standardized projects and industrially manufactured prefabricated elements. Development on these construction methods began in the second half of the 1960s with *PI EKE Projekt* and by the year 1970's, all tedious phases of construction, from the foundation to the roof, had been replaced with industrial solutions (Leppik, 1980). These dwellings were generally constructed as groups, placing identical designs together along a street or as a small housing district to create an ensemble. When possible, the landscape was carefully chosen to enhance the architectural quality of the overall ensemble (Kalm, 2013b), but generally they were seen as simply identical boxes, without character and with few ties to traditional rural architecture, especially designs from the 1980's (Kann, 1988).

3 METHODS

As per the literature review, typologies can be implemented in different ways according to their specific area of function. As of today, no comprehensive typology for detached housing suitable for planning renovation strategies has been developed for Estonia. As the largest section of detached houses in Estonia were built during the soviet era, the current work focuses on this period. Row-, terraced- or semi-detached dwellings were not included in this study. Aim of the work was to provide baseline input for renovaton strategy in Estonia by developing a multifunctional typology framework, that could be utilized in energy modeling software and for developing renovation strategies, as well as conducting renovation advice with respect to the architectural character of each dwelling. The proportion and occurence of each building type within the building stock was relevant to estimate the general structure of the building stock.

The typology shall be developed based on empricial data-based analysis of sources determined to be representative.

3.1 Typology parameters to be studied

In energy modeling, previous typology examples have attempted to correlate a building's massing (architecture) and construction year to a specific method of construction and resulting thermal properties of boundary surfaces. These correlations can be established either with expert knowledge or statistical data, yet a combination of both is likely to provide the most informed end-result, as was demonstrated by the typology of Estonian apartment buildings (Iliste, 2023). In energy calculations, the volume and composition of heated space is paramount. The way the heated space is laid out in terms of number of floors and composition, expressed by form factor and compactness, defines a building's energy efficiency.

The heated space is most likely to consist of living spaces, the composition and placement of which are defined by the building´s layout. The list of rooms used in soviet-era dwellings and therefore considered as forming the heated envelope were: the living room, dining room, bedrooms, office, kitchen, bathroom, WC, as well as connecting hall and closet spaces. Utility spaces such as garages, laundry kitchens (including saunas), storage spaces, furnace rooms, etc. were not considered to be part of the heated space in this study. Therefore, variations of utility space compositions were necessary to define as well. Roof shapes were also incorporated as an easily recognizable, yet defining feature in a building's design. In terms of level of detail, a more qualitative approach was taken within this study, with more quantitative aspects like average dimensions of footprints, areas of building sections and window areas left to future studies.

Thermal properties of a building's boundary surfaces define the heat transmission through the structure, and as the outer wall structures are generally known to be the most diverse during the soviet period, they were chosen as the focus for studying the constructive properties of building types in this study. A timeline of construction types was compiled from each town to establish a general develoment of construction trends, as well as their overall proportions. Construction types within each building type were compiled as well to establish, whether any strong correlations were noticeable and suitable for extrapolating data for energy modeling.

Proportions of building types, project approval years within each town were highlighted and compared as well, to determine when certain building types appeared and how common they were.

3.2 Sources for data analysis

Previous typologies for energy modeling have applied data from energy performance certificate databases, surveys, building registers etc. In the case of Estonia, energy performance certificates are not readily accessible en-masse. Another potential source was the Estonian Building Register (*EHR*), but it has proven to be an unreliable source for such a study as was demonstrated by E. Iliste (Iliste, 2023). No separate detailed survey information of soviet-era detached housing with floor plans and detailed construction data was located either. This meant that the sample of data needed to be generated as part of the study. As standardized and recommended for repeat-use projects were available and are known to have been used to a certain extent by individual dwelling builders during the soviet-era, these projects were hypothesized to form a representative cross-section of architectural developments in detached house architecture. Soviet-era construction practice was documented in handbooks, which are generally known to have been popular among builders as well as a fundamental source of knowledge.

Therefore a base typology considering building mass, possible construction year and general timeline of construction practice (along with possible construction types) may be developed from these sources. However, these sources are theoretical and previously unstudied in terms of proportion within the building stock and representativeness of real construction practice. Therefore, real buildings were needed as well to corroborate and supplement the results obtained from literary sources.

To make potentially nation-wide conclusions, these buildings would need to be from different regions in Estonia. Each sample would also need to reflect the soviet period as a whole and therefore need to have buildings from all decades, while remaining within a manageable sample-size. A small town established before the soviet era was hypothesized to contain construction practice from the entire soviet period and therefore, three were chosen: Väike-Maarja from the county of Lääne-Virumaa, Karksi-Nuia from the county of Viljandi and Pärnu-Jaagupi from the county of Pärnu (Figure 3.1).

Buildings within these regions were to be studied based on both external features like roof shape, number of floors and composition of massing, as well as project documentation. Physical project documentation of all buildings in Estonia can be found in Building Register files (*Hooneregistri toimikud*) kept by the National Archive of Estonia. A test-batch of archival folders was ordered to determine the data that may be collected. The full range of documentation included various contracts between the builder and local municipality, the original site plan with year of project approval, full project documentation, feedback letters, evaluation sheets, inventory plans and other various legal documentation.

Preliminary evaluation of the material displayed differences between original project documentation and inventory results, demonstrating a potential gap between recommended and real construction practice. Knowing the approval year, the original floor plan with headnote and inventory results was to be the optimal amount of data that would allow to determine a building's age, layout and likely construction type. This was not the case for all folders however, as a high number of them were missing either detailed inventory documentation or even original project documentation. Some included only recent inventory drawings without original plans, year of construction or even construction type. For this reason, a number of project folders had to be excluded from certain parts of the study or were dismissed entirely due to incomplete data.

Figure 3.1 *Locations chosen for collecting building data* (X-GIS [Core]. n.d.)

Figure 3.2 *Karksi-Nuia* (X-GIS [Core]. n.d.)

Figure 3.3 *Pärnu-Jaagupi* (X-GIS [Core]. n.d.)

Figure 3.4 *Väike-Maarja* (X-GIS [Core]. n.d.)

4 RESULTS & DISCUSSION

4.1 Typology structure from standard and recommended for repeat-use projects

In order to identify a representative typology structure for classifying soviet era detached housing, standard and recommended for repeat-use project albums from the period were analyzed. Division of heated and unheated space, year of origin, roof shape and floor plan layouts were all factors in defining each building type.

The division of heated, or living space is generally between two options: the space is either stacked vertically or placed horizontally within the building volume (Figure 4.1). Stacking entails the use of at least two floors where living spaces forming the upper floor are directly on top of the ground floor. Horizontal placement however utilizes a single level of heated space within the volume with little to no overlap.

Dwellings with stacked living spaces can be divided into two types: the upper level is either an attic floor beneath a high-pitched roof; or a complete upper floor under a low roof. Dwellings with horizontally placed heated spaces can also be allocated between two options: the layout is either on a single shared level or it has been displaced vertically into two levels, requiring a small staircase for connection. These four subtypes can be divided further as well, based on different architectural characteristics, which are all explored in the following chapters.

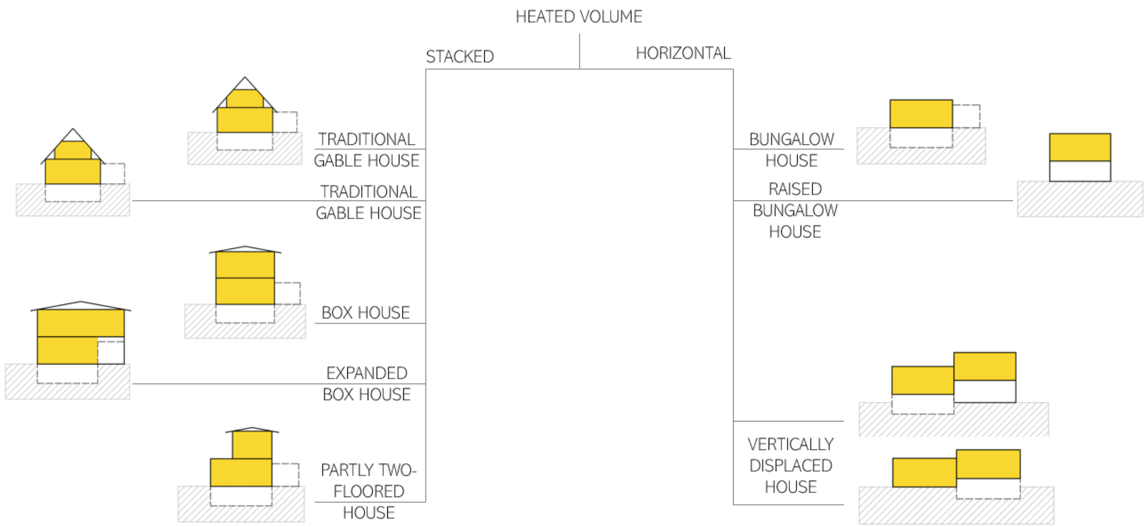


Figure 4.1 *Typology structure dependent on the layout of heated space within the dwelling*

4.1.1 The traditional gable house

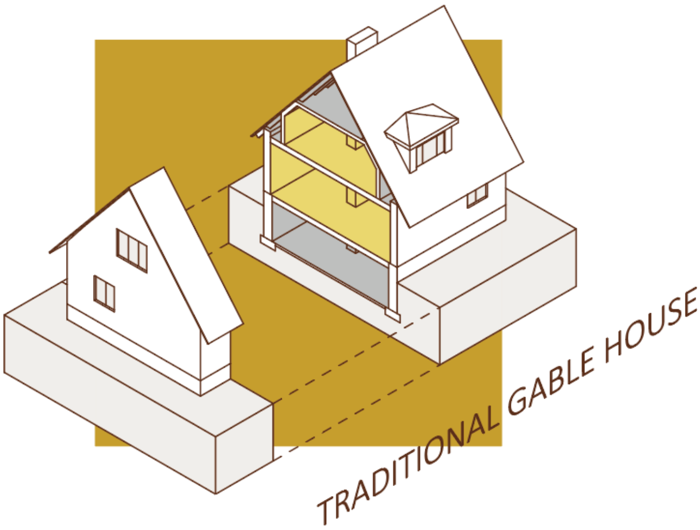


Figure 4.2 *The archetypical form of the traditional gable house*

The most archaic and arguably iconic type of individual dwelling in Estonia is the high-pitched gable house. With clear ties to the german kleinhaus, or "small house" (Lorbek, 2018), this dwelling type can be defined as a continuation of pre-war architecture in Estonia, found in both urban and rural areas (Kalm, 2001) (Figure 4.3).

Figure 4.3 *Examples of pre-war influences (left to right: german kleinhaus (Lorbek, 2018); dwelling in Tallinn (E. Kuusik) (Eesti Arhitektuurimuuseum, n.d.); rural dwelling from 1924 (Peterson, 1966))*

The very first standardized projects published in year 1946 to year 1949 all follow this traditional form with very little variation in layout and massing (Figure 4.4). Ground floor plans had two to three rooms, a kitchen with pantry, and an entry hall with WC, staircase and built-in closet space. Attic floors had one to two stove-heated rooms with varying compositions. Some designs also included an auxiliary wing containing a laundry kitchen/sauna and storage space. The laundry kitchen also highlights the general lack of bathrooms or washing facilities within the main dwelling (Vendach, 1946; Tarvas, 1949).

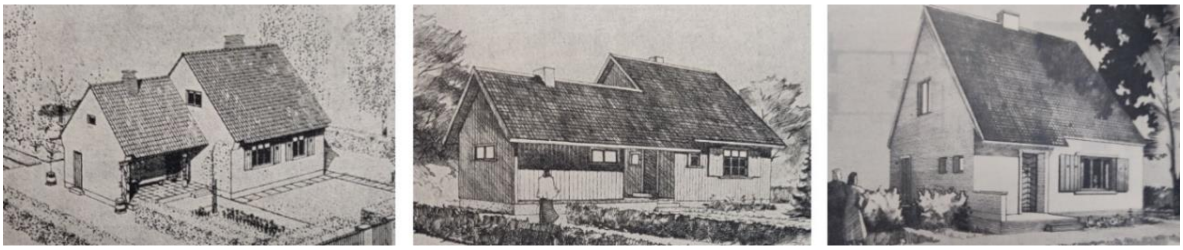


Figure 4.4 *Examples of early standard projects with similar morphology, architects left to right: E. Velbri (Vendach, 1946); P. Tarvas & A. Volberg (Vendach, 1946); P. Tarvas (Tarvas, 1949)*

As is demonstrated in Figure 4.5, two-room ground floor variations follow a clear four-quarter division, while three-room options divide the building layout into five distinct sections. This is likely due to the primary heating system of the period of stove heating, with a central chimney placed at the center of the building to provide equal heat distribution throughout the dwelling. This also defines the compact nature of the building footprint, which generally remains within a proportion of 1:1 and 1:5. It is clear that while two-room four-quarter layouts have no trouble managing with a single chimney, three-room layouts begin to struggle with stove placement and room distances, leading to the use of horizontal flues (Vendach, 1946; Tarvas, 1949).

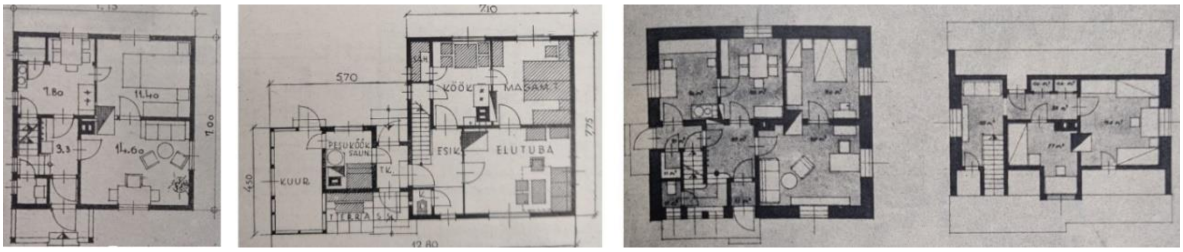


Figure 4.5 *Examples of early layout variations from 1946 to 1949, architects left to right: G. Jomm (Tarvas, 1949); P. Tarvas & A. Volberg (Vendach, 1946); P. Tarvas (Tarvas, 1949)*

By year 1954, 16 high-pitched gable houses were identified among 27 projects - all others were single-floored dwellings (VPI Estonprojekt, 1954). In terms of layout, these dwellings follow the same aforementioned trends, with the more frequent inclusion of bathrooms, placed either at the center of the building footprint next to the chimney (with no daylight and questionable ventilation), or against the outer wall with access from either the staircase or the kitchen. The introduction of enclosed unheated verandahs next to living and dining rooms is noticeable as well. Attic floors also follow previous trends, with two room layouts being more common, as they utilize the space more effectively. Attic floors also commonly feature dormers for additional daylight. Cellar spaces range from being non-existent to occupying the entire building envelope, housing the laundry kitchen, and various combinations of fuel, food or general storage spaces.

The introduction of the bathroom within the building footprint leads to challenges in the ground floor layout, especially in the case of three-room variations. Accompanying the previous challenge of stove distribution, the space necessary to fit the bathroom is often compensated by reducing the size of the entry hall; or by moving load-bearing walls and somewhat dissolving the clear five-section division of space (Figure 4.6).

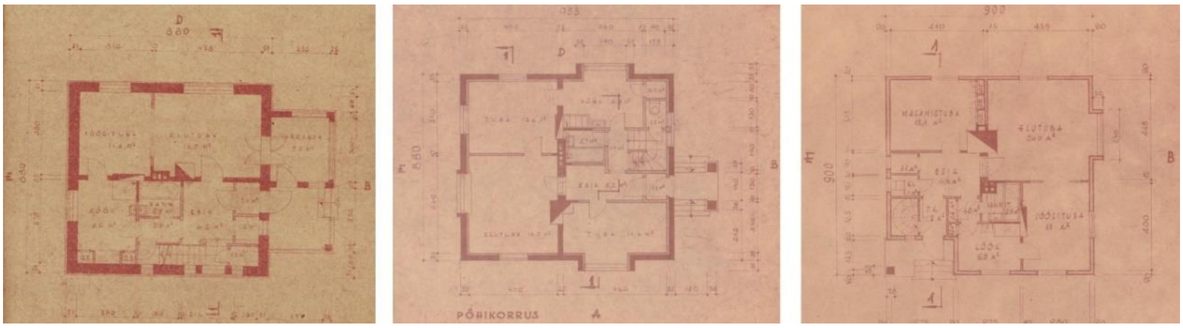


Figure 4.6 *Examples of layout variations from 1954 (left to right: project 16; project 25; project 17) (VPI Estonprojekt, 1954)*

By year 1956, 16 out of 23 projects were high-pitched gable houses (RPI Estongiprogorstroi, 1956) (Figure 4.7). No major changes in layout trends were noticeable, except for the introduction of auxiliary wings with garages, occasional upper floor bathrooms and somewhat larger verandahs.

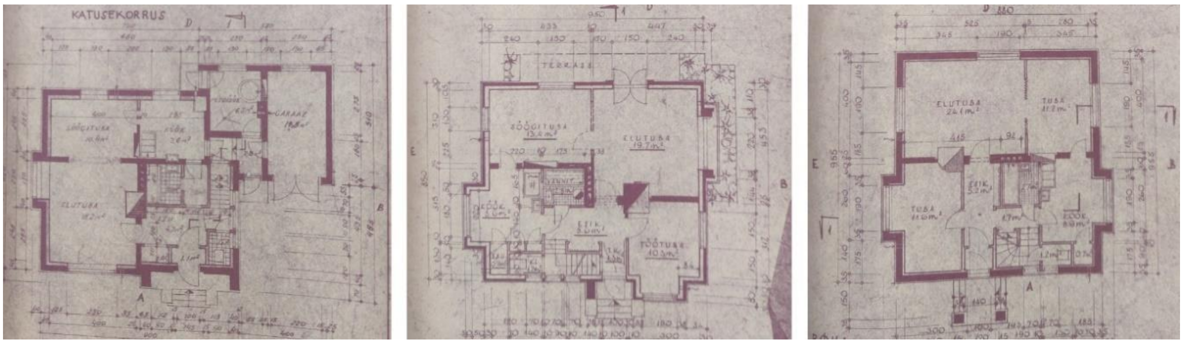


Figure 4.7 *Examples of layout variations from 1956 (left to right: project 40; project 51; project 53) (RPI Estongiprogorstroi, 1956)*

As no complete set of containing all E-series projects has been located by the author, conclusions concerning this period had to be drawn from the limited number of 24 detached house projects that were found. Most located projects published under the E-series are generally repeat-projects from the previously mentioned albums with minor alterations in window or facade design; although a number of new projects are introduced as well. Out of 24 projects, 14 were high-pitched gable houses (Figure 4.8) (ENSV Põllumajanduse Ministeerium, 1958; ENSV MN Riiklik Ehituse ja Arhitektuuri Komitee, 1959). No previously unseen trends or changes are noticeable among this building type.

The following fourth album, published in 1965, makes no mention of this building type at all, signifying that it had begun to go out of fashion. As the 1960's signaled the introduction of industrial and sleek modernist architecture in the ESSR (Kalm, 2001), the traditional gable-house form was likely becoming a rudiment of the past.

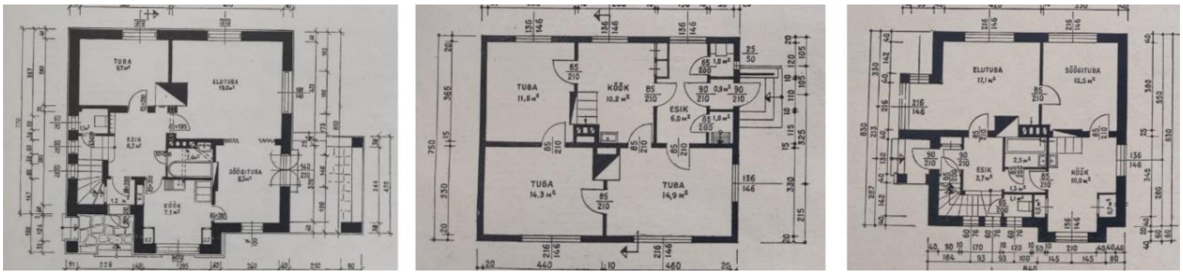


Figure 4.8 *Examples of layout variations from 1958 and 1959 (left to right: project E-16; project E-25; project E-35) (ENSV Põllumajanduse Ministeerium, 1958; ENSV MN Riiklik Ehituse ja Arhitektuuri Komitee, 1959)*

In the 1976 album, four examples of the high-pitched gable house reappear among 39 overall projects (Berends & Dobrõš, 1976). While three (14-66, 37-66, 103-74) follow previous trends in terms of layout, 104-74 is an example of stylistic development, with a modernized window placement and general layout (Figure 4.9).

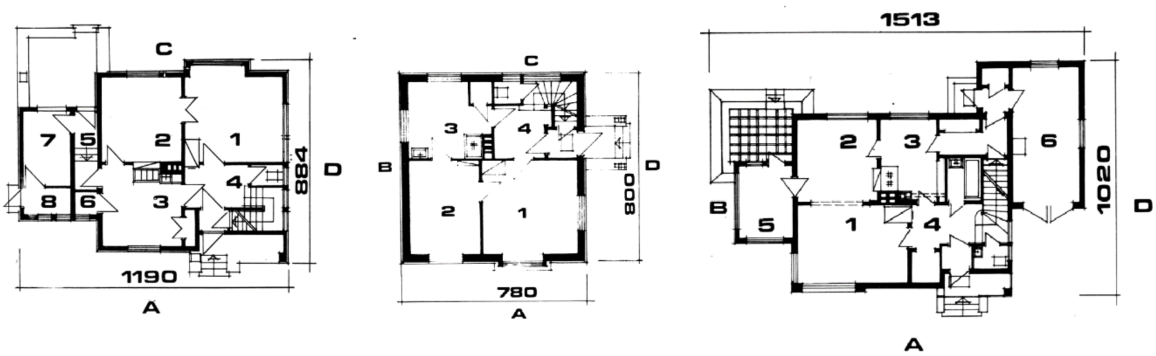


Figure 4.9 *Examples of layout variations from 1976 (left to right: project 37-66 (E.Laasi); project 14-66 (E. Laasi); project 104-74 (V. Harjo)) (Berends & Dobrõš, 1976)*

This means that this building type was not neglected entirely. After this album however, the building type seems to become obsolete by the 1980's, as there is no further mention of them in any project albums.

In conclusion, this building type can be described as having a very limited variety in terms of architectural form and floor plan layout, possibly hinting at a highly optimized building type that naturally required few alterations. They are generally stove-heated with a single central chimney. Ground floors have two to three rooms, a kitchen with pantry, stair hall with WC, numerous wall cabinets and occasionally bathrooms. Upper floors have one to two heated rooms, storage spaces and rarely a bathroom. Roof shape always remains the same, forming a high-pitched gable, occasionally with dormers. The dwelling may have an auxiliary wing or unheated verandah placed at its sides, with the roof of the verandah often acting as an upper floor balcony. Few changes to layout and architecture are noticeable across multiple decades and therefore identifying this type ought to be straightforward. Any examples after 1980 are unlikely to be found.

4.1.2 The post-1980 gable house

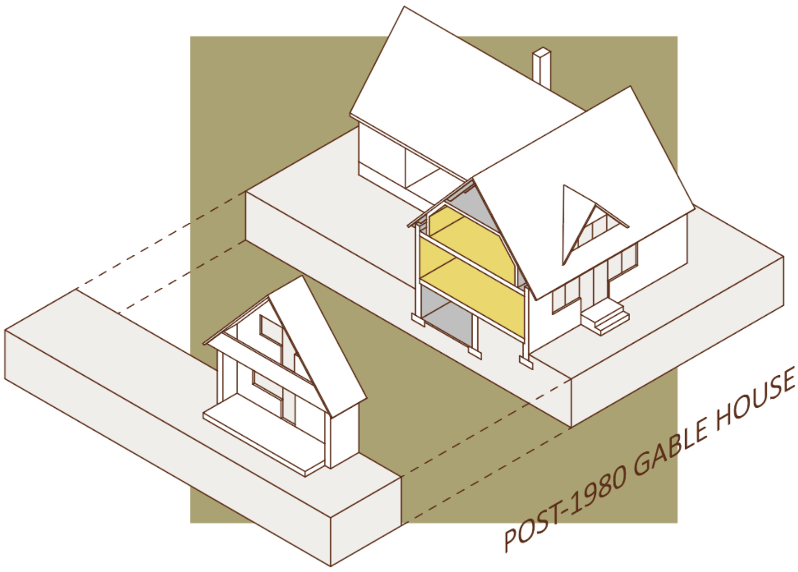


Figure 4.10 *The archetypical form of the post-1980 gable house*

By the mid 1970's, a complete reinvention of the gable house form takes place in terms of layout and architectural character. During this period of early postmodernism (Kalm, 2001), two main subtypes can be highlighted: the standardized or mass-produced dwelling (1) and the postmodern individually designed dwelling (2). While documentation concerning standardized dwellings is readily available, individually designed gable roofed projects have so far been analyzed in detail only by T. Reidla (Reidla, 2019), whose results depict an architecturally diverse building subtype. While both standard and individual projects may share a division of heated space, they express two very distinct architectural concepts in terms of individuality and standardization and may be discussed further separately in future studies. However, due to a lack of comprehensive base knowledge concerning individual projects, they have been excluded from this analysis.

As part of the series of standardized projects developed by the *EKE Külatare* initiative, the first examples of the type emerge in the form of the B-2-2/73 (M. Noor) (EKE Külatare, n.d.-a), the Põrgupõhja (H. Piiber, 1975) (PI EKE Projekt, 1975a) and Ants (A. Mellik, 1978) (PI EKE Projekt, n.d.-a). Over the 1980's these were then followed by an undetermined amount of standard projects, with examples in different layout variations, like the Raja (A. Mellik) (PI EKE Projekt, n.d.-b), the Peeter (T. Lukk) (PI EKE Projekt, n.d.-c), the Muri (A. Kotli) (PI EKE Projekt, n.d.-d), the Madis (Ü. Eljand) (PI EKE Projekt, n.d.-e) and a myriad of other peculiarly titled and potentially so-far academically unstudied projects (Figure 4.11). This building type can be characterized as following the same distribution of heated space as traditional gable houses: a ground floor and an attic floor, both containing living spaces. Cellars have become much more prominent, occasionally forming remarkably tall plinths, requiring either an outdoor or indoor staircase to enter the ground floor of the dwelling.

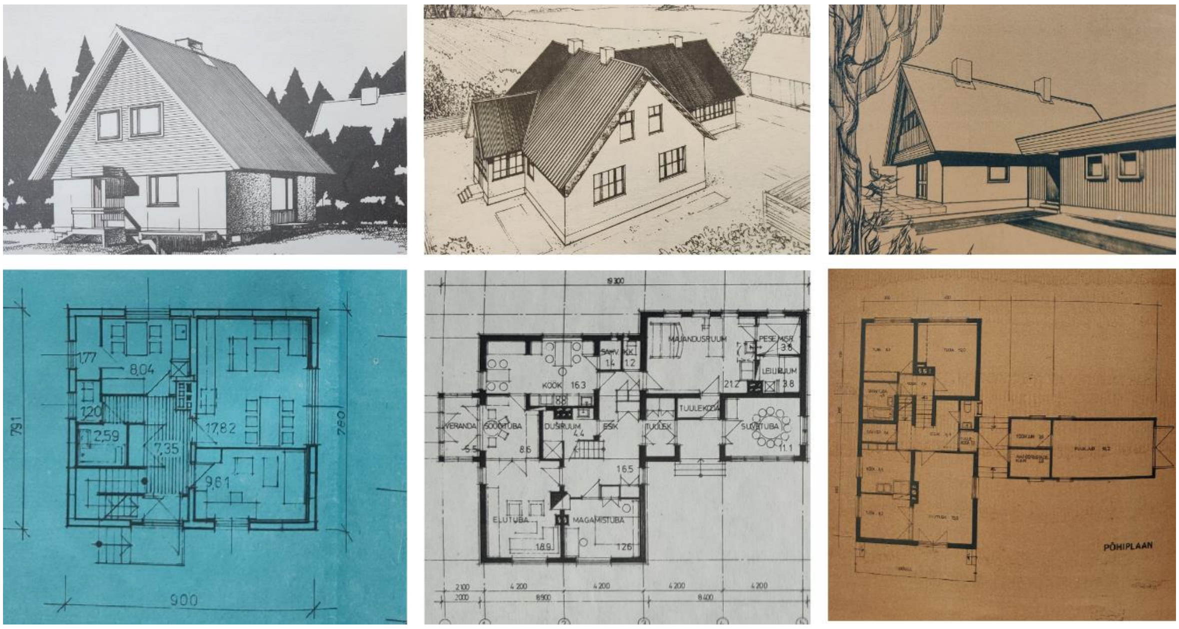


Figure 4.11 *Examples of post-1980 gable houses (left to right: project Ants-4 (PI EKE Projekt, n.d.-a); project Muri 1 (PI EKE Projekt, n.d.-d); project Põrgupõhja (PI EKE Projekt, 1975a))*

In the year 1981 project album, 13 projects featured heated attic floors under a high-pitched roof out of 27 total projects (Asszonyi & Amjärv, 1981). Some designs have now begun to feature six-room designs as well due to more relaxed dwelling size limitations. All projects are designed with central heating. Ground floor plans often feature auxiliary wings either under a separate or joined roof. These wings contained garages, storage spaces, utility spaces, saunas, etc. Ground floors of the main dwelling include a living room, occasionally a dining room or bedroom, a kitchen, the bathroom and utility spaces. In terms of layout trends, very few general characteristics can be established other than the attempt to provide access to all rooms through a central hall space or hallway. Rooms are placed relatively erratically, often creating an irregularly shaped and difficult to define heated volume in most cases (Figure 4.12). Upper floors feature three to four bedrooms, a bathroom and attic spaces. Cellars continue to contain storage spaces, furnace rooms, laundry kitchens and saunas. Certain designs also begin to feature extensive auxiliary wings rivaling the main dwelling in size. They are also characterized by more expressive roof designs, including a variety of dormers and under-roof balconies.

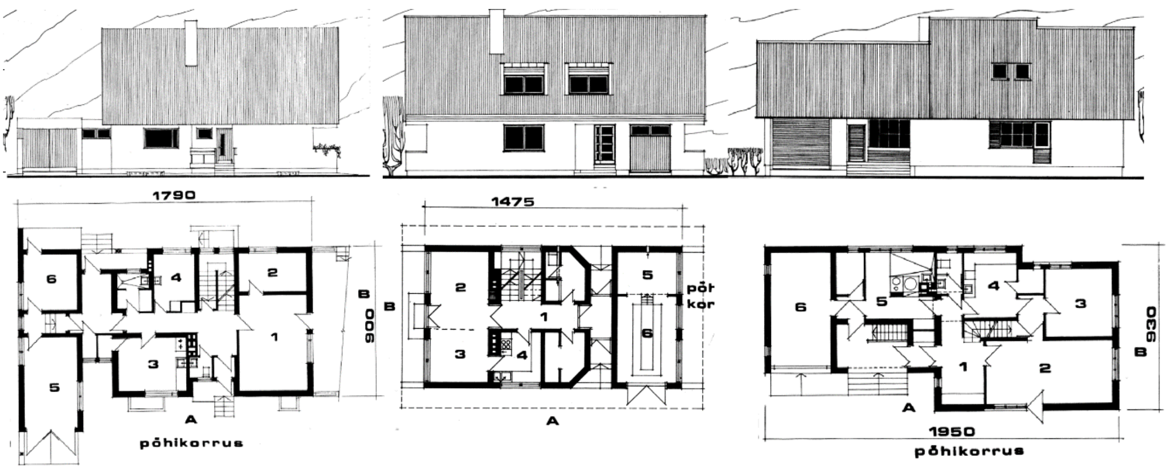


Figure 4.12 *Examples of post-1980 gable house layouts (left to right: project IE-6-04-81 (T. Liigand); project IE-6-02-81 (L. Aljaste); project IE-4-09-81 (A. Kotli)) (Asszonyi & Amjärv, 1981)*

In conclusion, all examples of this building type were designed with central heating and for this reason, layouts of these projects rarely follow any uniform trends as there is no need for heated rooms to remain in proximity to chimneys or stoves. Standard footprints of building envelopes are rare. Ground floors generally have a living room, dining room, kitchen, bathroom, occasional bedrooms and utility rooms. Upper floors contain bedrooms, attic and storage spaces and occasionally bathrooms. The proportion between attic and living spaces on the attic floor often depends on the proportions of the footprint of the dwelling. In more compact cases, the attic is fully occupied by heated spaces. In less compact cases, attic floors may have only a single bedroom due to the limitation on number of rooms. Auxiliary wings may be very extensive with numerous utility spaces, with either a high-pitched gable roof and unheated attic space, or a low-pitched roof.

4.1.3 The box house

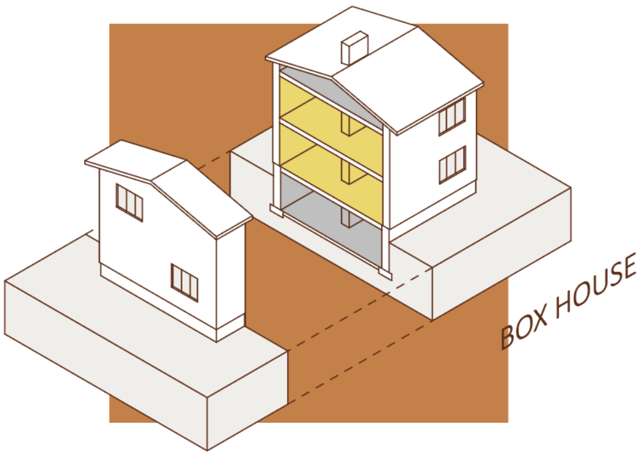


Figure 4.13 *The archetypical form of the box house*

"The box house", as this building type is generally nicknamed among architects and historians in Estonia, is defined by its full height upper floor. The entire heated volume generally remains within a compact, vertically extruded building footprint. As a general rule, individual dwellings did not have full-height upper floors until the second half of the 1950's, illustrated by the fact that such dwellings do not appear in neither the earliest standard projects nor the 1954 two-part album. By year 1956 however, the first four fully two-floored dwellings appear among the 23 published projects (Figure 4.14) (RPI Estongiprogorstroi, 1956). Their ground-floor layouts have two rooms: a living room and dining room, followed by a kitchen with pantry space and the entry hall with staircase and WC. Enclosed unheated verandahs connected to the living room or dining room remain popular, although at times they may form part of the living room and heated volume as well. Upper floors generally contain three rooms, which are mostly bedrooms, or occasionally an office, the bathroom and stair hall. The roof of the ground floor verandah often forms an upper floor balcony. It is notable that the added space provided by a full upper floor creates a more clear division of function, allowing for the ground floor to remain more public, with the upper floor becoming a private area. Cellars exist in all projects, ranging from inhabiting the entire building footprint to at least half of it, housing the laundry kitchen and fuel, food or general storage spaces. Roofs of these dwellings are all low unheated hip roofs.

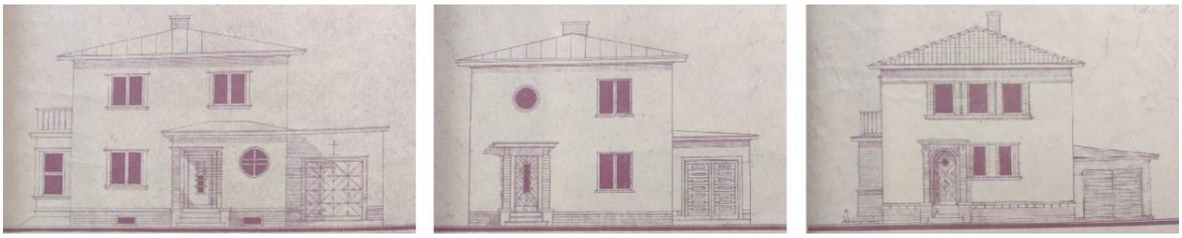


Figure 4.14 *Examples of box houses from 1956 (left to right: project 47; project 50; project 52) (RPI Estongiprogorstroi, 1956)*

In terms of layout composition, the simple four-quarter design with stove heating and central chimney that was previously noticed in gable houses, remains the norm among all four projects on both ground floors and upper floors. All projects include auxiliary wings as well in the form of garages facing the same direction as the main entrance to the building. They are either slightly hidden from view towards the back of the dwelling, or to the contrary, they are placed towards the front, forming a shared canopy above the main entrance (Figure 4.15).

Among the 24 identified E-series projects, four fully two-floored dwellings were found, although no major changes in layout division were noticed, apart from an example of verandah placement towards the street, while all other examples faced the yard.

Within the year 1965 album, a single fully two-floored dwelling can be found among the 16 projects (RPI Estonprojekt, 1965). Project 66 illustrates a complete reinvention of layout and architectural style for the dwelling type (Figure 4.16). While all previously mentioned box house projects had low overhanging hip roofs, this project displays an asymmetrical low gable roof. The division of public and private functions between two floors remains, yet the composition of layouts has changed. Instead of the previous four-quarter division, a large central living room inhabits the composition with all other rooms surrounding it in an L-shaped pattern, yet still maintaining stove heating with a central chimney.

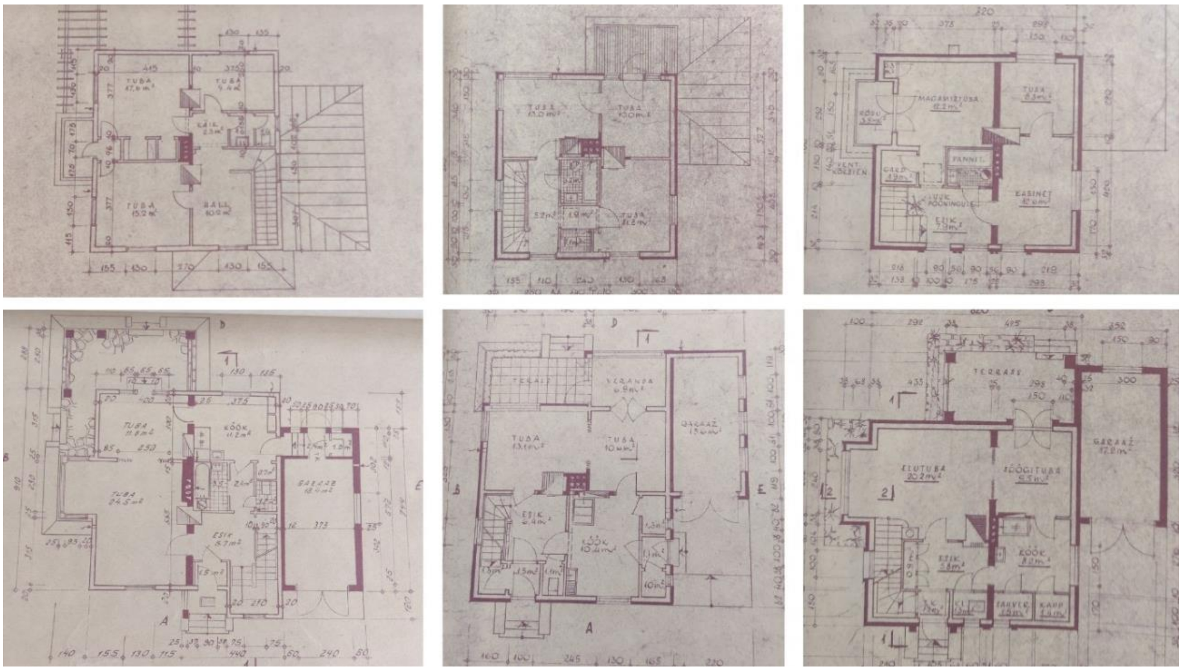


Figure 4.15 *Examples of box house ground floor and upper floor layouts from 1956 (left to right: project 47; project 50; project 52) (RPI Estongiprogorstroi, 1956)*

The upper floor houses no more than two bedrooms, a bathroom, the stair hall and compact attic space. Here too the four-quarter design seems to have been lost. The balcony, previously placed on top of the roof of the verandah, is now placed into the building volume. The cellar occupies the full building footprint, housing the laundry kitchen, storage spaces and a work-room that may be remodeled into an underground garage.

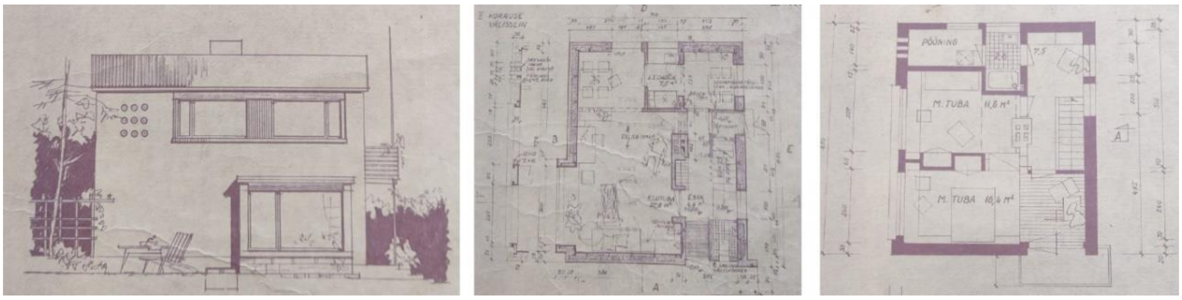


Figure 4.16 *Project 66, example of a box house design from 1965 (left to right: elevation; ground floor; upper floor) (RPI Estonprojekt, 1965)*

By year 1976, four fully two-floored dwellings can be found among the 38 published projects (Berends & Dobrõš, 1976). In terms of style and layout, another reinvention has taken place and all four display a unique architectural style. Roof shapes have shifted towards achieving a more monumental appearance with either flat roofs or roofs with a single slant (Figure 4.17). Due to Estonia´s climatic conditions, some of these flat roofs were deceptive, as the parapet around the building's roof could be left open on either one side, creating a slanted roof, or on two opposite sides, creating a low gable roof.

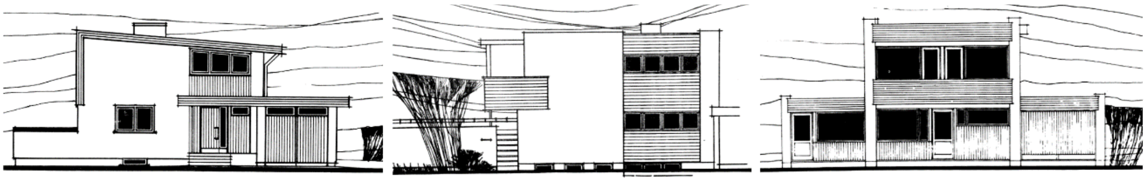


Figure 4.17 *Examples of box house designs from 1976 (left to right: IE-03 (H. Kingo); 80-74 (J. Pärnik); 91-74 (L. Aljaste)) (Berends & Dobrõš, 1976)*

This period is also when heating systems begin to shift from stoves to central furnaces, liberating the floor plan and living spaces from proximity to chimneys and stoves. While two projects, 80-74 (J. Pärnik) and IE-3 (H. Kingo) echo the previously established four-quarter division in terms of room placement, projects 85-74 (I. Puumets) and 91-74 (L. Aljaste) display an entirely new layout functionality (Figure 4.18). Instead of placing the chimney as a central element within the heated volume, a central hall on two floors with a staircase connecting all living spaces has become the new focal point. The ground floors contain the living room, kitchen and WC, supplemented by a dining room in the case of 91-74, while the upper floor has four equal-sized rooms and a bathroom, connected by the central stair hall.

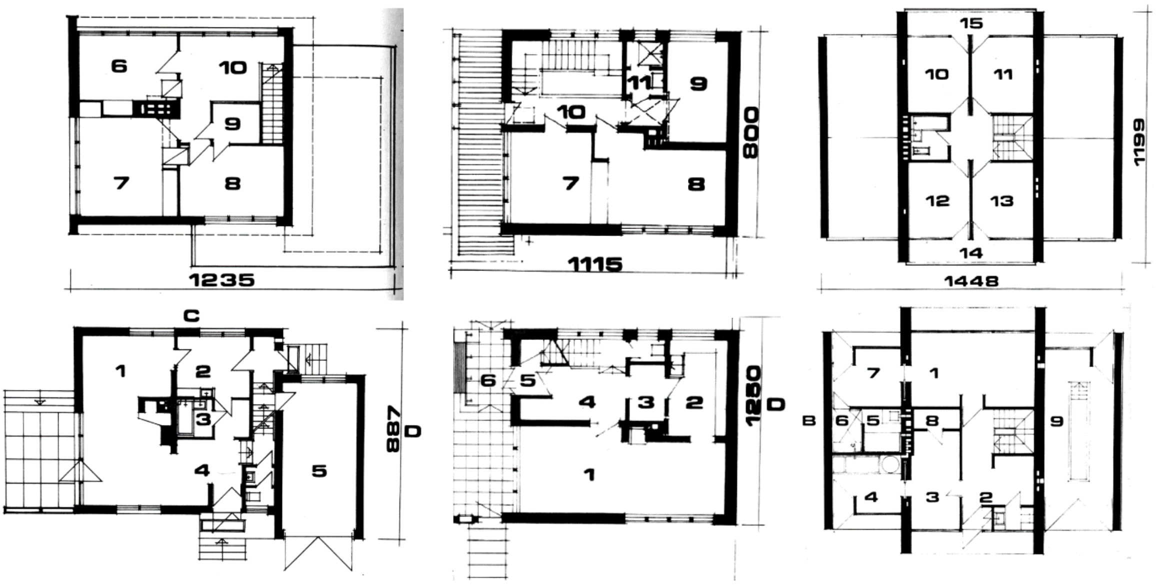


Figure 4.18 *Examples of box house ground floor and upper floor layouts from 1976 (left to right: IE-03 (H. Kingo); 80-74 (J. Pärnik); 91-74 (L. Aljaste)) (Berends & Dobrõš, 1976)*

85-74 displays an interesting occurrence, where the layout allows for six fully functional rooms, yet the design norms of the period allowing up to five rooms have forced the architect's hand in naming the fourth potential bedroom on the upper floor as an attic. Both projects also include auxiliary wings containing the garage, sauna and laundry kitchen.

Among later albums this building type does not seem popular, as only a single example, project 5-06-81 (J. Pärnik) appears in the year 1981 project album (Asszonyi & Amjärv, 1981). This design features a single-slope roof and no new layout characteristics (Figure 4.19). However, since these later albums are directed towards more rural areas, the box house may have still remained popular and been even re-imagined in urban areas, as is illustrated by the cover art of T. Masso’s 1990 handbook (Figure 4.20; A. Eigi).

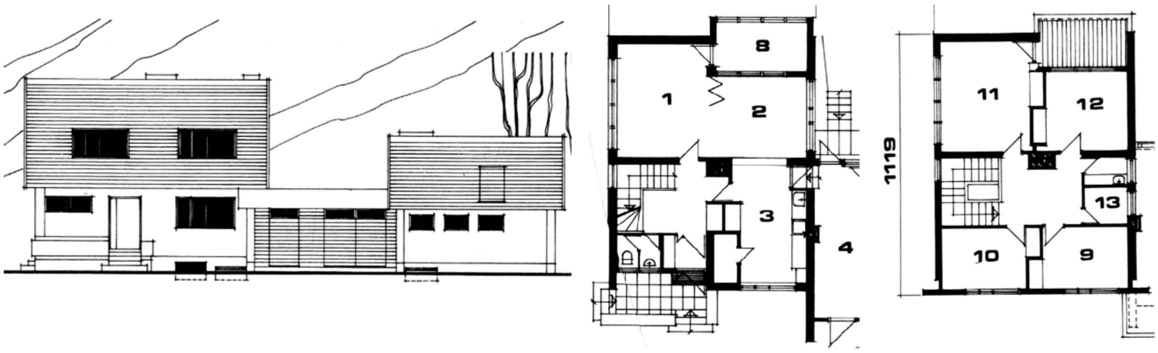


Figure 4.19 *Project IE-5-06-81, example of a box house design from 1981 (left to right: elevation, ground floor, upper floor) (Asszonyi & Amjärv, 1981)*

Figure 4.20 *Cover art of T. Masso´s 1990 construction handbook ”Väikemajad” (Masso, 1990)*

In conclusion, the box house can be described as a later addition to the building typology, appearing during the second half of the 1950’s. Ground floors have two rooms, a kitchen, stair hall with WC and occasionally bathrooms. Upper floors have two to three heated rooms, storage spaces and a bathroom. Roof shapes are always low, although forms may change according to the architectural trends of each decade. The dwelling may have an auxiliary wing or unheated verandah. Although type seems to go through numerous stylistic changes across decades, the core division of space remains the same in the case of both stove and central heating. In terms of layout, central heating allowed for a more effective division of space within the dwelling. The type seems to remain somewhat relevant throughout the entire soviet period, also hinting at an optimized building form.

4.1.4 The partly two-floored house

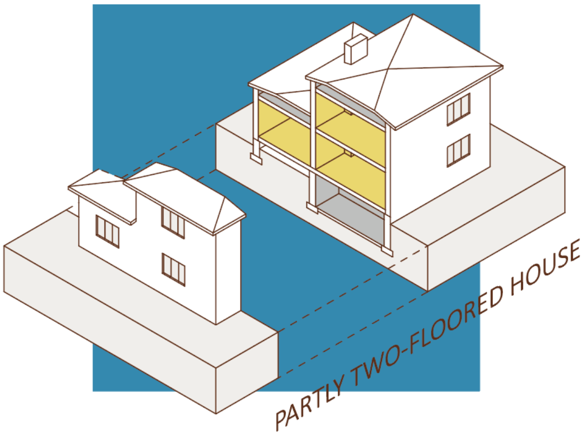


Figure 4.21 *The archetypical form of the partly two-floored house*

The partly two-floored dwelling is defined by the reduced size of the upper floor living space when compared to ground floor living spaces. Having its roots as a potentially more affordable option to the fully two-floored "box house" dwelling, the building type makes its first appearance among the studied material in the second published assortment of E-series standard projects. However, only a single example can be found in the "E-series" (ENSV Põllumajanduse Ministeerium, 1958; ENSV MN Riiklik Ehituse ja Arhitektuuri Komitee, 1959). Titled E-34, the ground floor of the project follows the same layout trends as the box house: a four-quarter division between living room, dining room, kitchen, and entry hall with staircase, WC and bathroom (Figure 4.22). The upper floor is more compact however, with only two bedrooms, the stair hall and a large attic space. The roof on top of the ground floor created by the reduced size of the upper floor may have been constructed into a balcony. Cellar space occupies the entire building footprint and includes a garage as well. While the building mass may seem more complicated, the heated volume follows a simple vertical L-shape.

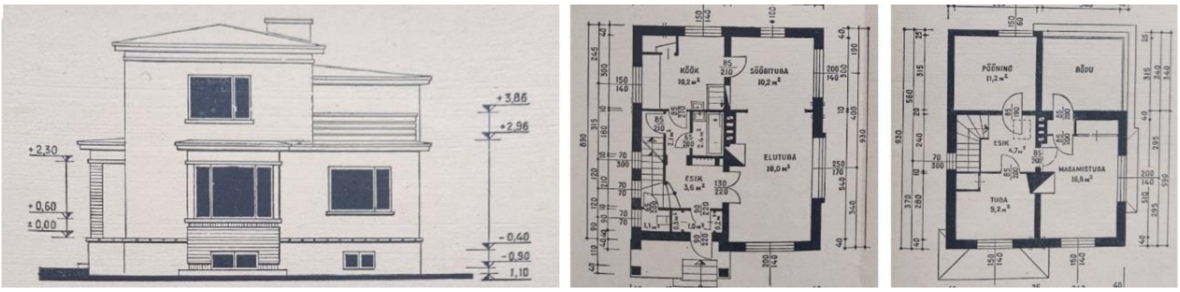


Figure 4.22 *Project E-34, an early example of a partly two-floored dwelling (left to right: elevation; ground floor; upper floor) (ENSV MN Riiklik Ehituse ja Arhitektuuri Komitee, 1959)*

This building type is also somewhat explored in the 1959 construction handbook among example projects (Veski, Aarmann & Niine, 1959) (Figure 4.23).

By 1965 however, the building type has been modernized and two examples appear among the 16 projects (RPI Estonprojekt, 1965). Project 68 (arch. H. Karro) is one such example (Figure 4.24). The ground floor continues the same four-quarter division of space and the upper floor is divided into a bedroom and stair hall, also used as an office space. This project also displays vertical displacement on the ground floor, differentiating between the public living and dining room and the more private and modest kitchen and entry hall section.

Another example is project 67 (Figure 4.25), where the general massing of the building may appear as a box house with an unheated auxiliary wing; the ground floor plan reveals that this appearance is deceptive. The secondary wing contains, aside from the laundry kitchen, the main kitchen and bathroom as well, leaving more space in the main wing for a larger shared living and dining room, an office and the entry hall. The upper floor has two bedrooms, a hallway with staircase and an unheated attic space. Both projects utilize stove heating and therefore generally maintain a central chimney.

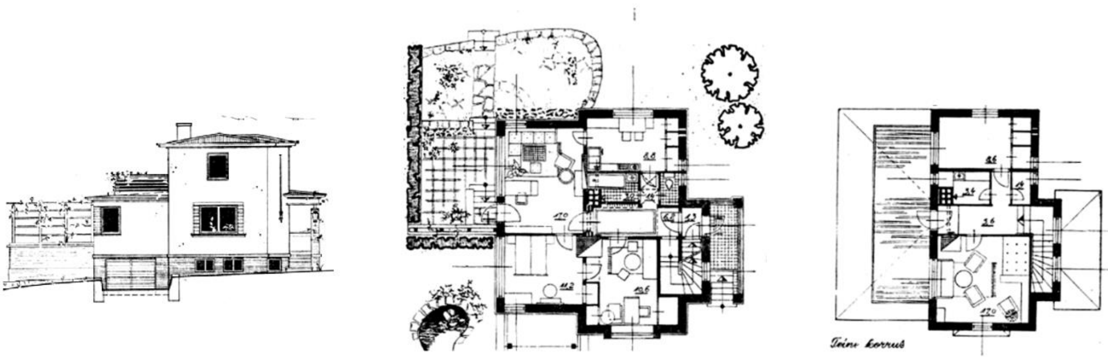


Figure 4.23 *An example of a partly two-floored dwelling from 1959 by L. Volkov (left to right: elevation; ground floor; upper floor) (Veski, Aarmann & Niine, 1959)*

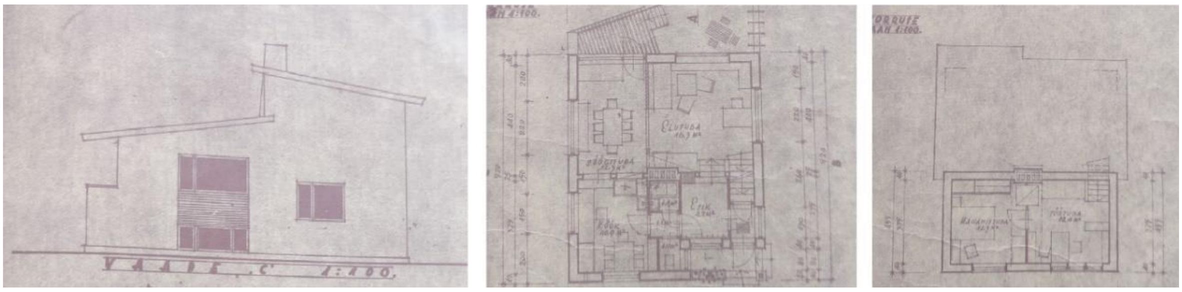


Figure 4.24 *Project 68, an example of a partly two-floored dwelling from 1965 (left to right: elevation; ground floor; upper floor) (RPI Estonprojekt, 1965)*

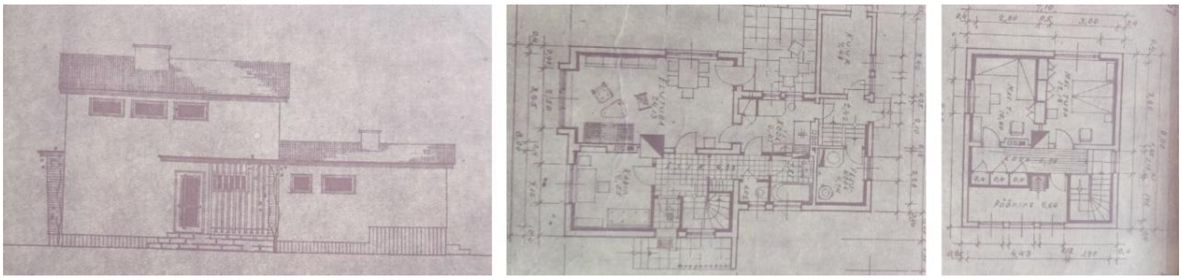


Figure 4.25 *Project 67, an example of a partly two-floored dwelling from 1965 (left to right: elevation; ground floor; upper floor) (RPI Estonprojekt, 1965)*

By 1976, two projects may be highlighted as featuring partly stacked heated space, yet both demonstrate two entirely different architectural concepts (Berends & Dobrõš, 1976). Project 88-74 (T. Tomiste) is composed of two building volumes under single-sloped roofs, one of which has the primary living spaces and the other containing the sauna and part of the entry hall and WC. The ground floor of the primary volume is composed of the living room, dining room, kitchen and stair hall, while the upper floor has two bedrooms connected by a long hallway. The space above the living room is towards the lower end of the sloped roof, potentially containing an empty space (Figure 4.26).

Project 100-74 (A. Eigi) demonstrates a newer architectural language, where the building volume is composed of two box-shaped volumes with flat roofs, with the upper floor rotated 90 degrees and overhanging the ground floor (Figure 4.27). The ground floor contains the living room, kitchen, office, stair hall with WC and storage space. The slightly overhanging upper floor contains three rooms, a balcony, a bathroom and central stair hall. Both projects utilize central heating, which has allowed for a more liberal division of living spaces.

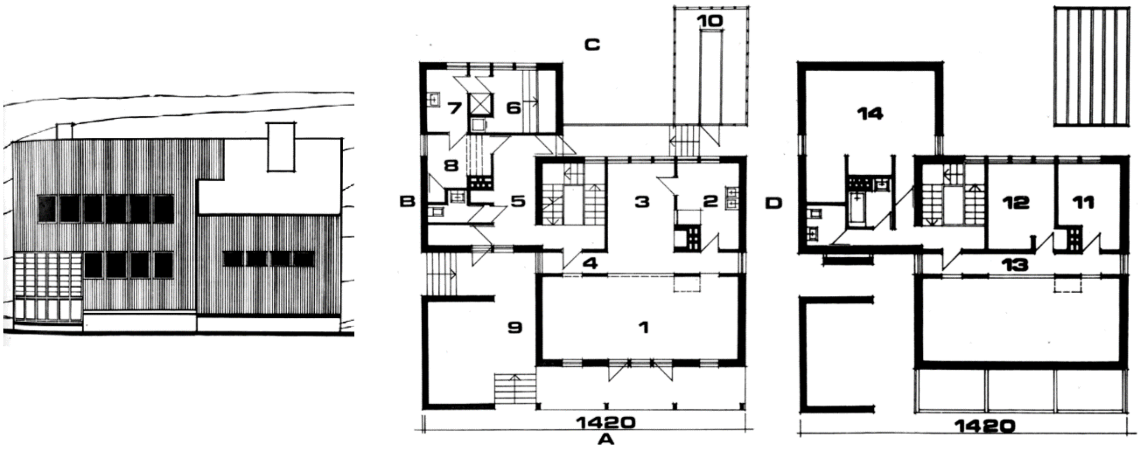


Figure 4.26 *Project 88-74, an example of a partly two-floored dwelling from 1976 (left to right: elevation; ground floor; upper floor) (Berends & Dobrõš, 1976)*

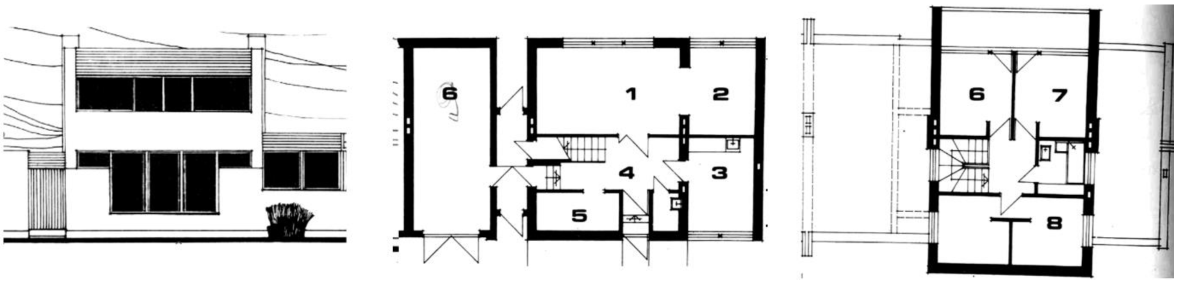


Figure 4.27 *Project 100-74, an example of a partly two-floored dwelling from 1976 (left to right: elevation; ground floor; upper floor) (Berends & Dobrõš, 1976)*

The partly stacked dwelling makes two appearances in the year 1981 album, in the shape of 5-11-81 (M. Hansmann) (Figure 4.28) and 6-03-81 (E. & M. Raigna) (Figure 4.29) (Asszonyi & Amjärv, 1981). While 5-11-81 remains more compact, project 6-03-81 demonstrates a much more spread-out and undefinable building mass.

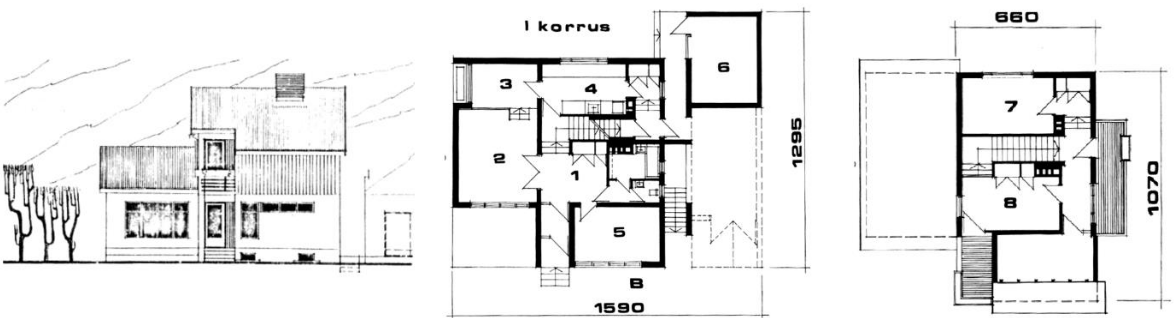


Figure 4.28 *Project 5-11-81, an example of a partly two-floored dwelling from 1981 (left to right: elevation; ground floor; upper floor) (Asszonyi & Amjärv, 1981)*

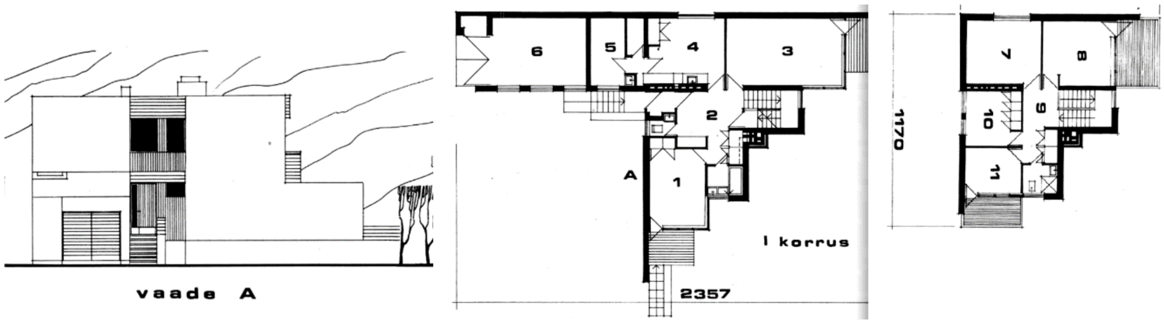


Figure 4.29 *Project 6-03-81, an example of a partly two-floored dwelling from 1981 (left to right: elevation; ground floor; upper floor) (Asszonyi & Amjärv, 1981)*

In conclusion, this building type can be noticed among several project albums across multiple decades, although in generally low numbers, signifying that it may not have been popular, but still remained somewhat relevant. This low number of examples makes the building type difficult to define. This option of building a smaller upper floor when compared to the ground floor footprint may have originally been a more affordable option to constructing a complete box house, but by the 1960's, some box houses seem to begin utilizing auxiliary wings as heated spaces, shifting their building type into a partially stacked dwelling. By the 1970's and once again in the 1980's, the building type seems to repeatedly define a new architectural character. The division between public and private space between the ground and upper floor remains, yet the compositions of layouts are varied. The compositions of auxiliary wings within this building type are difficult to define as well, although in the examples that were found, the auxiliary wing remains a recognizably distinct building mass from the main dwelling, except in the case when the auxiliary wing also houses heated spaces. Roof shapes are diverse as well, from hip to gable to single-slope to flat roofs, owing to the more challenging nature of the composition of the building mass.

4.1.5 The bungalow house

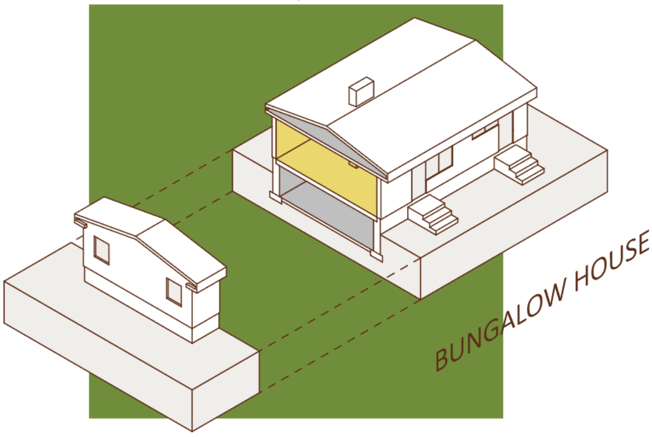


Figure 4.30 *The archetypical form of the bungalow house*

The "bungalow", defined by its single heated floor and a low roof, was introduced alongside the gable house in the very earliest published standard projects. A more affordable option when compared to the gable house, as the construction process was simpler and quicker due to the lack of a tall roof and upper floor. Their limited size however was likely to become the main issue of this building type. In the 1954 two-part album, 9 examples of the bungalow appear among the 27 projects, either with a low gable or hip roof. Most projects share similar ground floor layouts to gable houses with two to three rooms along with kitchen, entry hall and occasional bathroom, yet some follow a distinctly different layout (Figure 4.31). Some have auxiliary wings as well, identical to the layouts found among traditional gable houses (Figure 4.32). By year 1956, three bungalows appear among the 23 projects and by year 1958, 6 bungalows appear among 24, hinting at a low level of popularity at the second half of the 1950's. These designs are generally identical to the previously established design characteristics (Figure 4.33).

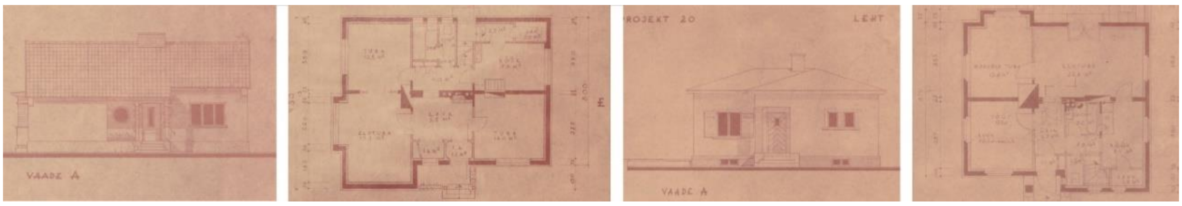


Figure 4.31 *Examples of bungalow dwellings from 1954 (left to right: project 19 with elevation and ground floor; project 20 with elevation and ground floor) (VPI Estonprojekt, 1954)*

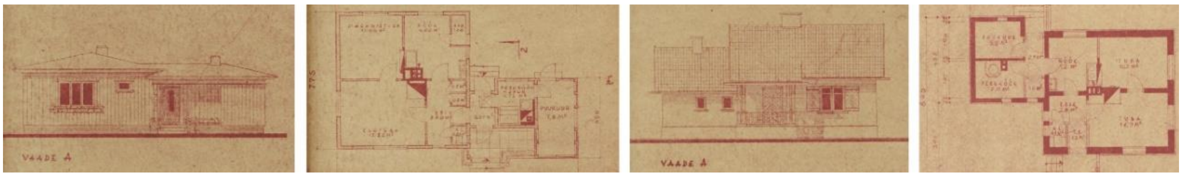


Figure 4.32 *Examples of bungalow dwellings from 1954 with auxiliary wings (left to right: project 8 with elevation and ground floor; project 7 with elevation and ground floor) (VPI Estonprojekt, 1954)*

By the 1960's however, the bungalow is rediscovered, illustrated by the 1965 project album with 8 bungalows out of 16 projects. Fitting the modernist nordic style of the late 1950's and early 1960's in Estonia, the bungalow became the fashionable form of individual dwelling during the 1960's (Veski, 1969). For this reason, its originally modest and compact form was reinvented to fit a more modern aesthetic, with some designs utilizing previously established three-room layouts, and others rearranging the living space around a larger central living room (Figure 4.34). Stove heating remains, meaning that the division of the layout is still dependent on remaining compact around a central chimney for equal heat distribution The two room variations seems to have gone out of fashion, likely due to lack of space. Auxiliary wings do not appear among these projects. Roof shapes are low pitched gable roofs as a general rule, with some acting as cathedral ceilings, meaning that the roof slopes act as a ceiling as well, creating taller interior spaces.

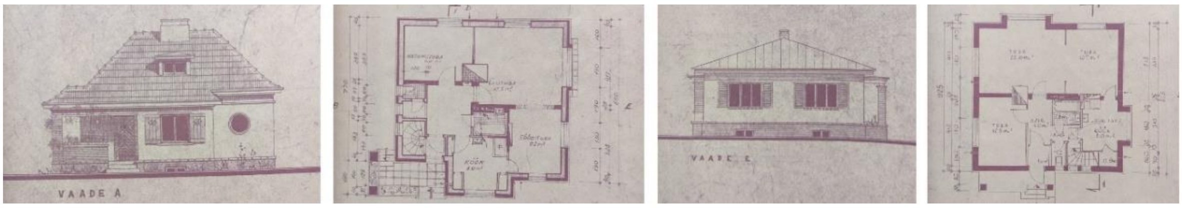


Figure 4.33 *Examples of bungalow dwellings from 1956 (left to right: project 34 with elevation and ground floor; project 35 with elevation and ground floor) (RPI Estongiprogorstroi, 1956)*

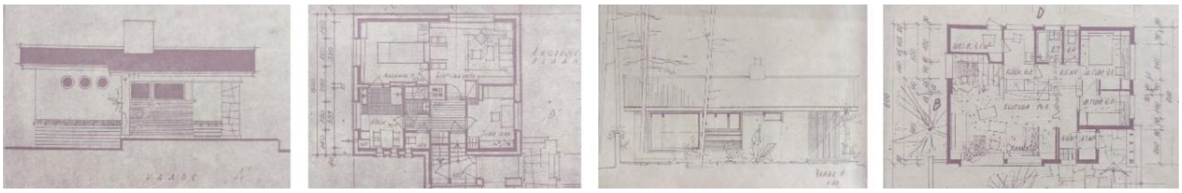


Figure 4.34 *Examples of bungalow dwellings from 1965 (left to right: project 60 with elevation and ground floor; project 61 with elevation and ground floor) (RPI Estongiprogorstroi, 1956)*

In year 1966, the newly formed design firm *EKE Projekt* began developing rural dwellings suitable for mass production. For this end, a series of fashionably low roofed bungalow designs were produced by 1968 (Vanaselja, 1968), titled as series 17421 (E. Laasi) (Figure 4.35).

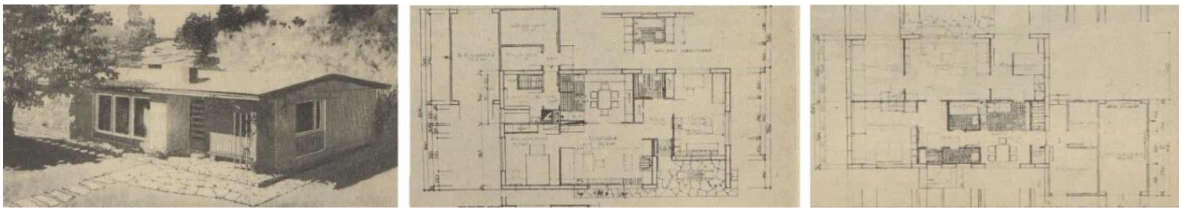


Figure 4.35 *Rural bungalow dwellings from 1968 (left to right: elevation, three-room layout, four-room layout) (Vanaselja, 1968)*

These designs often had a distinct auxiliary wing as well, housing the garage and storage spaces. These were sometime later followed by design series utilizing prefabricated wood panels, like the 19123 (RPI Eesti Maaehitusprojekt, 1977), the 10052 (V. Kaasik) (EKE Projekt, n.d.-f) and the E-907 (V. Kaasik & T. Rein) (Veski, 1969), some buildable as either detached or semi-detached. These projects were still mainly utilizing stove heating, although central heating was becoming an option as well. These layouts had a basic layout of three to four rooms, a kitchen, an entry hall, a WC and bathroom (Figure 4.36). Auxiliary wings were usually designed as part of the main building mass. Roof shapes remained as either low-gable or single-slope roofs with wide overhangs.

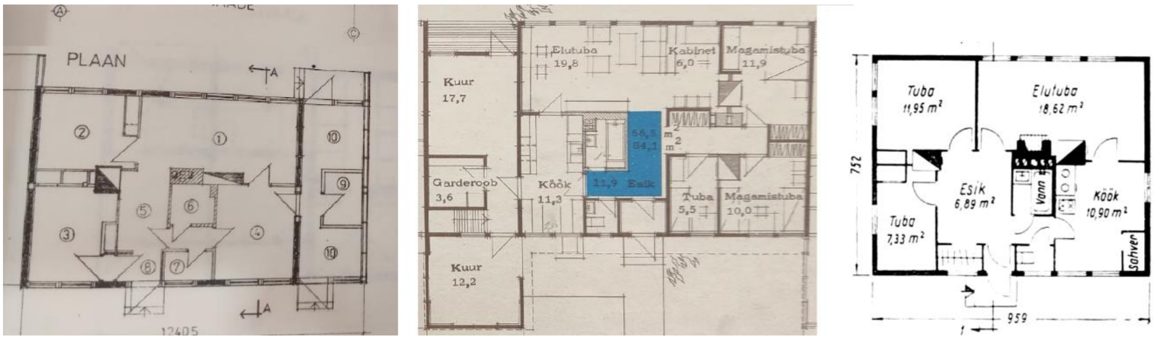


Figure 4.36 *Rural bungalow dwellings estimated to be from the second half of the 1960´s (left to right: 19123 (RPI Eesti Maaehitusprojekt, 1977), 10052-IV (EKE Projekt, n.d.-f), E-907 (Veski, 1969))*

By 1975, the iconic *Kullipesa* (T. Kull) had been introduced, accompanied by the *Ella* (Ü. Eljand) and the *Taru* (T. Kull) (PI EKE Projekt, 1975b) (Figure 4.37). These designs feature a variety of layouts, which have begun to grow, now more frequently housing four to five rooms in addition to the kitchen, instead of the previously common two to three room variations. These projects are all now designed with central heating. They also feature distinct auxiliary wings, with roof shapes ranging from low-pitched gable roofs to single-slope roofs to flat roofs.

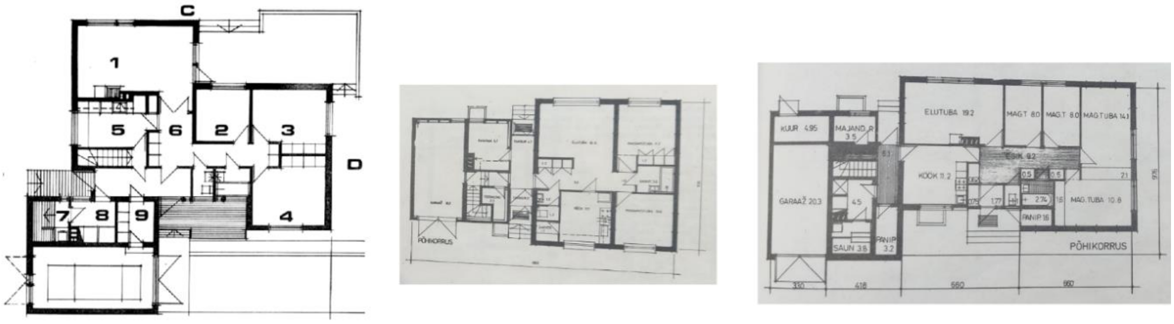


Figure 4.37 *Rural bungalow dwellings from the first half of the 1970´s (left to right: Kullipesa-4, Taru-4, Ella-5) (PI EKE Projekt, 1975b)*

In 1976, the bungalow remains a common design, appearing as 9 projects out of 38, with a variety of footprints to fit the maximum number of rooms onto a single floor (Berends & Dobrõš, 1976). All bungalows from this point are all meant to utilize central heating. Two of these projects are previous *EKE* designs (17421-3, Kullipesa-4). The IE-01 is an earlier standard project as well from 1967 (R. Urb & E. Kaasik) (H. Roopalu, 1967). All others are newer and display very extensive and complicated footprints containing four to five rooms, completely disregarding the compactness that had characterized previous bungalow designs. Heating such layouts with stoves would not be practical considering the number of necessary chimneys, so it can even be stated that the availability of central heating facilitated the development of such previously unseen layouts. Most designs feature flat roofs either with internal drainage or a combination of low gable or single-slope roof and concealing parapets. In terms of dividing heated living space from unheated utility space, some designs like 95-74 (architect unmentioned) and 106-74 (R. Karp) have developed a somewhat clear division, yet the others like 93-74 (K. Valdre), 92-74 (I. Puumets) and 84-74 (R. Kersten) are difficult to define. 83-74 (J. Jaama, K. Ehrenbusch) has placed all utility spaces into the cellar, leaving the entire ground floor as heated space. (Figure 4.38).

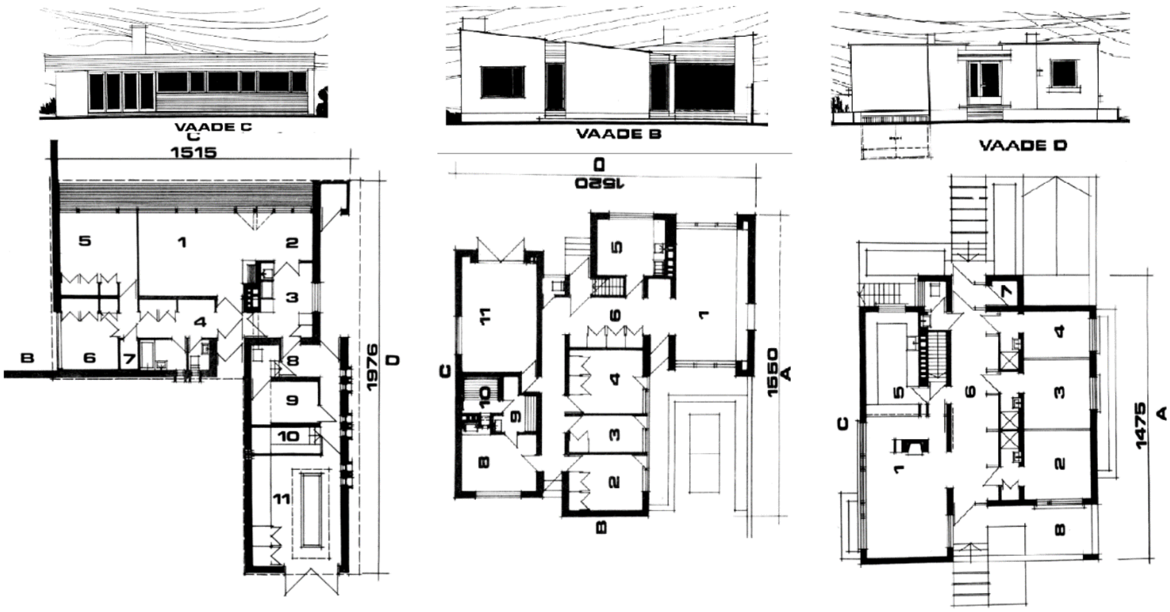


Figure 4.38 *Bungalow dwellings from 1976 (left to right with elevation and layout: 106-74, 92-74, 83-74) (Berends & Dobrõš, 1976)*

By 1977, more rural standard bungalows from prefabricated wood elements had been developed by *EKE*, like the *Mini-Priit* (A. Ringo), the *Maxi-Priit* (A. Ringo), the *T-3* (V. Taidur), developing a more traditional style from the previous modernist aesthetic of the second half of the 1960's and beginning of the 1970's (RPI Eesti Maaehitusprojekt, 1977) (Figure 4.39).

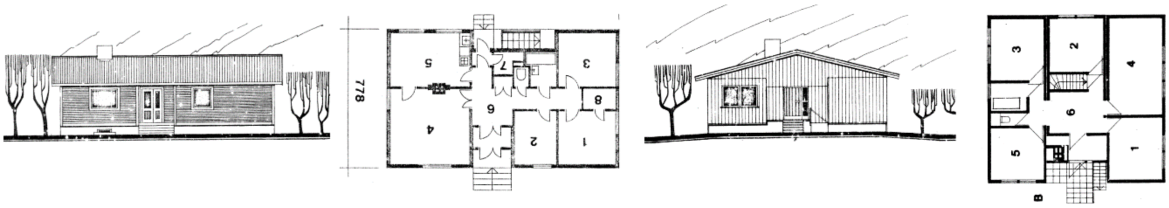


Figure 4.39 *Rural bungalow dwellings likely from the second half of the 1970´s (left to right, elevation and layout: Mini-Priit, T-3) (Amjärv, 1983)*

By the 1980's, rural standard bungalows continued to be either very rational and simplistic in design, like the *Peeter* (Ü. Eljand) (PI EKE Projekt, n.d.-g), the *Kristiina* (Ü. Eljand) (PI EKE Projekt, n.d.-h), the *Maali* (Ü. Eljand) (PI EKE Projekt, n.d.-i) or the *Tõnn* (T. Kull & A. Mellik) (PI EKE Projekt, n.d.-j) (Figure 4.40); or more extravagant, like depicted within the 1981 album. Four projects out of 27, the 4-02-81 (G. Arikainen), the 4-08-81 (H. Roopalu), the 5-10-81 (H. Roopalu) and the 5-05-81 (P. Jänes) can be highlighted as bungalow designs (Figure 4.41) (Asszonyi & Amjärv, 1981). Their layouts remain extensive, relatively complicated and difficult to define, aside from the generally shard characteristic of providing access to all rooms through a central hallway. Most feature large auxiliary wings.

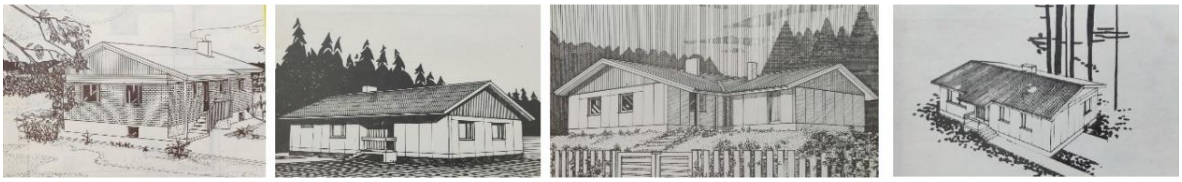


Figure 4.40 *Rural bungalow dwellings developed during the 1980´s (left to right: Peeter-2 (PI EKE Projekt, n.d.-g), Kristiina-4 (PI EKE Projekt, n.d.-h), Maali-4 (PI EKE Projekt, n.d.-i), Tõnn-4 (PI EKE Projekt, n.d.-j))*

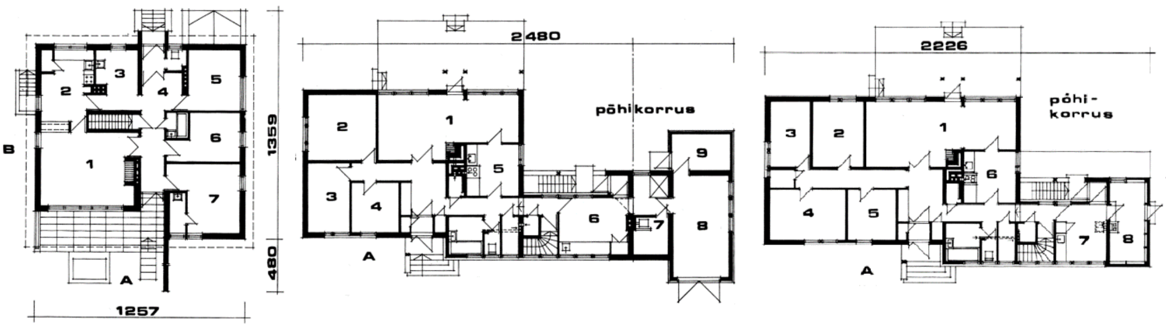


Figure 4.41 *Rural bungalow dwellings developed during the 1980´s (left to right: 4-02-81, the 4-08-81, the 5-10-81) (Asszonyi & Amjärv, 1981)*

In conclusion, the bungalow is as old as the traditional gable house, sharing many characteristics in terms of layout and massing, apart from roof shape. Remaining as simply a more affordable dwelling option until the end of the 1950's, a reimagining took place in the following years for the building type, making it the architecturally preferred form of dwelling during the 1960's, as it embodied integration and proximity to the surrounding landscape. During this time, the bungalow began to grow, integrating more rooms and creating more distinction between public and private areas within the dwelling. Many standard projects were developed under this building type for rural areas. During the 1970's and 1980, bungalows began getting increasingly complex in terms of layout and footprint, now being able to fit the maximum number of rooms allowed by dwelling size regulations. Roof shapes remained fairly simple, utilizing either low hip, gable, single-slope or flat roofs. Auxiliary wings may be distinguished at times, however they may also be seamlessly integrated into the building volume as well.

4.1.6 The raised bungalow house

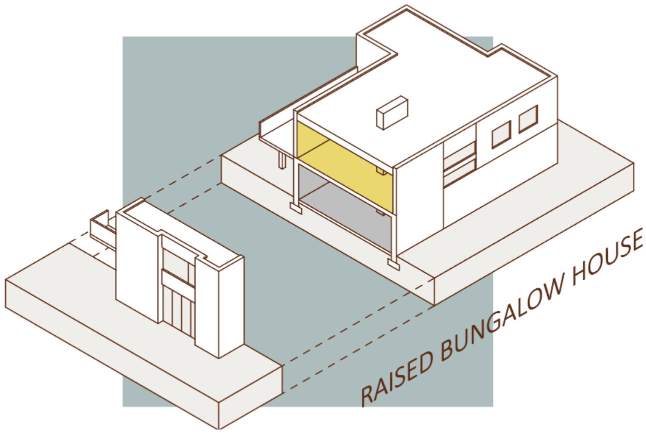


Figure 4.42 *The archetypical form of the raised bungalow house*

In some cases it was necessary to raise the cellar and plinth of a dwelling either due to high ground water levels, to include a garage space, or to simply more successfully integrate the dwelling into the landscape. From this detail, a somewhat separate subtype emerged by the 1970's, integrating aspects of both the bungalow and the previously established box house. This new subtype was a dwelling, where the entire living or heated space remained on a single level, but this level was on top of a full-height, mostly unheated ground floor, housing the garage, sauna, storage spaces, etc., creating a "raised bungalow". This unheated ground floor, which for all intents and purposes functioned as a cellar, may be somewhat integrated into the landscape, but generally it makes the dwelling appear identical to a box house. This type is most clearly illustrated in the 1976 project album by projects 90-74 (K. Luts), 96-74 (J. Pärnik, H. Roopalu), 101-74 (I. Puumets) and 105-74 (M. Masso) (Figure 4.43) (Berends & Dobrõš, 1976). A standard design by EKE, the *Jaan* (J. Pärnik) is another example of this design philosophy. Although seemingly not very popular, as this dwelling type does not appear before or after the 1970's among project albums, the mentioned example projects were not possible to distinguish as neither bungalows nor box houses, making a somewhat separate subtype necessary.

Figure 4.43 *Raised bungalow examples from 1976 (left to right: 90-74, 96-74, 105-74) (Berends & Dobrõš, 1976)*

4.1.7 The vertically displaced house

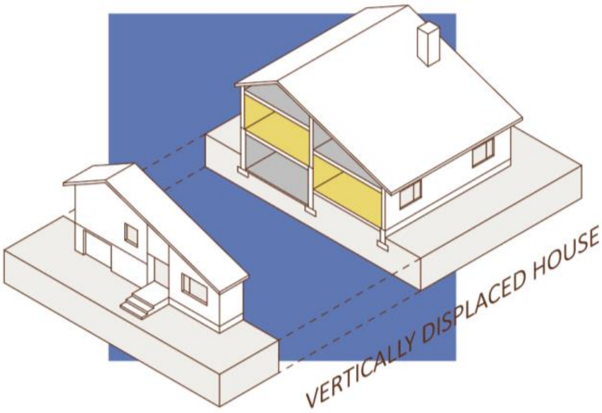


Figure 4.44 *The archetypical form of the vertically displaced house*

The second main type of utilizing horizontally distributed heated space, alongside the bungalow, is the vertically displaced dwelling. With its roots in the same period of nordic modernism as the bungalow of the 1960’s, this building type arose from the need to tackle high ground water for constructing cellars, while keeping a comfortable connection between the living spaces and surrounding landscape (Kammal, 1966). The defining feature of this dwelling is a vertical offset between two sections of the living space, often between public and private areas. Public areas like the living room, kitchen and dining space generally remain closer to the ground, while the more private spaces like the bedrooms and bathroom are placed on top of a cellar or garage space, elevating them. There are also two subtypes depending on the size of the cellar and garage space: the dwelling can have either a single cellar halfway underground (1), or a half-buried cellar and full-height garage and utility space (2).

In the 1965 album, five vertically displaced dwellings can be found, all generally compact in form and with either a single roof or two separate roof sections (RPI Estonprojekt, 1965) (Figures 4.45 & 4.46). Heating this kind of space was evidently a challenge however, as most designs feature two separate chimneys to heat the two sections. During this period, the footprints of these dwellings generally remain relatively compact, although examples of horizontal displacement, where the two building volumes are connected by their corners, occurs as well.

In the 1976 album, 12 examples of vertically displaced dwellings appear, making it the most common building type among 38 projects (Berends & Dobrõš, 1976). The displaced sections may form a single volume, with either a flat roof, like 78-74 (I. Laasi, K. Laasi); a single-sloped roof, like 82-74 (J. Jaama, K. Ehrenbusch), 87-74 (M. Annus) and IE-02 (H. Kingo), or an asymmetric gable roof, like MAX-4 (A. Eigi, N. Eigi) (Figure 4.47).

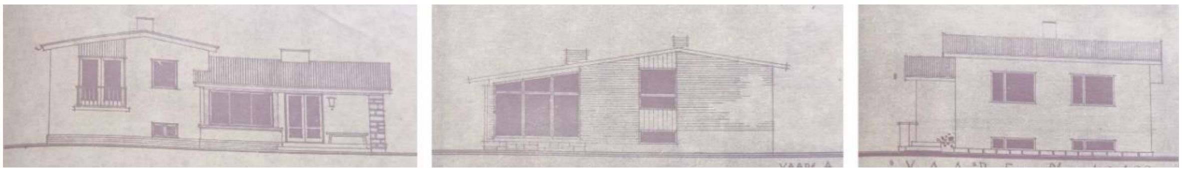


Figure 4.45 *Vertically displaced dwelling examples from 1965 (left to right: project 70, project 63, project 69) (RPI Estonprojekt, 1965)*

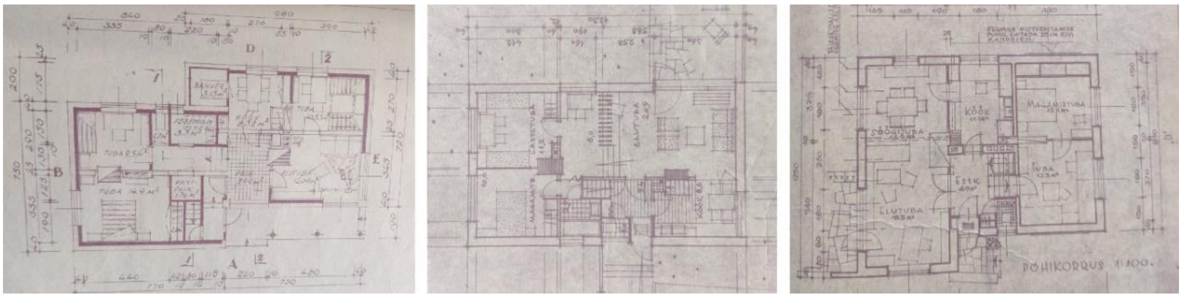


Figure 4.46 *Vertically displaced dwelling layout examples from 1965 (left to right: project 73, project 63, project 69) (RPI Estonprojekt, 1965)*

The other option is to form a composition of building masses joined at their corners, like 79-74 (I. Laasi, K. Laasi), 81-74 (P. Jänes), 94-74 (H. Roopalu, M. Piiroja), 102-74 (M. Piiroja, H. Roopalu), all with flat roofs (Figure 4.48). Auxiliary functions, such as garages, saunas, storage spaces, furnace rooms are generally integrated within the building volume within the cellar, but in the case of a single half-buried cellar, the garage may be placed within a separate added building volume, as in 94-74 and 102-74.

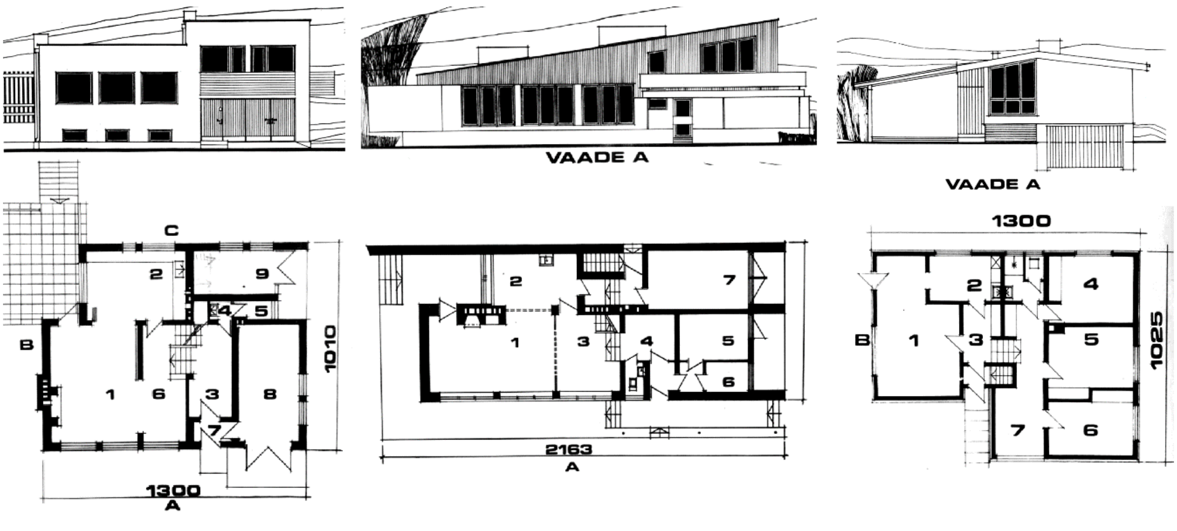


Figure 4.47 *Vertically displaced dwelling examples from 1976 (left to right: project 78-74, project 82-74, project MAX-4) (Berends & Dobrõš, 1976)*

The division of space between public and private functions within the two separate levels is evident in all projects. The number of rooms ranges between three and five, in addition to the kitchen.

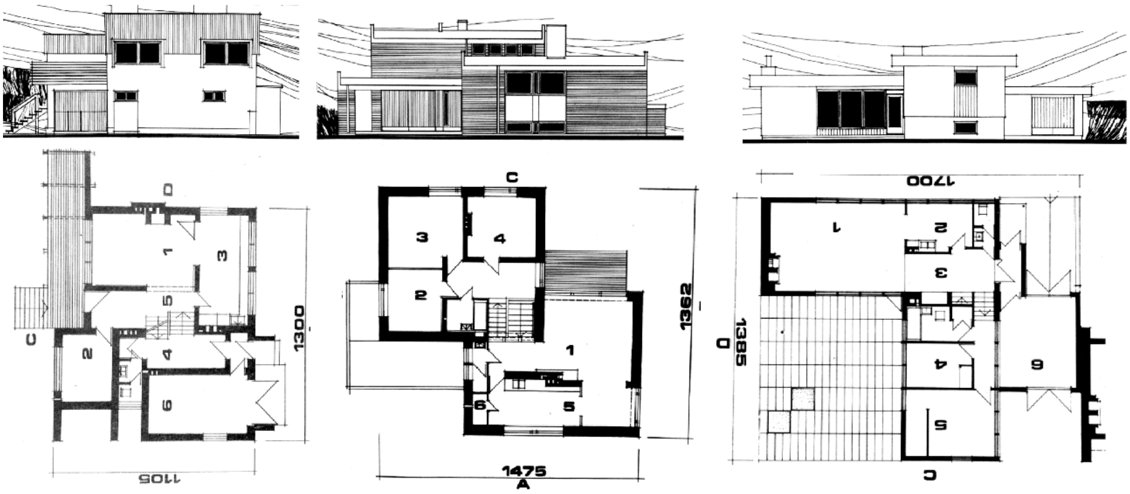


Figure 4.48 *Vertically displaced dwelling examples from 1976 (left to right: project 79-74, project 81-74, project 94-74) (Berends & Dobrõš, 1976)*

Within the 1981 album, five examples of vertically displaced dwellings are present: the 4-01-81 (K. Valdre), the 4-10-81 (M. Annus), the 5-01-81 (R. Kersten), the 5-03-81 (A. Raid) and the 5-08-81 (M. Annus) *(Asszonyi & Amjärv, 1981)* (Figure 4.49). One more example may he highlighted from the 1983 album, labelled as project 20 (M. Hansmann).

All projects display complicated footprints, yet the division of public and private functions across separate floor levels remains. Auxiliary functions are all within the main building mass. Roof shapes have begun to diversify, with examples of single-sloped roofs, asymmetric low-pitched gable roofs, flat roofs and offset slope compositions.

A popular *EKE* example from the 1980's is generally known to be the *Toomas* series (A. Mellik, T. Lukk, Ü. Eljand) (PI EKE Projekt, n.d.-k), which features a compact footprint and asymmetrical gable roof (Figure 4.50).

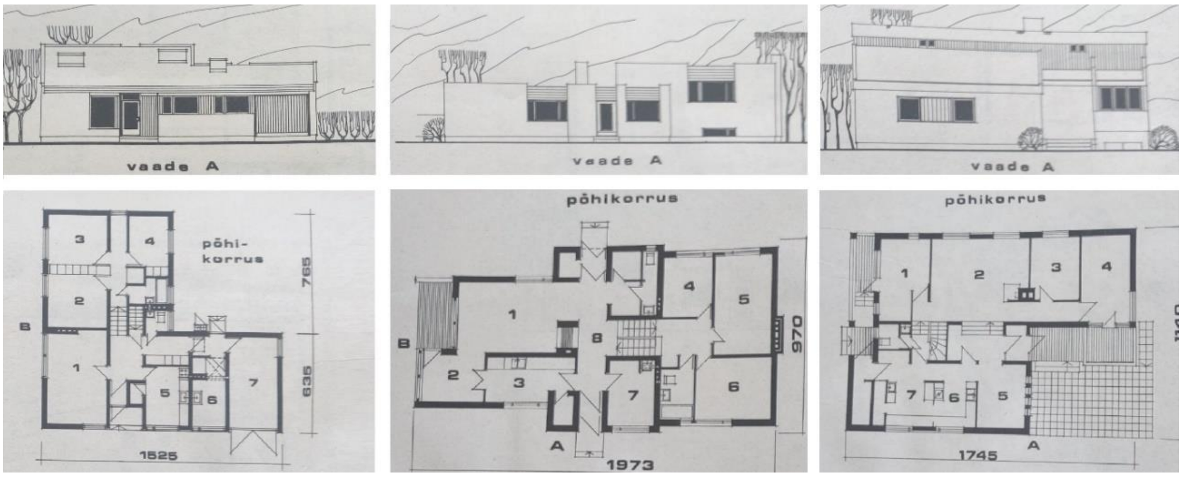


Figure 4.49 *Vertically displaced dwelling examples from 1981 (left to right: project 4-01-81, project 5-01-81, project 5-03-81) (Asszonyi & Amjärv, 1981)*

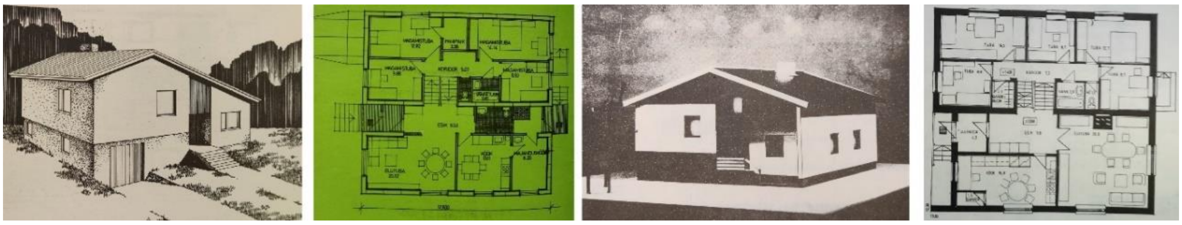


Figure 4.50 *Examples of the Toomas series, (left to right: Toomas-5, visualization and floor plan (PI EKE Projekt, n.d.-k); Toomas 131, visualization and floor plan (PI EKE Projekt, n.d.-l))*

In conclusion, the vertically displaced dwelling appeared during the 1960's and remained in use until the 1980's. The building type developed from a desire to reduce plinth heights of cellars and provide a better connection between the landscape living spaces. An effective division between public and private functions is achieved while creating a dynamic connection between the two. The level closer to the ground generally houses the living room, dining room, kitchen and entry hall, while the elevated level houses bedrooms and the bathroom. Heating was done by stoves during earlier periods, yet this required two separate chimneys to be built and then heated, making central heating much more appropriate for this dwelling type during the 1970's. Utility spaces are always placed beneath the elevated level under the bedrooms, but another even lower cellar level may be included as well beneath the lower heated volume. Separate auxiliary wings occur rarely. Roof shapes, as well as building footprints can be very diverse and appear in a number of combinations, likely due to the architecturally unique division of space, encouraging architects to experiment more with the building's design.

4.2 Construction types of individual dwellings

4.2.1 Timber structures

Wooden walls were built either out of horizontal logs, or as a frame-structure. Horizontal log walls are an archaic, yet reliable method of wood construction, which continues to be used until this very day. However, they required a skilled hand to construct properly and required a much larger volume of material to construct when compared to frame structures. Therefore, horizontal log structures were not recommended, but still remained as a point of discussion throughout all handbooks due to their timeless nature (Tamm & Jomm, 1949; Masso 1990). Frame structures could be built as either heavy or light, depending on the material used to fill the frames. Heavier materials were either vertically placed logs (püstpalk), or two layers of thick lumber planking (topeltplank). Lighter materials were aerated infills like sawdust (termoliit) or other natural material, lined with planking on both sides. According to handbooks, heavier frame structures are discussed in 1949 (Tamm & Jomm, 1949; Jürgenson, 1949), however by 1959 they are not mentioned, likely due to their poor abilities of heat-retention and inefficient use of resources (Veski, Aarmann, & Niine, 1959). Light frame structures continue to be discussed and developed until the end of the soviet era (Masso, 1990).

Figure 4.51 *Examples of dwellings with timber structures (left to right: horizontal log (Võrumaa Muuseum, 1957), heavy timber frame with vertical logs (Valga Muuseum, 1957), light timber frame (Eesti Rahva Muuseum, 1962))*

In terms of thickness, horizontal log and heavy frame structures were 150 mm thick as a general rule (not accounting for any additional layers). The general thickness of light frame structures depended on the timber that was used, which came in a variety of dimensions and are therefore more difficult to define. The most common timber material was manufactured with widths at an interval of 50 mm (50 mm, 100mm, 150mm and 200 mm); and thicknesses from between 20 to 25 mm, to 50 mm and 100 mm in various combinations. These structures may receive an external finishing as well, such as wood siding, brick or rendering. Brick linings may have been laid either flat or on their side (Veski, 1969) (Figure 4.52).

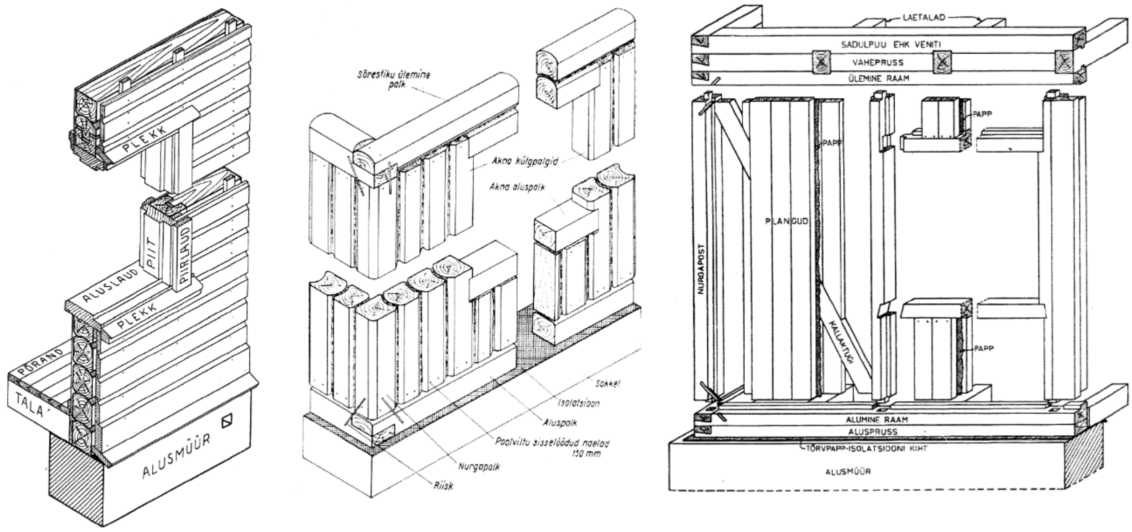


Figure 4.52 *Examples of heavy timber structures (left to right: horizontal log (Masso, 2022), heavy timber frame with vertical log infill (Veski, 1969), heavy timber frame with double planking (Masso, 2022)*

Prefabricated wood panels were produced during the soviet period as well for constructing standard projects, however their construction is not described with adequate detail to make conclusions about any common traits (Veski, 1969).

4.2.2 Brick structures

While in 1949 Leo Jürgenson describes a wide variety of stone construction types, including clay, concrete blocks, limestone and brick; the other handbook published in the same year contains a much narrower selection of wall types (Jürgenson, 1949). From 1948 onwards, the use of less-efficient brick walls was banned for buildings with no more than a couple floors, due to their resource-costly construction and low level of heat retention. This means that only insulated brick walls were left as an option when wishing to construct individual dwellings from stone material after 1948 (Tamm & Jomm, 1949).

The types of brick available were generally either ceramic ("red brick") or from silicate ("white brick"), which came in the form of standard (25 x 12 x 6,5 cm), modular (25 x 12 x 8,8 cm) or hollow bricks (with both standard and non-standard measurements).

4.2.3 Insulation materials

Insulation methods were not of a wide variety. The main categories were: air-cavity, aerated infill or prefabricated insulation panels. Air-cavities were used based on the assumption that the still air within the wall would provide safety against moisture, as well as act as insulation for heat-retention and noise insulation (Grauen & Alver, 1936). While more popular before the Second World War (Grauen & Alver, 1936), their usage as insulation layers seems to diminish after the beginning of the soviet occupation. This is illustrated in the 1959 handbook, where wall structures incorporating wide air-cavities have been placed into the list of un-recommended wall types (Veski, Aarmann & Niine, 1959).

Aerated infills incorporated a variety of combinations from natural materials like sod, peat, flax bone and sawdust to stone materials like oil-shale, lime and cement (Tamm & Jomm, 1949; Veski, Aarmann & Niine, 1959). The two most commonly discussed solutions incorporated sawdust and slag (Veski, 1969). The saw-dust variation (termoliit), was mixed with 1:10 powdered lime, which would allow the saw-dust to harden into a solid, yet aerated and effective layer of insulation. The slag variation was either simply oil-shale or coal slag used as infill, which was not recommended, or mixed into a concrete using cement (Jomm & Tamm, 1949). Out of the two, the saw-dust infill was by far more favorably recommended and by 1959, the usage of slag as anything other than a complementary layer to saw-dust was frowned upon (Veski, Aarmann & Niine, 1959).

Originally, the main available insulation panels were roliit and TEP. Roliit was manufactured out of reed, which was compressed and sewed together into a panel using special machinery. TEP was manufactured out of wood-chips mixed with cement to produce a hard panel. By 1959, wood-fibre boards and mineral wool had also become available, although mineral wool seems to have been used primarily in its non-compressed loose form rather than mats or panels (Veski, Aarmann & Niine, 1959; Veski 1969).

4.2.4 Insulated brick structures

Insulated brick structures, a combination of brick and insulation, occasionally incorporating light wood frames, are presented as common in construction handbooks (Tamm & Jomm, 1949; Veski, Aarmann & Niine, 1959; Veski, 1969; Masso, 1990). Structures incorporating only brick and insulation came in three main variations, titled as *Gerard*, *Nopsa* and *Rolok* walls depending on the technique with which the bricks were laid (Figure 4.53). Brick structures combining insulation with light wood frames came in two main variations, titled as *Harju* and *Nõmme* walls depending on whether the layer of bricks had extra pilasters within the structure or not (Figure 4.54). The standard dimension for a *Gerard* wall is 510 mm and *Nopsa* and *Rolok* walls are recommended to be approximately 430 mm. *Harju* walls are 380 mm and *Nõmme* walls are either 300 mm or 350 mm depending whether the bricks are laid flat or on their side.

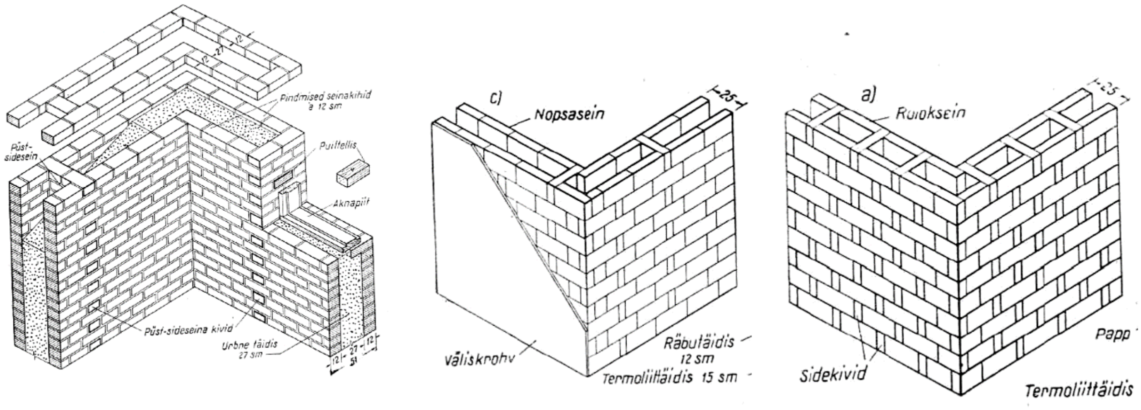


Figure 4.53 *Examples of insulated brick structures incorporating exclusively brick and insulation (left to right: Gerard wall, Nopsa wall, Rolok wall) (Veski, 1969)*

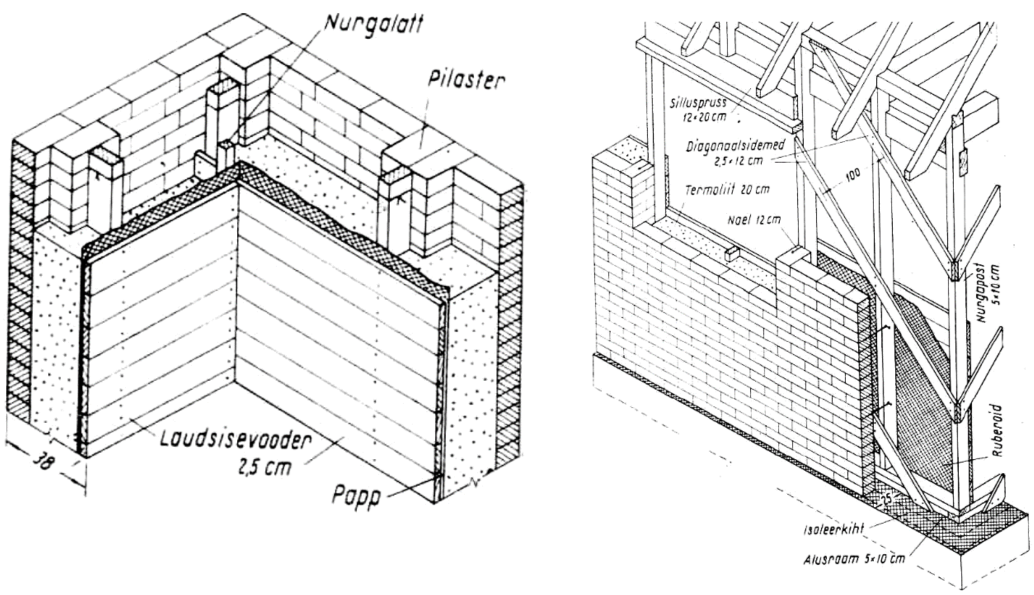


Figure 4.54 *Examples of insulated brick structures incorporating both brick and timber structures (left to right: Harju wall, Nõmme wall) (Veski, 1969)*

Harju, Rolok, Nopsa and *Gerard* walls are identifiable based on external visual examinations of their brick pattern, however Gerard (in certain variations) and Nõmme walls may not display any characteristic pattern, making them difficult to distinguish.

4.2.5 Concrete structures

Concrete outer wall structures existed in Estonia before World War 2 in the form of hollow blocks, however they are not mentioned in any other handbooks except

Jürgenson´s (Jürgenson, 1949). The first mention of concrete structures is in 1969, where two distinct forms are mentioned: saw-dust concrete and aerated concrete blocks. Saw-dust concrete was a combination of wood material, such as saw-dust or wood chips; mixed with cement. Aerated concrete blocks are briefly mentioned in 1969, however few examples are given (Veski, 1969). By 1990, two types of aerated concrete exist: oil shale ash concrete and silicalcite. The production of silicalcite in Estonia began in 1966 in Aravete (Leppik, 1980), while the production of oil shale ash concrete may have began in 1961 (Eesti Filmi Andmebaas, 1961). Blocks manufactured from these materials could be either compact, suitable for constructing by hand; or large, which required small cranes to lift them into place. Oil shale ash concrete was manufactured into both large and small blocks, while silicalcite came only in large blocks. These blocks came in a variety of dimensions, but their thickness was generally 300 mm, although smaller blocks could be installed as 200 mm as well. Insulation and exterior finishings were occasionally added to these concrete structures as well (Masso, 1990) (Figure 4.55).

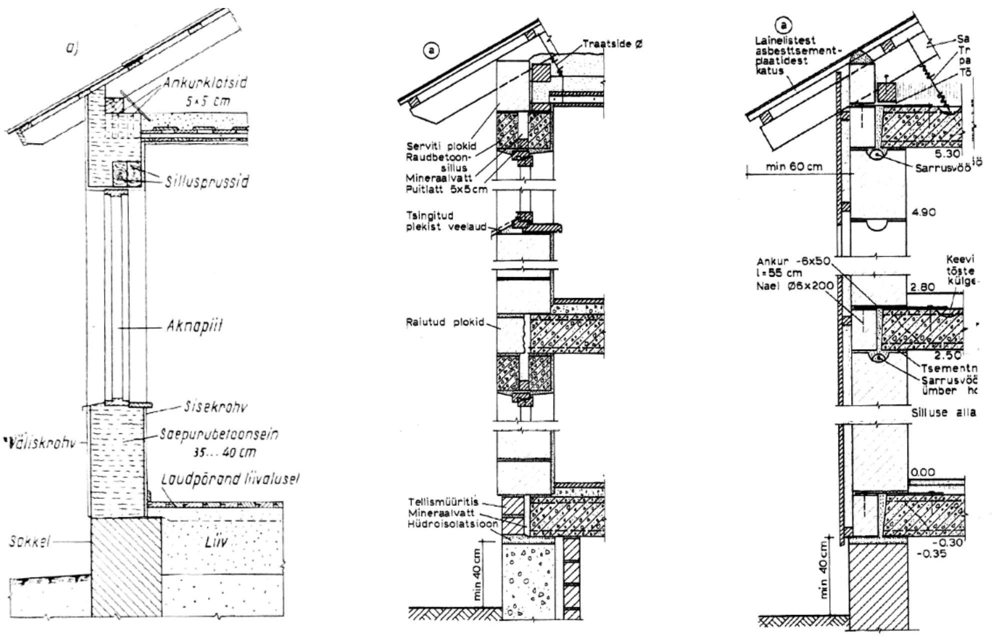


Figure 4.55 *Examples of concrete structures (left to right: saw-dust concrete wall (Veski, 1969), small aerated concrete block structure (Masso, 2022), large aerated concrete block structure (Masso, 2022))*

In conclusion, the variety of construction types in the soviet era remains within certain boundaries. Heavier timber structures are more characteristic for earlier decades, which begin to fade out in later construction handbooks. Light timber frames remain in use throughout the entire period. Insulated brick structures remain relevant in all handbooks, hinting at their potential dominance within soviet-era construction practice, until the introduction of aerated concrete structures. All structures are given comparatively standard thicknesses, meaning that by establishing a buildings construction type, a standard thickness and resulting U-value may be assumed.

4.3 Inventory of three small towns in Estonia

In order to study the representativeness of the typology structure, establish proportions of building types, their years of construction, as well as construction types, three towns in Estonia were inventoried and analyzed. All analyzed building addresses with corresponding archival source, established construction date and construction types are presented in Appendix 1.

4.3.1 Differentiating between soviet and non-soviet dwellings

All three chosen towns had been established as settlements before the soviet period (Leppik, 1999; Riisalo, 1966; Seeland, 1991), meaning that a number of detached houses were likely to be unsuitable for the current study. Dwellings built after the soviet era were also to be excluded. Differentiating between these different periods was done with the help of historical maps and aerial photographs using X-GIS software provided by Maa-amet (X-GIS [Core_aluskaardid]. n.d.). Streets that did not appear on maps from 1939 were assumed to be from the soviet period. Streets that had already been established by the end of the 1930's were carefully analyzed by comparing plot borders and locations of marked down building outlines with modern day maps to detect whether a building was from an earlier period or not. Estonian Building Register (Ehitisregister, n.d.) data was compared as well and buildings that were marked as having two or more apartments were excluded, as these did not fit the profile of single-family detached housing.

After all single-family detached dwellings likely built in the soviet era were identified, all dwellings within the sample were then classified based on the typology structure developed in this study using visual external evaluation using the Street View application on Google Maps (Google, n.d.) and recent angled aerial photographs provided by Maa-amet (X-GIS 2.0 [Core], n.d.). The addresses of these buildings were then used to access their respective archival Building Register files, however due to time constraints, a number of randomly selected files were left out of the study. A small number of older buildings, mischaracterized in this study as being from the soviet era were examined as well, yet their data was excluded from analysis.

4.3.2 Concerning data quality of archived Building Register files

Establishing a year of construction for soviet era dwellings is not an exact science, since the years for moving in and finishing construction may be different, as was typical for the period. Therefore the year of project approval was chosen to characterize each dwelling, which does not reflect when a building was finished, but does provide a reliable earliest possible date for each building and type. Information concerning construction type came in the form of original project documentation and inventory drawings done at a later stage. The original construction type could be extracted primarily from the headnote (*seletuskiri*), since floor plans provided little information concerning construction type other than wall thickness. Inventory drawings optimally contained both a construction type and wall thickness, however at times one or the other was missing. Mischaracterizations occurred as well, where the inventory describes a construction method that does not match with the building's externally identifiable construction type. This occurred several times between insulated brick walls (*Harju, Nopsa, Gerard, Nõmme)* and light timber frame structures with an external brick layer. For example, Põhja 4 (1971) in Karksi-Nuia was described as a *Harju* wall, yet the pattern of bricks did not confirm this. Uus 3 in Karksi-Nuia displayed an opposite occurrence, where inventory data described a *Nõmme* wall, yet the brick pattern was clearly done in the *Harju* manner. It can be therefore deduced that even inventory data may not be entirely accurate for analyzing construction types, but due to the lack of alternative data sources, such inaccuracies will need to be accepted.

In some cases a building may have already gone through a renovation or notable maintenance, making it impossible to verify the inventory data with visual evaluation, but if the inventory data had enough detail, the thickness, year and wall composition was still included into the study.

4.3.3 Building type proportions

All buildings were able to be categorized using the typology structure developed in this study and their statistical breakdown is presented in the following chapters.

Within the town of Väike-Maarja, 192 soviet-era individual dwellings were identified. It was found that dwellings utilizing stacked heated space were in the majority, forming approximately 60 % of all dwellings when compared to dwellings utilizing horizontally distributed heated space. The most common building type in Väike-Maarja was the traditional gable house type with 66 examples, forming 34 % of the sample. The second most common type was the bungalow due to the high number of *EKE* standard dwellings in the area, with altogether 49 examples and 26 %. These were followed by the vertically displaced dwelling with 24 buildings and 12 %, the box house with 22 buildings and

11%, the post-1980 gable house with 19 buildings and 10%, the partly two-floored dwelling with 10 examples and 5% and finally the raised bungalow with two examples and 1 % (Figure 4.56). The full timeline of dwellings with verified project approval years in the town are shown in Figure 4.57 (standard projects generally not included).

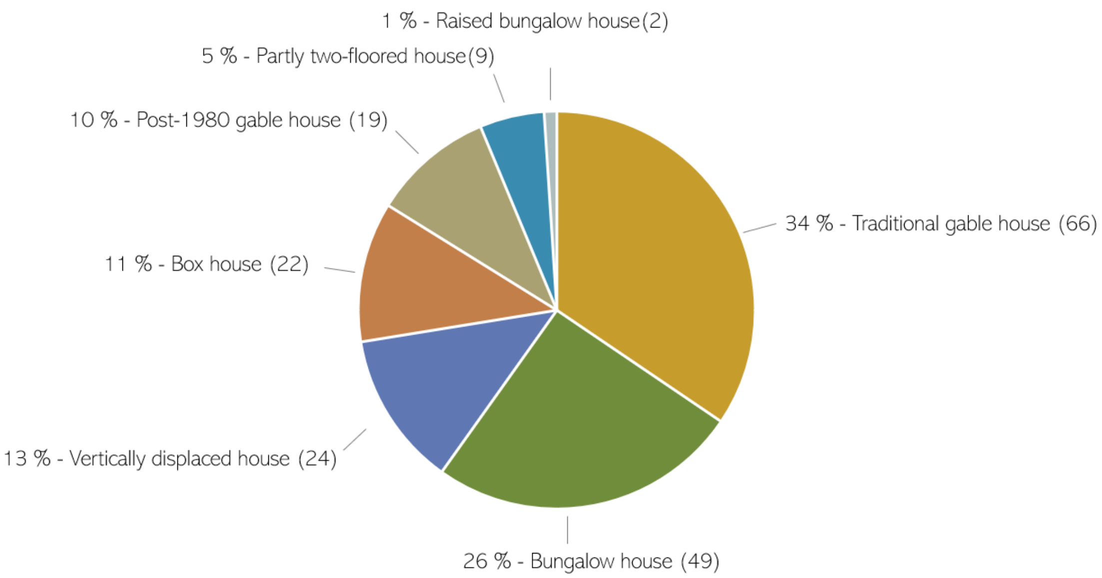


Figure 4.56 *Proportions of building types in Väike-Maarja*

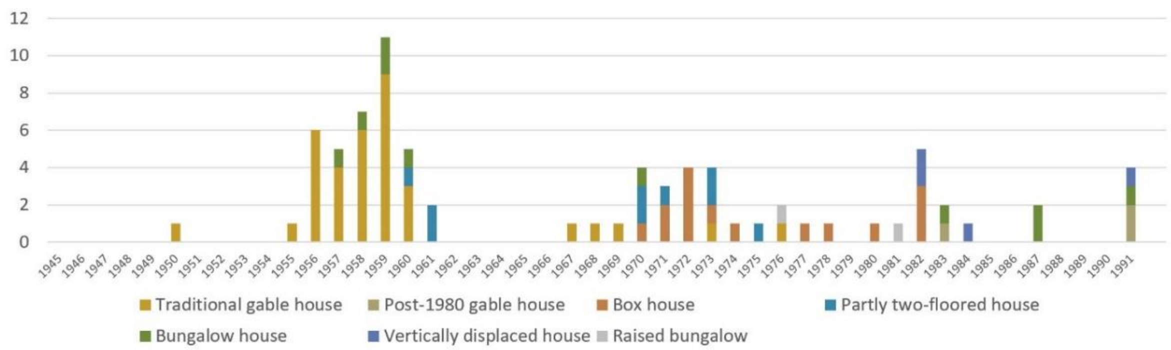


Figure 4.57 *Timeline of building types in Väike-Maarja*

Within the town of Karksi-Nuia, 173 soviet-era individual dwellings were identified. Most dwellings utilize stacked heated space, forming 74 % of the sample. Traditional gable houses are the most common, with 64 examples, forming 37 % of all studied buildings, followed by box houses with 42 examples, forming 24 %. The two less common dwellings under this subtype are the post-1980 gable dwelling, with 17 examples forming 10% and the partly two-floored dwelling, with only 5 examples and forming no more than 3%. The dwellings with horizontally divided heated space are made up of the the third most common dwelling type, which is the bungalow with 36 examples and 21%, and the vertically displaced dwelling with only 9 examples forming 5% of the town's soviet-era detached housing stock (Figure 4.58). The full timeline of dwellings with verified project approval years in the town are shown in Figure 4.59, although standard projects are not included in the timeline due to low data quality and scope limitations.

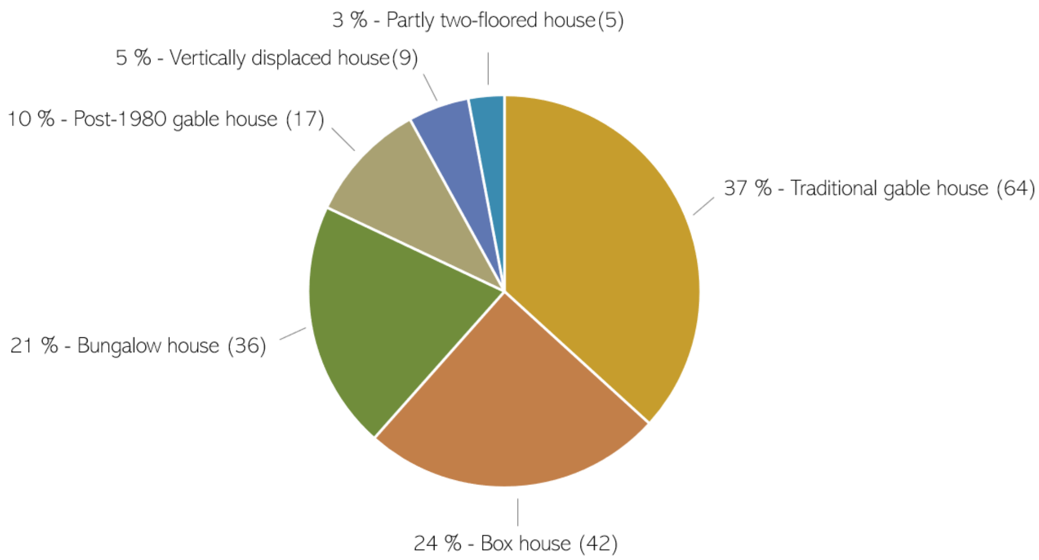


Figure 4.58 *Proportions of building types in Karksi-Nuia*

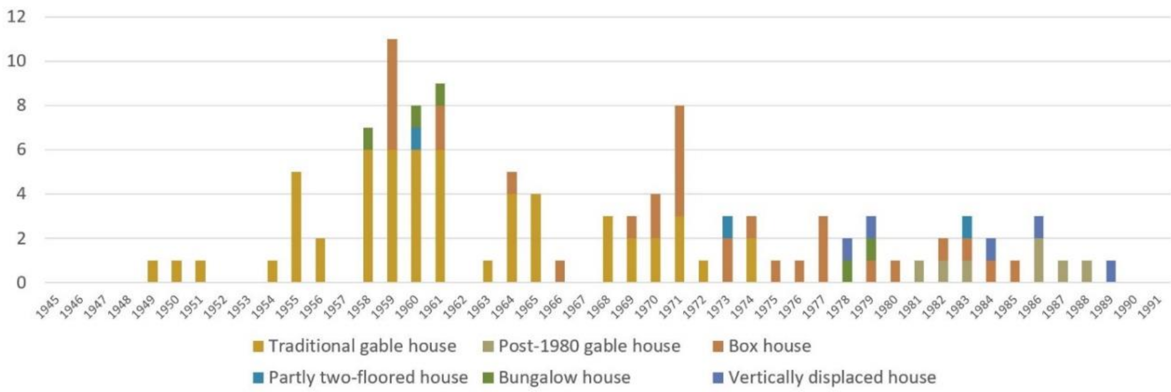


Figure 4.59 *Timeline of building types in Karksi-Nuia*

Within the town of Pärnu-Jaagupi, 130 soviet residential dwellings were identified. The most common form of heated space distributions was once again found to be stacking, forming 76 % of the sample of buildings. Traditional gable houses were in the overwhelming majority, with 82 examples, forming 63 % of all studied buildings. The second most common building type was the vertically displaced dwelling, with 19 examples forming 15 %, although 10 of these are identical standard rural dwellings.

These were then followed by the bungalow, with 12 examples forming 9 % and the box house, with 12 examples forming 9 %. The less common building types were the partly two-floored dwelling with three examples, and the post-1980 gable dwelling with two examples, each forming 2 % within the sample. The least common building type was the raised bungalow, with a single example, forming 1% of the sample (Figure 4.60). The full timeline of dwellings with verified project approval years in the town are shown in Figure 4.61 (standard projects generally not included).

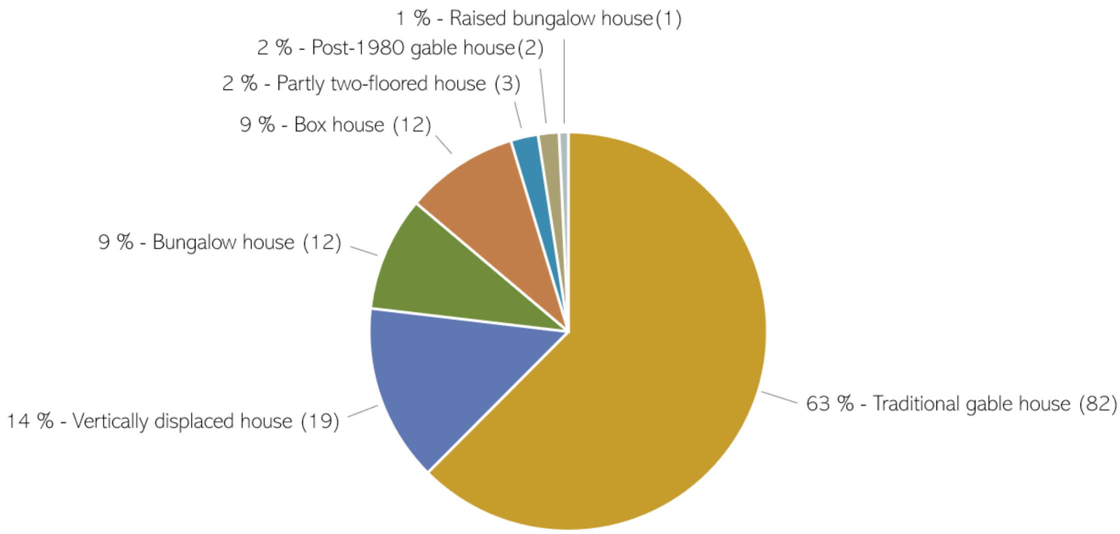


Figure 4.60 *Proportions of building types in Pärnu-Jaagupi*

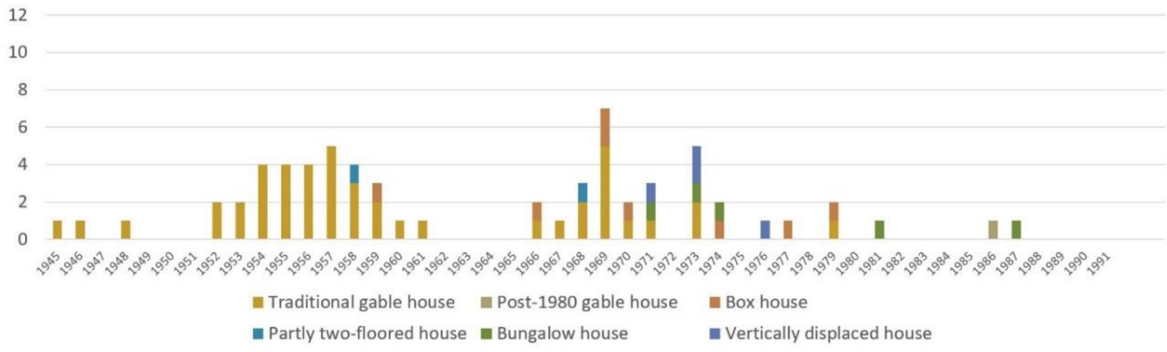


Figure 4.61 *Timeline of building types in Pärnu-Jaagupi*

In conclusion, it is clear that the traditional gable house building type can be titled as the most prevalent building type across all three towns. The second and third most common type was more commonly a combination of the box house, the bungalow or the vertically displaced dwelling (Figure 4.62). All in all, it can be stated that vertically stacked heated volumes are generally more common for Estonia, as across all three towns the proportion was between 61 % and 76 %. Partly two-floor dwellings were found to be in the absolute minority across all three analyzed towns. As these results were collected from three different counties in Estonia, the dominance of the traditional gable house type may be potentially aggregated to the national level. The same may be hypothesized concerning the low prevalence of the partially two-floored house and the raised bungalow house.

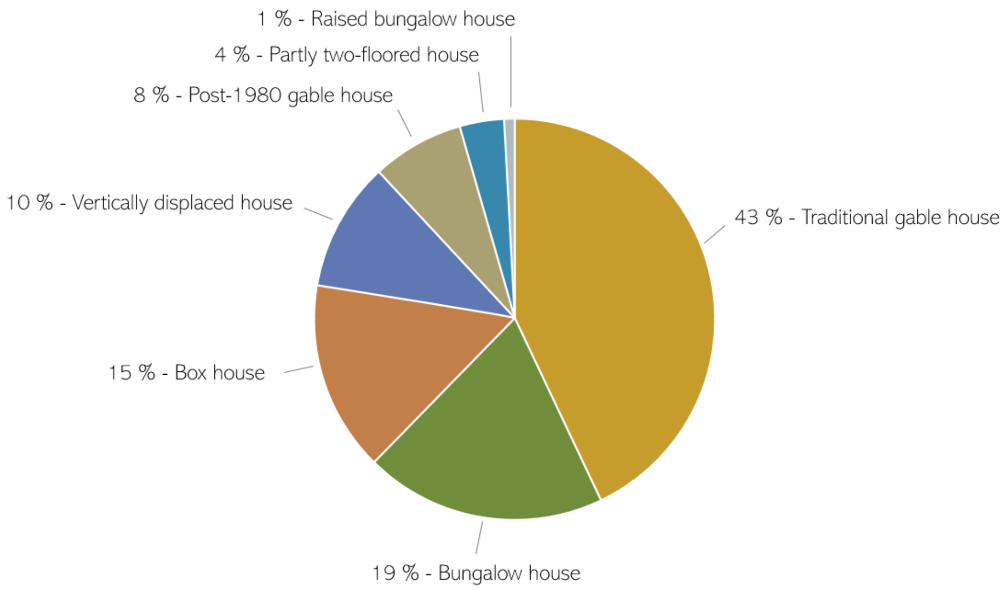


Figure 4.62 *Total proportions of building types across all three towns*

4.3.4 The traditional gable house

The earliest example of the gable house was found in Pärnu-Jaagupi (Kalli mnt 21) with a project approval year of 1946. While earlier examples appear as well, the main period of construction takes place during the second half of the 1950's across all three towns. Following the turn of the decade however, the numbers of approved projects decline rapidly in Väike-Maarja and Pärnu-Jaagupi by the early 1960's. During the second half of the 1960's and the early 1970's, the building type has a slight revival in Pärnu-Jaagupi, however by the mid-1970's, the building type seems to fade away (Figure 4.63). The singular exception to this trend is one example in 1979 (Lepa 5), which was found to be an old project originally approved decades earlier, yet modified and constructed during the early 1980's. In Väike-Maarja there is a slight revival of the building type as well, although considerably more modest and here too the building type seems to disappear during the second half of the 1970's. In Karksi-Nuia projects continue to be approved at a relatively steady pace following the highpoint of the late 1950's, although a downward trend is clearly noticeable and the final projects to be approved are from 1974. This was well illustrated in the file of Lepiku 7, where the owner was submitting a gable house project from 1958 (E-8) and received feedback from the local government that using such an outdated design in 1971 was not recommended. Therefore, all three towns show that the traditional gable house was most popular during the late 1950’s and early 1960’s, after which this building type begins to fade away and becomes completely obsolete among individual builders by the second half of the 1970’s.

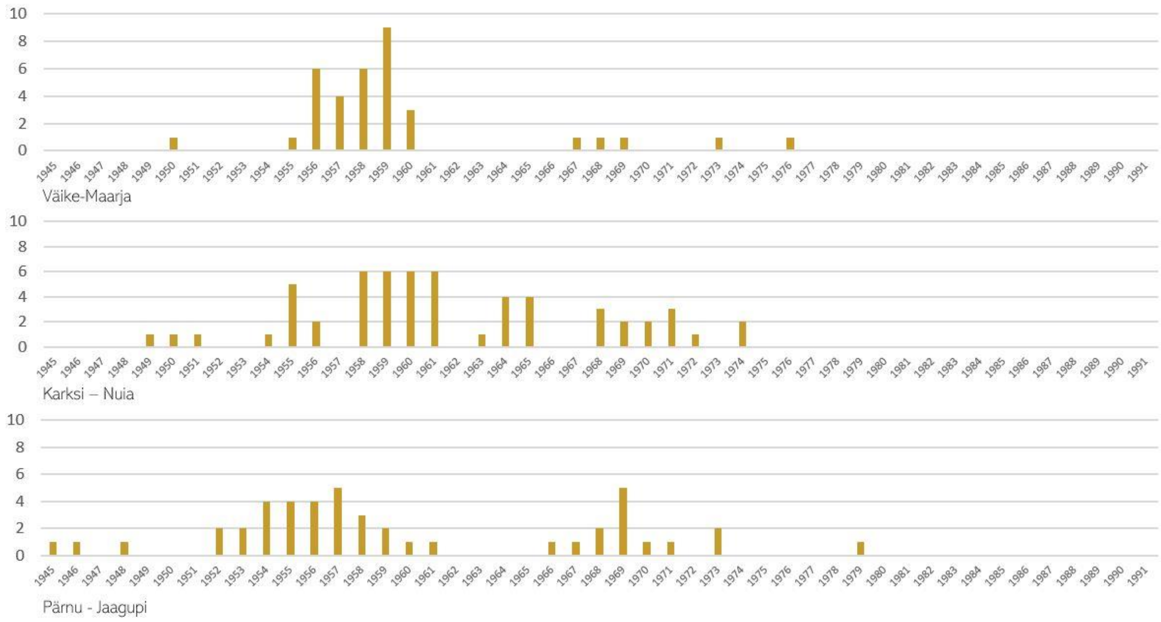


Figure 4.63 *Traditional gable house project approval years*

Characteristics of all traditional gable roof dwellings were found to generally match the profile established within evaluation of standard and recommended project albums. A number of standardized projects were found. In Karksi-Nuia, the E-25 (Aia 8, 1961), the E-11 (Kaare 4, 1960; Nurme 1, 1965; Piiri 7, 1963), the E-8 (Lepiku 7, 1971; Piiri 5, 1964; Piiri 9, 1964) and the E-6 (Piiri 1, 1960) are established examples of E-series projects. Within Pärnu-Jaagupi, examples from the four-part album published by “Estonprojekt” can be found, like number 38 (Kalli 15, 1969), number 23 (Kergu 18, 1958), number 46 (Männi 16, 1957) and number 52 (Männi 18, 1958). Väike-Maarja has examples of from both projects series, like number 45 (Aia 26, 1958), number 38 (Energia 10, 1958), number 46 (Energia 14, 1958; Põhja 9, 1959; Uus 8, 1959), number 22 (Koidu 1, 1959; Uus 11, 1960), the E-8 (Uus 22, 1959) and the E-6 (Uus 24, 1959).

Ground floors contain two to three rooms, a kitchen with pantry, an entry hall with WC, staircase and occasionally a bathroom. New three-room layout variations previously unidentified within the standard and recommended project albums were discovered as well, as demonstrated in Figure 4.64. These projects contain the original four-quarter layout, with the exception that the hall and storage function has been moved into a separate added part of the layout, leaving space for three entitre rooms and the kitchen.

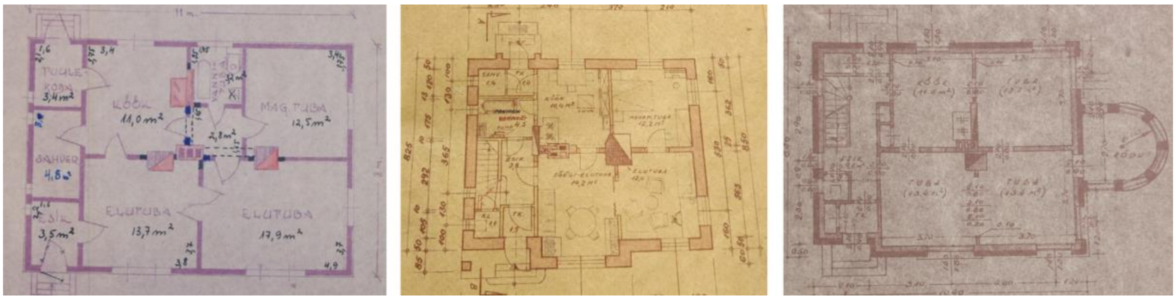


Figure 4.64 *Examples of four-guarter three-room layouts (left to right: Vana-Kergu mnt 8 (1952) in Pärnu-Jaagupi; Loode 9 (1958) in Karksi-Nuia; Nurme 1 (1956) in Väike-Maarja)*

Some minor alterations had been done to ground floor layouts when comparing original projects to inventory drawings, but generally their layouts remained largely the same. Attic floors, usually containing one to two rooms, had often been altered when comparing original projects to inventory drawings. In some cases only a couple walls may have been moved, in other cases the entire layout was unrecognizable or left completely empty. Therefore the layouts of attic floors are not predictable. This may also affect whether the upper floor was heated or not, as there were some cases where the attic floor stoves had not been installed (Figure 4.65).

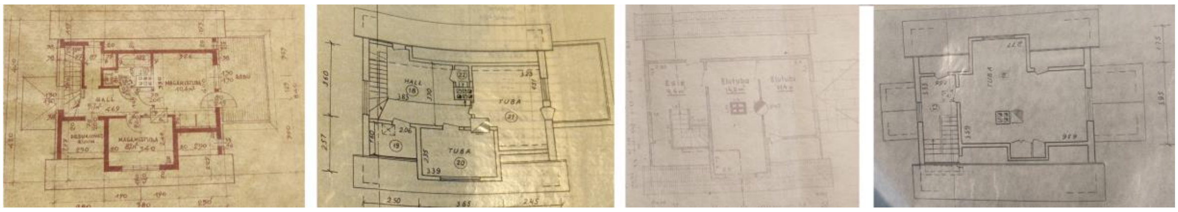


Figure 4.65 *Examples of alterations done to attic spaces (left to right: project and inventory of J. Kivistiku 7 (1965), and project and inventory of Uus 7 (1956) in Karksi-Nuia)*

Among roof shapes, the traditional gable form with dormers was confirmed to be the most common, although some exceptions were found as well. Uus 3 (1955), Tartu mnt 9 (1955), Piiri 2 (unknown year) in Karksi-Nuia and Põhja 2 in Pärnu-Jaagupi all feature additional gable walls. Piiri 2 in Karksi-Nuia is another exception with an almost pyramid-shaped hip roof with an attic floor underneath. J. Liivi 12 (1955) in Väike-Maarja is a single example of a mansard roof (Figure 4.66).

Figure 4.66 *Examples of alternative roof shapes (left to right: Põhja 2 (1955) in Pärnu-Jaagupi, Piiri 2 (unknown year) in Karksi-Nuia and J. Liivi 12 (1955) on Väike-Maarja)*

A certain number of buildings did not match the developed profile of a high-pitched gable house in terms of size. Three categories can be highlighted: larger, more extravagant dwellings (1), more modest dwellings (2) and dwellings with an alternative layout composition (3); when compared to the common form of a traditional gable house. The first category can be illustrated by two examples in Karksi-Nuia: Eha 2 (1955) and Uus 1 (1955); however these dwellings are not common (Figure 4.67).

Figure 4.67 *Examples of more extravagant dwellings in Karksi-Nuia (left to right: Eha 2 (1955), Uus 1 (1955))*

The second category can be illustrated by two examples as well, Uus 17 in Väike-Maarja (1957) and Pargi 3 in Pärnu-Jaagupi (1969) (Figure 4.68). These dwellings mirror even more archaic roots in their layouts than the main gable roofed dwelling, yet no other examples of these were found and therefore cannot be regarded as popular.

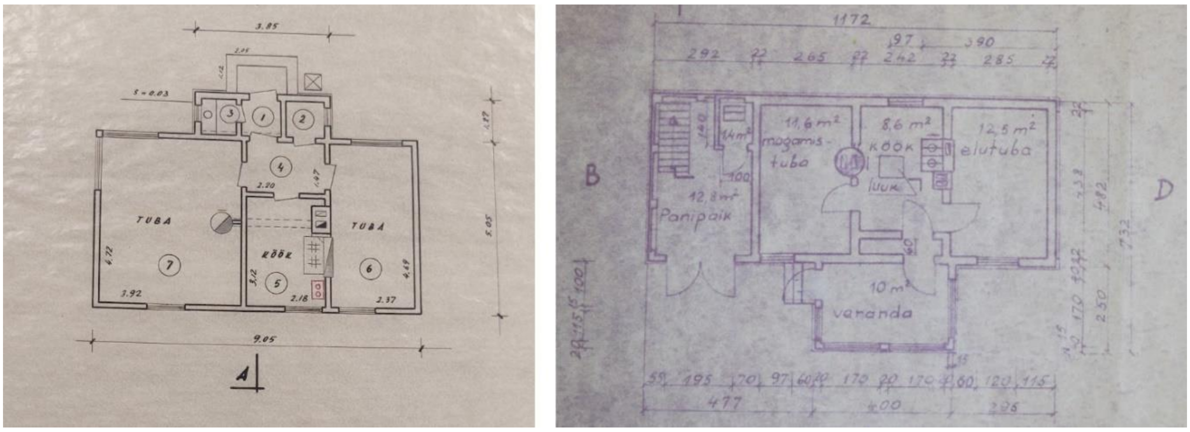


Figure 4.68 *Examples of more modest dwellings (left to right: Uus 17 (1957), Pargi 3 (1969) in Pärnu-Jaagupi)*

The third category can be illustrated with examples from all three towns. In terms of layout and footprint composition, a number of identical, yet unique projects were located. In Karksi-Nuia, Tartu mnt 15 (1950), Tartu mnt 47 (1960) and Umb 1 (1959) all display a similar layout, hinting at a regional characteristic (Figure 4.69). Another exemplary occurrence is that of placing the traditional gable house on top of a hillside, as can be seen in the case of Loode 5 (1970) and Loode 7 (1974) in Karksi-Nuia, utilizing a full height cellar floor and creating an almost two-floored appearance (Figure 4.70).

Figure 4.69 *Examples of a potentially regional characteristic in Karksi-Nuia (left to right: Tartu mnt 15 (1950) and Tartu mnt 47 (1960))*

Figure 4.70 *Examples of a raised cellar in Karksi-Nuia (left to right: Loode 5 (1970), Loode 7 (1974))*

Auxiliary wing designs occured in Karksi-Nuia (Aia 7 (1961), Piiri 7 (1963), Nurme 1 (1965), Piiri 9a (1965), Loode 7 (1974), Lepiku 5 (1968)) and Pärnu Jaagupi (Männi 4 (1967), Männi 6 (1966), Männi 12 (1968), Kergu mnt 36 (1973), Kalli mnt 11 (1969)) (Figure 4.71). Few auxiliary wings were noticed in Väike-Maarja among this building type, however. One archaic variation was found in Kergu 22 (1961) in Pärnu-Jaagupi, where large storage spaces formed a full-height extension to the main dwelling, somewhat echoing estonian barn-dwelling architecture.

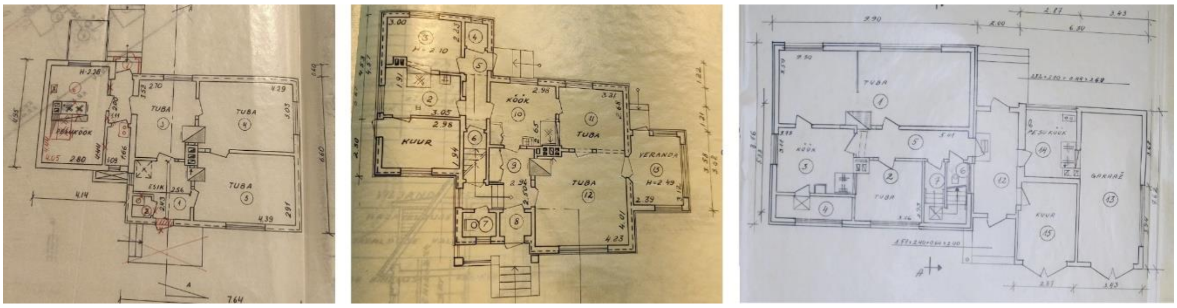


Figure 4.71 *Examples of auxiliary wing layouts (left to right: Aia 7 (1959) and Piiri 7 (1963) in Karksi-Nuia and Männi 4 (1967) Pärnu-Jaagupi)*

In terms of alterations done to original designs, numerous trends can be highlighted. Minor changes include sealing up the street-side entrance, potentially due to lack of use. More drastic changes were likely related to lack of space, facilitating the need for extensions and new wings. Builders have added garages (Väike-Maarja: Põhja 7, 1950), wings containing saunas (Pärnu-Jaagupi: Kergu 102 (1955), Pargi 1 (1956); Karksi-Nuia: Tartu mnt 15 (1950)) or entire extensions (Väike-Maarja: Aia 22, Põllu 2 (1956); Karksi-Nuia: Uus 13 (1968)) (Figure 4.72). Examples of reconstructing the attic floor into full upper floors was found as well. In the case of Aia 28 in Väike-Maarja, the attic floor has been built into a partial full upper floor. Tartu mnt 16 in Karksi-Nuia is a rare example of a traditional gable house becoming a box house.

Figure 4.72 *Examples of auxiliary wings or extentions added later (left to right: Põhja 7 (1957), Aia 22 (unknown year) and Põllu 2 (1956) in Väike-Maarja)*

In conclusion, the original compact footprint characteristic for this building type may have been lost through reconstructions or alterations, making it more difficult to recognize. Lack of space can be seen as a persistent issue, as there are examples of residents adding auxiliary spaces. Layouts of attic spaces may be difficult to predict as well, as inventory drawings show that these might have been built out either entirely, partly, or left completely without any interior walls.

4.3.5 The post-1980 gable house

The earliest example of the post 1980 gable house can be found in Karksi-Nuia in 1981 and these dwellings continue to be approved until the very end of the soviet era. The presented timelines (Figure 4.73) do not take into account the high number of gable-roofed standard dwellings found in Väike-Maarja and Karksi-Nuia, as their years of project approval were not studied due to the limited scope of this study. These standard projects came in seven variations: the *Ants*, the *Tõnu*, the *Villi*, the *Talu*, the 4-06-81 and two unidentified standard projects used 13 times in Karksi-Nuia (Figure 4.74). Pärnu-Jaagupi did not have a single standard gable house.

Figure 4.73 *Post-1980 gable house project approval years*

These standard dwellings to not display any noticeable changes to their established profile. Their roof shapes remain simple with occasional dormers. Footprints remain simple as well, although their ground floor and attic floor layouts are generally diverse and difficult to categorize thanks to central heating not restricting the placement of heated spaces. Cellars and plinths remain tall, requiring external staircases to access the ground floor. They also occasionally feature distinct auxiliary wings.

Figure 4.74 *Examples of standard post-1980 gable houses (left to right: Loode 3 (4-06-81, 1989), Piiri 21 (unknown project, 1991) in Karksi-Nuia; and Kolde 9 (Ants, unknown year), Nurme 5 (Villi-6, 1991) in Väike-Maarja)*

Individually designed post-1980 gable dwellings are more rare, as only six examples can be highlighted across the three towns (Figure 4.75). Their footprints are diverse and layouts are even more difficult to define than standardized gable designs. Defining a clear division of heated and unheated space within the dwelling is a challenge, as functions begin to become intertwined within the envelope. For example Lõuna 8 (1986) and and Lõuna 6 (1986) both have large auxiliary wings, yet only the lower level has a utility function, with the upper level containing bedrooms. Roof shapes are diverse as well, featuring a number of different footprint compositions, as well as dormers, gable walls, windows, etc. Cellars and plinths remain tall, requiring external stairwells to access the ground floor.

Figure 4.75 *Examples of individual post-1980 gable houses (left to right: Lõuna 8 (1986), Lõuna 6 (1986) and Loode 15a (1987) in Karksi-Nuia; and Põllu 3 (1992) in Väike-Maarja)*

This building type generally do not display any additions to massing as they were already designed during a time of more relaxed size limitations and plenty of auxiliary space.

4.3.6 The box house

The earliest box houses appear in both Karksi-Nuia and Pärnu-Jaagupi in 1959, a couple years after the publication of the first box house designs among standard projects in the 1956 album (RPI Estongiprogorstroi, 1956). The building type doesn´t appear in Väike-Maarja however, until 1970. The last examples of the box house appear around the beginning or the second half of the 1980’s (Figure 4.76).

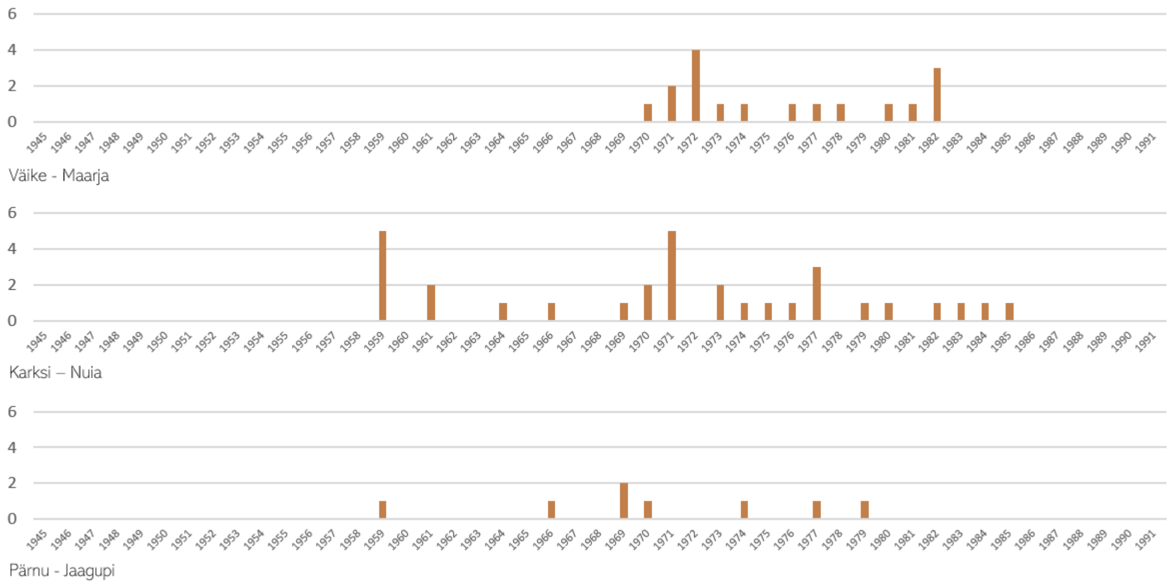


Figure 4.76 *Box house project approval years*

As was concluded from the album analysis, the box house can be viewed as a diverse and versatile building type that was re-imagined to display any architectural trend during the soviet period. The first box houses appear in Karksi-Nuia during the late 1950's, and generally follow the architectural characteristics established for the period, with low hip roofs and auxiliary wings containing garages. Ground floors generally have two rooms (which may have been joined into a single room at later stages), a kitchen and stair hall with WC; arranged in a roughly four-quarter division around a central chimney. Bathrooms appear occasionally as well. Upper floors have different combinations of three to two bedrooms, bathroom, stair hall and attic or laundry drying room. Examples of earlier standard projects were noticed as well, like the E-17 (Uus 16 (unknown year) in Pärnu-Jaagupi) and E-19 (Kesk 3 (unknown year) in Väike-Maarja) (Figure 4.77).

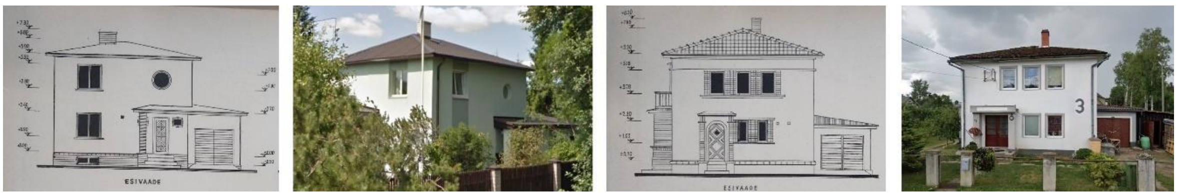


Figure 4.777 *Examples of implemented early standard projects (left to right: project E-17, Uus 16 in Pärnu-Jaagupi, project E-19, Kesk 3 in Väike-Maarja)*

By 1960 however, the first signs of modernization can be seen, with a new low-pitched gable roof and updated facade compositions featuring a vertical negative space in one corner for an upper floor balcony. Ground and upper floor layouts remain mostly the same as before, as does the heating system. Auxiliary wings begin to receive an unheated upper floor, commonly titled as the laundry drying room (Figures 4.78 & 4.79).

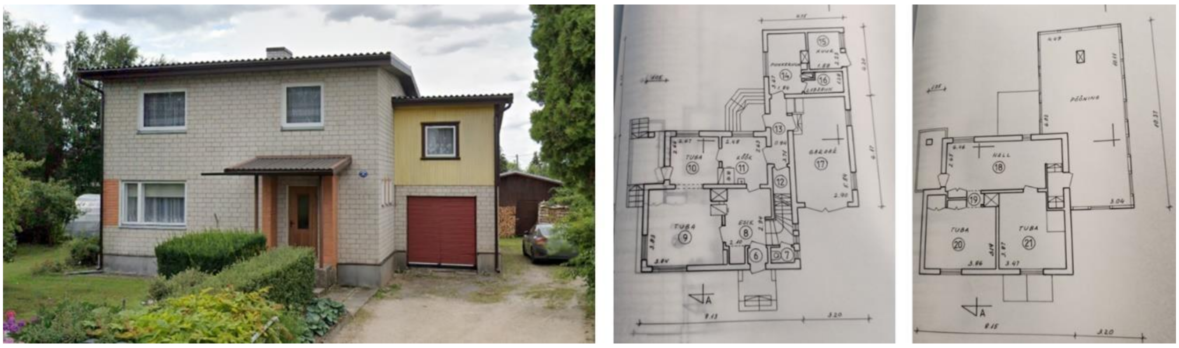


Figure 4.78 *Rahumäe 8a (1964), an example of a 1960´s box house with taller auxiliary wing in Karksi-Nuia (left to right: view, ground floor layout, upper floor layout)*

Figure 4.79 *Examples of auxiliary wings with upper attic floors (left to right: Nurme 10 (1971) and Lõuna 17 (unknown year) in Karksi-Nuia and Lõuna põik 3 (1978) in Väike-Maarja)*

By the early 1970´s, some changes begin to take place. Central heating begins to overtake stove heating during the first half of the 1970's, although this does not seem to affect the division of space for quite some time. The previous architectural trends continue to be more predominant, yet some examples do exhibit trends characteristic to the 1970's. These examples include Ülase 6 (1975), Kergu 23 (1970) and Ülase 2 in Pärnu-Jaagupi, as well as Lõuna põik 3 (1978) and Energia 29 (1980) in Väike-Maarja (Figure 4.80).

Figure 4.80 *Examples of 1970´s box houses (left to right: Ülase 6 (1975), Kergu mnt 23 (1970) in Pärnu-Jaagupi and Energia 29 (1980) in Väike-Maarja)*

All previously mentioned dwellings are examples of a more monumental design with false flat roofs, where parapets conceal the real, low gabled or a one-sided slope roof. Numerous standard projects from the 1976 album were found as well, like the 85-74 (Lepiku 21 in Karksi-Nuia; Metsa 10 and Energia 15 in Väike-Maarja), the 91-74 (Lõuna põik 6 in Väike-Maarja; Lõuna 33, Uus 4, and Uus 10 in Karksi-Nuia), the IE-3 (Lõuna 9 in Karksi-Nuia) and the 5-06-81 (Energia 13 in Väike-Maarja) (Figure 4.81). These standard project designs, originally with flat roofs, have been modified with low roofs as well, either behind parapets or with gable-roofs simply placed on top (Lepiku 21).

Figure 4.81 *Examples of standard dwellings (left to right: Metsa 10 (unknown year), Lõuna põik 6 (unknown year), Energia 13 (unknown year) in Väike-Maarja)*

Projects from the 1980's generally continue the modern architectural trends established during previous periods in the 1960's and 1970's. As this was a period of more relaxed size regulations, some dwellings begin to noticeably grow in size and layout. Roof shapes are generally low gable roofs, except for a single example in Karksi-Nuia, where Lõuna 23 (K. Voolaid, 1979) displays a new type of undefinable roof shape (Figure 4.82).

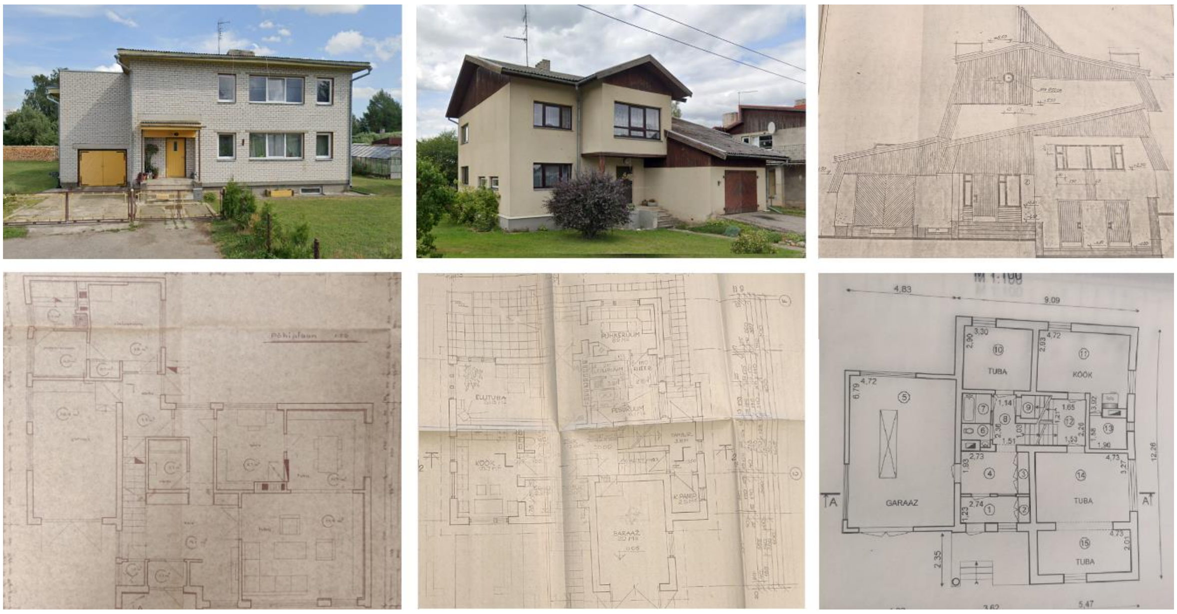


Figure 4.82 *Examples of box houses from 1980´s (left to right: Lõuna 7 (1982) in Väike-Maarja; and Rahumäe 16 (1984), Lõuna 23 (1986) in Karksi-Nuia)*

As was established with album analysis, the number of rooms on the ground floor dictated how many rooms could fit onto the upper floor without breaking dwelling size restrictions. In the case of Soo 3 (1972) in Väike-Maarja, the ground floor was designed with three rooms in addition to the kitchen, leaving only two rooms that could be built on the upper floor, leaving the rest of the space as attic and storage rooms. The fate of these spaces today is unknown, whether they have remained as attics or have been built out into bedrooms or other living spaces (Figure 4.83).

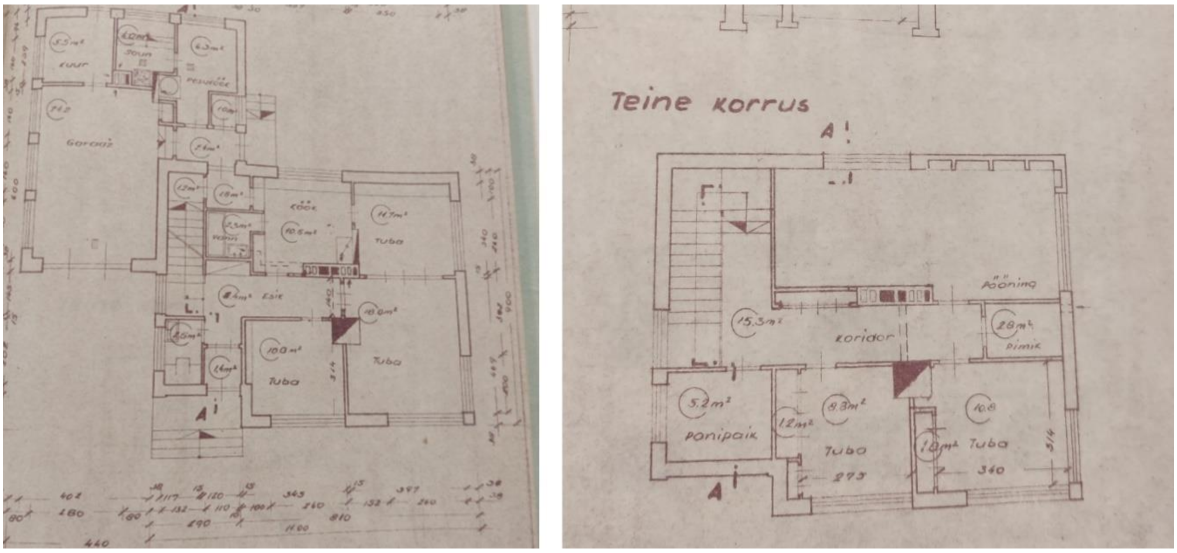


Figure 4.83 *Example of a large attic space on the upper floor in Soo 3 (1972) in Väike-Maarja (left to right: ground floor, upper floor)*

Upper floor space was also reduced by utilizing unheated verandahs, like in the case of Energia 5 (1972) in Väike-Maarja (Figure 4.84).

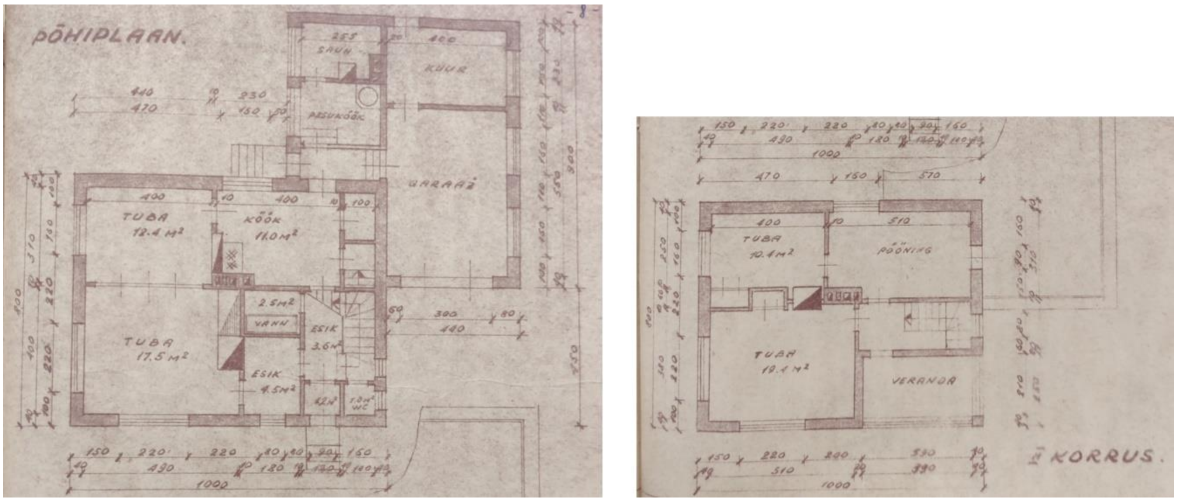


Figure 4.84 *Example of an upper floor verandah within the building volume in Energia 5 (1972) in Väike-Maarja (left to right: ground floor, upper floor)*

In the case of Põhja 2 (1971) in Karksi-Nuia, the upper floor seemed to have been converted into a separate apartment as there is a separate kitchen space on this floor that is not present in the original floor plan. Some builders had left the upper floor noticeably different in terms of layout as well. For example, Aia 10a (1972) in Väike-Maarja and Nurme 10 (1971) in Karksi-Nuia display a simplified version of the original project with auxiliary storage spaces left unbuilt (Figure 4.85).

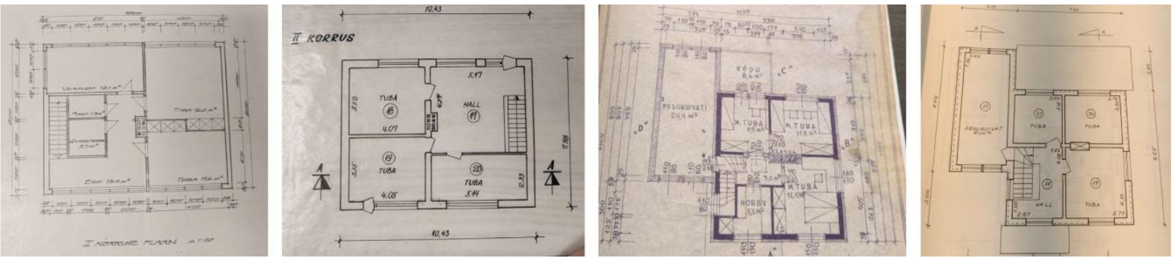


Figure 4.85 *Examples of alterations in upper floor layouts (left to right: Aia 10a (1972) in Väike-Maarja, original project and inventory drawing; Nurme 10 (1972) in Karksi-Nuia, original project and inventory drawing)*

In the case of Eha 1 (1971) in Karksi-Nuia, a more dramatic contradiction can be seen, where the entire upper floor entirely ignores the original floor plan. Instead, a basic division of two bedrooms and large hall space is created. In the case of Lõuna 5 (1971) in Väike-Maarja, the builder has decided to ignore a terrace or roof that had been designed in the original project, preferring to finish the area as a living space (Figure 4.86).

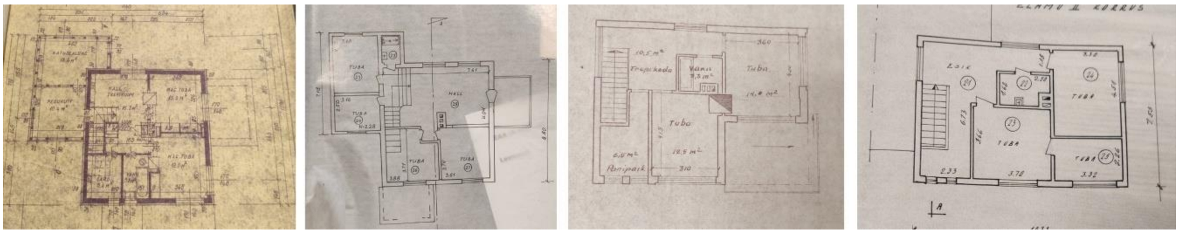


Figure 4.86 *Examples of alterations in upper floor layouts (left to right: Eha 1 (1971) in Karksi-Nuia, original project and inventory drawing; Lõuna 5 (1971) in Väike-Maarja, original project and inventory drawing)*

In some cases, these dwellings have been expanded at later stages, technically creating other building subtypes. Two examples can be highlighted in Pärnu-Jaagupi. Kergu 19 (1974) is an example of constructing living spaces above the garage, unified under a single roof. This can be regarded as a newer subtype of the box house, which is elaborated in the next chapter. Kergu 21 (1968) displays an earlier box house with an entire wing containing a new living room added at a later stage, technically creating a partially two-floored dwelling (Figure 4.87).

Figure 4.87 *Examples of alterations affecting the placement of heated space (left to right: Kergu 19 (1974) and Kergu 21 (1968) in Pärnu-Jaagupi)*

In conclusion, the box house with auxiliary wing is a generally optimally-sized dwelling, as few alterations were noticeable. Their ground floor layouts generally contain the same selection of rooms in different variations depending on the heating system. Their upper floors are considerably more varied, not only due to the original projects but due to alterations and peculiar solutions as well. The variety of architectural style and facade elements is varied.

4.3.7 The box house subtype with expanded upper floor

A previously unknown distribution of heated space was identified in Karksi-Nuia and Väike-Maarja: the box house with full-height heated space above the garage. As a new subtype of stacked heated space, this variation can be characterized as a further development of the box house. While the previously established box house type had no heated space constructed above the auxiliary wing, this subtype has fully incorporated the space above the garage into its composition, sharing a roof. Examples of this building type were found mainly in Karksi-Nuia (Lepiku 15 (1980), Lepiku 17 (unknown year), Lepiku 19 (unknown year) and Tartu mnt 44 (1984)), with one example from Väike-Maarja (Lõuna põik 10 (1982)) (Figure 4.88).

Figure 4.88 *Examples of box houses with heated space above garages (left to right: Tartu mnt 44 (1984), Lepiku 17 (unknown year) in Karksi-Nuia; and Lõuna põik 10 (1982) in Väike-Maarja)*

4.3.8 The partly two-floored house

The dwelling with partly stacked heated space was among the least frequently occurring building types across all three towns. For this reason it is among the most difficult to study in terms of architecture due to the low number of examples found. The examples that were identified, however, display a wide variety of architectural style and composition. The earliest examples appear in all three during the late 1950’s or beginning of the 1960’s. The next main period is the first half of the 1970’s, with a single example from the 1980’s (Figure 4.89).

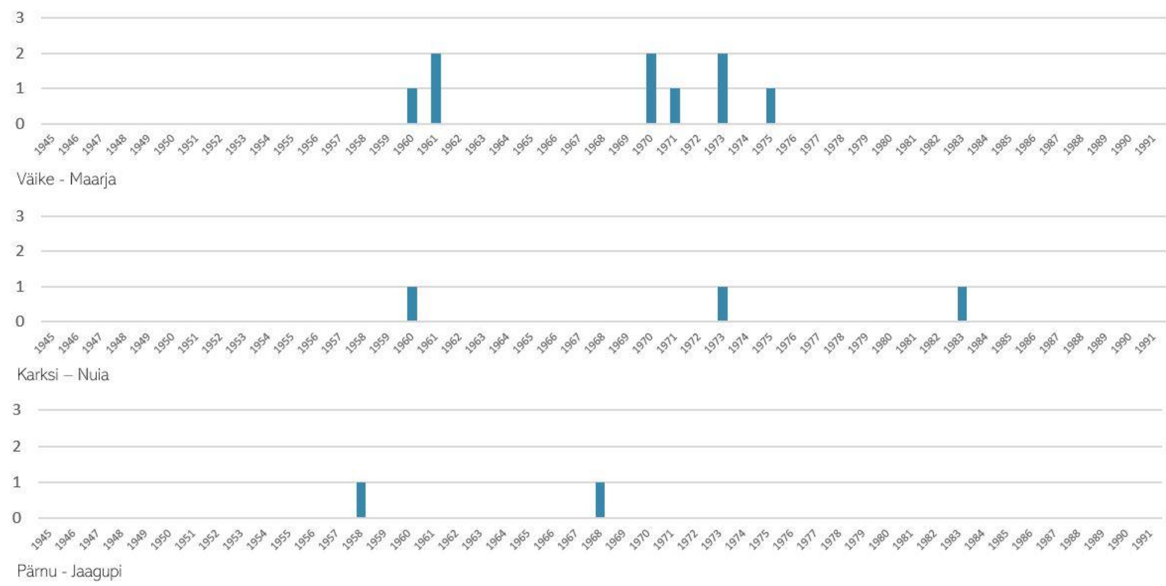


Figure 4.89 *Partly two-floored house project approval years*

In terms of composition, two variations can be highlighted in this period. The proportions between upper and lower floors may vary, creating a variety of volume compositions. The upper floor may be a distinctly smaller space containing a single room, for example Uus 12 (1960) in Väike-Maarja. The upper floor may also be about half the size of the ground floor, generally containing two rooms, for example Ravi 5 (1961), Uus 16 (1961) and Lõuna 3 (1970) in Väike-Maarja and Kooli 5 (1958) in Pärnu-Jaagupi (Figures 4.90 & 4.91).

The upper floor may also be three-quarters the size of the ground floor, as was the case with E-34 (Figure 4.18), for example Lõuna põik 4 (1973) in Väike-Maarja (Figure 4.92). The final option is an almost full upper floor with the exception of a couple heated spaces on the ground floor, also seen in project 67 from the 1965 album, for example Kalda 1-a in Karksi-Nuia (1972) (Figure 4.93).

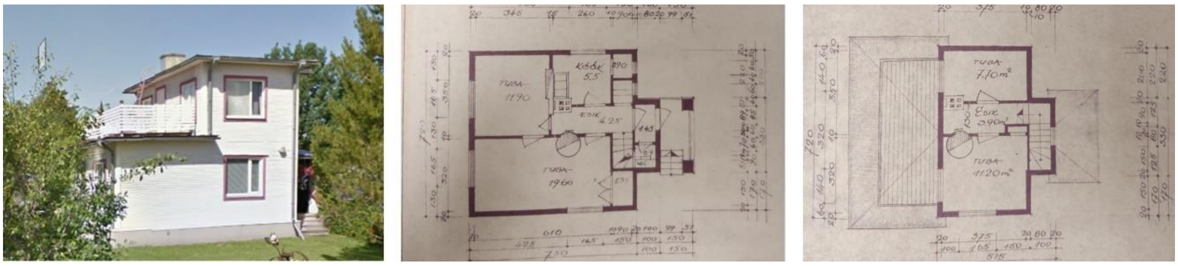


Figure 4.90 *Uus 16 (1961) in Väike-Maarja (left to right: view, ground floor layout and upper floor layout)*

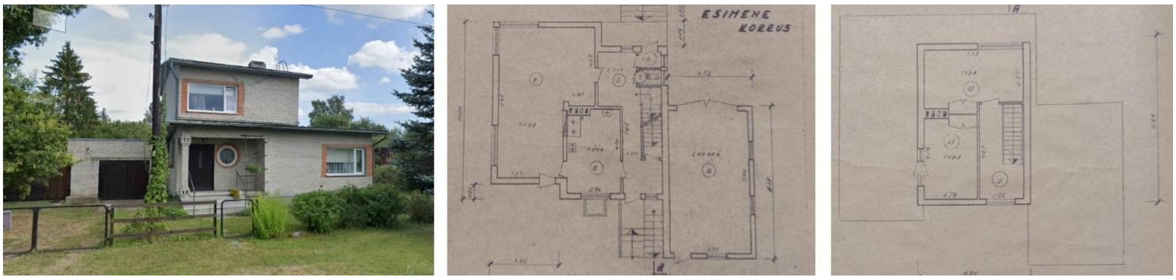


Figure 4.91 *Lõuna 3 (1970) in Väike-Maarja (left to right: view, ground floor layout and upper floor layout)*

Footprints of these dwellings can be either simple or complex, depending on the placement and size of the upper floor. Auxiliary wings may exist as well, adding to the general complexity of the composition. Roof shapes remain as either low hip or gable roofs.

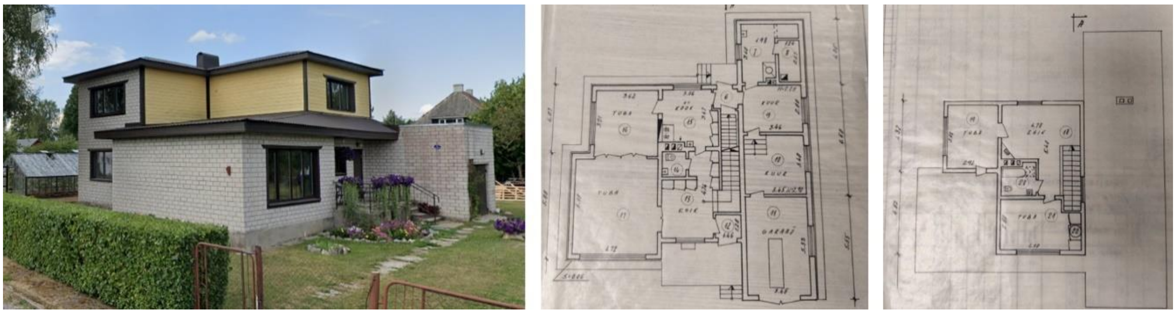


Figure 4.92 *Lõuna põik 4 (1973) in Väike-Maarja (left to right: view, ground floor layout and upper floor layout)*

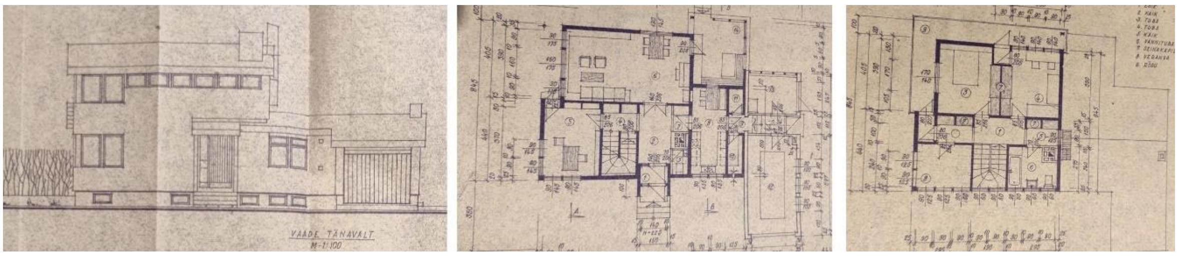


Figure 4.93 *Kalda 1-a (1972) in Väike-Maarja (left to right: elevation, ground floor layout and upper floor layout)*

An example of an overhanging upper floor, as was also seen in the 1976 album (project 100-74), was found in Pärnu-Jaagupi (Pärnu mnt 5), although its documentation was not inventoried. The dwelling has an auxiliary wing and low single-slope roofs. The most recent example from Karksi-Nuia (Rahumäe 14, 1983) from the 1980’s joins the entire dwelling under a single roof with an irregular roof design (Figure 4.94).

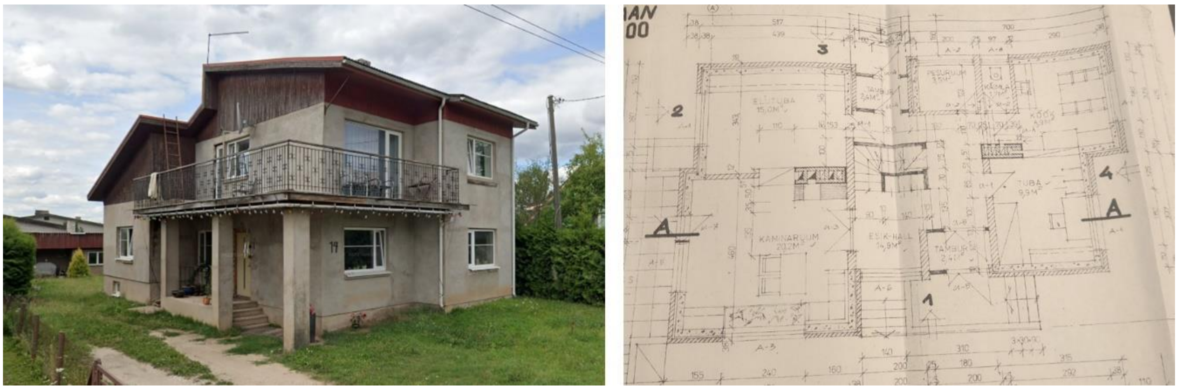


Figure 4.94 *Rahumäe 14 (1983) Karksi-Nuia (left to right: view, ground floor layout)*

In conclusion, this building type is not common and has a wide range of architectural form due to its somewhat abstract definition (a wide range of upper floor sizes and proportions are possible). Different architectural periods have utilized the building type in different ways, making it difficult to establish solid characteristics that would be applicable throught the decades at this time.

4.3.9 The bungalow house

The earliest bungalow projects appear in Karksi-Nuia and Väike-Maarja during the late 1950's. The earliest examples of this building type in Pärnu-Jaagupi appear as late as the 1970's (Figure 4.95).

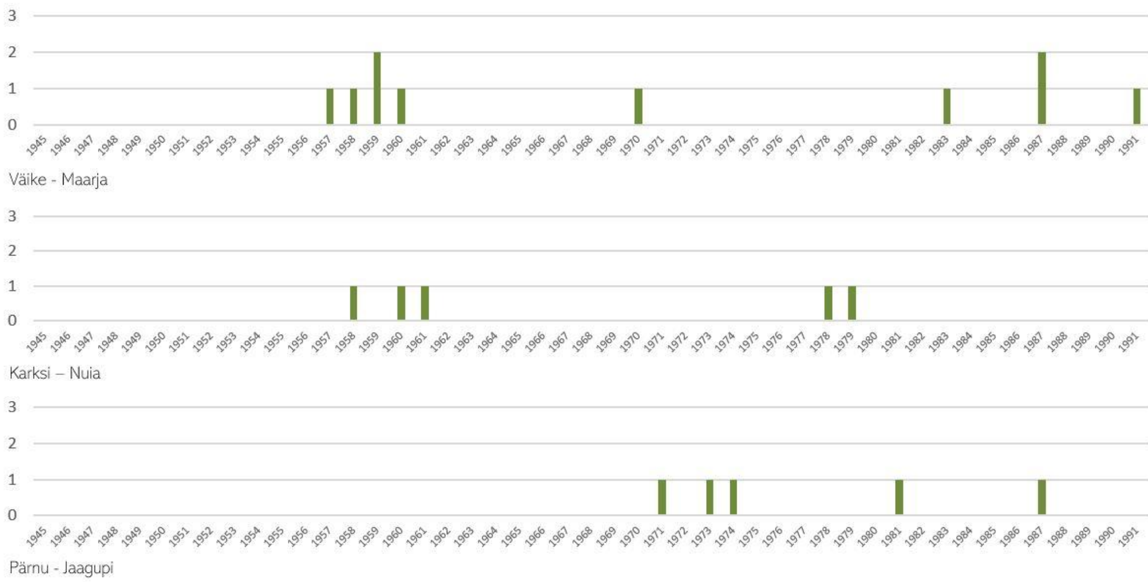


Figure 4.95 *Bungalow house project approval years*

The earlier dwellings are very similar in layout and facade design to the bungalow designs featured in earlier standard project albums before the newer fashions of the

1960’s (Figure 4.96). Their layouts have two to three rooms, a kitchen and entry hall with WC and other miscellaneous storage spaces. Roof shapes are either low hip or gable roofs and no auxiliary wings are present.

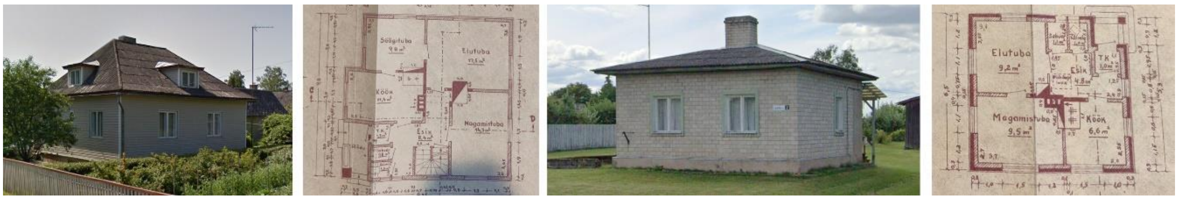


Figure 4.96 *Examples of early bungalows in Karksi-Nuia (left to right: Metsa 2 (1958) view and layout; Lepiku 2 (1960) view and layout)*

Standard projects were detected in Väike-Maarja, like number 9 (Kesk 4, 1959), number 32 (Energia 18, 1958) and E-2 (Aasa 5, 1959). The 1960’s seem to be a slow period for bungalows, yet by the 1970’s, a drastic change has taken place in architectural form. The previously discussed *EKE* designs are proven to be quite popular in these towns, although their exact years of construction have not been verified in this study. Väike-Maarja has 14 examples of Kullipesa designs, 10 examples of Ella designs, 7 examples of 19123 designs, one example of the 10052 design, one example of the E-907 design and two examples of 17421 designs. Four more examples seem very similar to the Taru design as well, but at this time are not verified. Karksi-Nuia has 8 examples of the E-907 design, 8 examples of 19123 designs, four examples of 10052 designs and 10 examples of T-3 designs (Figure 4.97). A number of archival files of these standard designs in Karksi-Nuia were inventoried as well, and most were found to be still utilizing stove heating, even with two chimneys if necessary. Pärnu-Jaagupi has one example of the 17421 design, three examples of 10052 designs, one potential Ella design and one potential E-907 design. It is notable that the same standard bungalow design series appear in all three towns, in different corners of Estonia.

Figure 4.97 *Examples of standard bungalows by EKE in Karksi-Nuia (left to right: project 19123, Lepiku 16 (unknown year); project 10052, Lepiku 22 (unknown year); and project E-907 (J. Kivistiku 13))*

Bungalows not recognized as standard designs appear in the 1970’s and come in a wide variety of compositions, as was noticeable among the designs in the 1976 album

(Berends & Dobrõš, 1976) (Figure 4.98). All dwellings have three to four rooms, with examples of both stove and central heating systems. Building footprints are generally large, sometimes with either integrated or separate auxiliary wings. Männi 1A (1971) in Pärnu-Jaagupi is an example of a more erratic and free-formed composition, while Kergu 84 (1974) in Pärnu-Jaagupi remains more compact and rational (Figure 4.99). Loode 11a is an example of a large dwelling integrated into the landscape, creating a full height accessible cellar floor at one end of the building. Examples from the 1980’s show similar trends as the 1970’s. Metsa 5 from Väike-Maarja is an example of 4-08-81 from the 1981 project album with a large auxiliary wing (Figure 4.100).

Figure 4.98 *Examples of individual bungalow projects (left to right: Uus 2c (unknown year) in Pärnu-Jaagupi, Energia 30 (1985) in Väike-Maarja, Kaare 5 (1964) in Karksi-Nuia)*

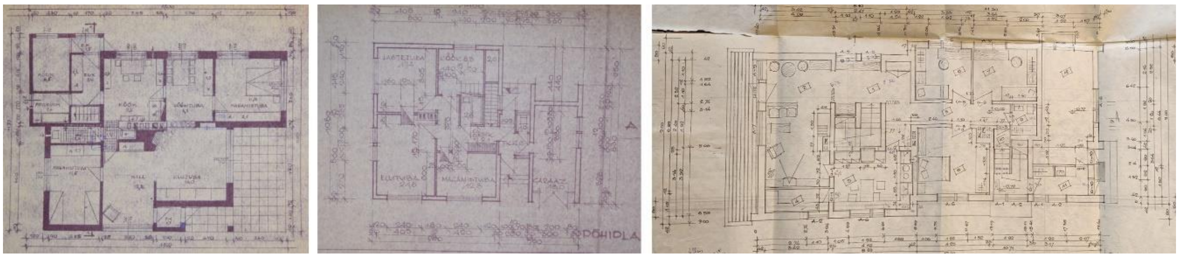


Figure 4.99 Examples of bungalow layouts (left to right: Männi 1A (1971) and Kergu mnt 84 (1974) in Pärnu-Jaagupi; Loode 11a (1979) in Karksi-Nuia)

Figure 4.100 *Metsa 5 (1983) in Väike-Maarja (project 4-08-81)*

Later alterations to this building type concern mainly the construction of an attic floor due to lack of space. This way, the bungalow turns into a high-pitched gable roof dwelling, yet in combination with the more spread out bungalow footprint, maintaining a balanced proportion may be challenge (Figure 4.101).

Figure 4.101 *Examples of bungalows with later added attic floors in Väike-Maarja (left to right: Säde 4 (1977), Kolde 7 (unknown year) and Uus 21 (1959))*

In conclusion, the bungalow goes through a notable transition through the decades. The positive aspects of this dwelling type is the lack of stairs and good connection to the surrouding landscape, yet fitting a complete five-room layout generates a large footprint, which is more of a challenge to heat. The roof shapes of these dwellings generally utilize low gable roofs or single slope roofs, however earlier designs also utilized hip roofs. Auxiliary wings may be distinctly separate, but they may also be seamlessly integrated into the building footprint.

4.3.10 The vertically displaced house

The first examples of vertically displaced dwellings appear in the late 1970's in Pärnu-Jaagupi. The main period of popularity for this building type is proven to be the 1980's, despite being developed as early as the 1960's (Figure 4.102). In general, all examples of these dwellings match the profile established in previous chapters.

A number of standard projects were identified. In Pärnu-Jaagupi, 10 examples of the 5-08-81, also titled *Suvi-5*, were found. In Väike-Maarja, 19 examples of this building type are the *EKE* standard project *Toomas* (Figure 4.103). Among designs from the 1970's, project 81-74 had been utilized in both Karksi-Nuia (Lepiku 13, 1979; Väike-aia 3, 1981) and Väike-Maarja (Metsa 2, 1982; Metsa 8, unknown year).

Lõuna 25 is another example from the 1976 album, utilizing project 82-74. A previously unidentified standard project, titled simply number 77, was utilized in Loode 29 (1978) in Karksi-Nuia as well (Figure 4.104).

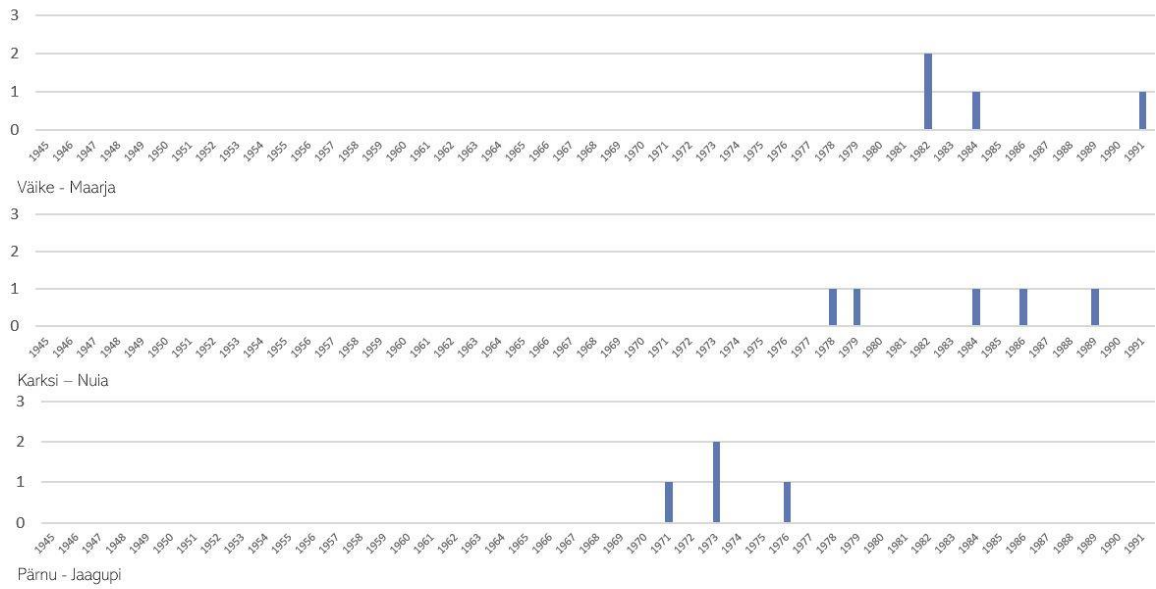


Figure 4.102 *Vertically displaced house project approval years*

Figure 4.103 *Examples of vertically displaced standard dwellings (left to right: Ülase 1, project Suvi in Pärnu-Jaagupi; Kolde 23, project Toomas in Väike-Maarja)*

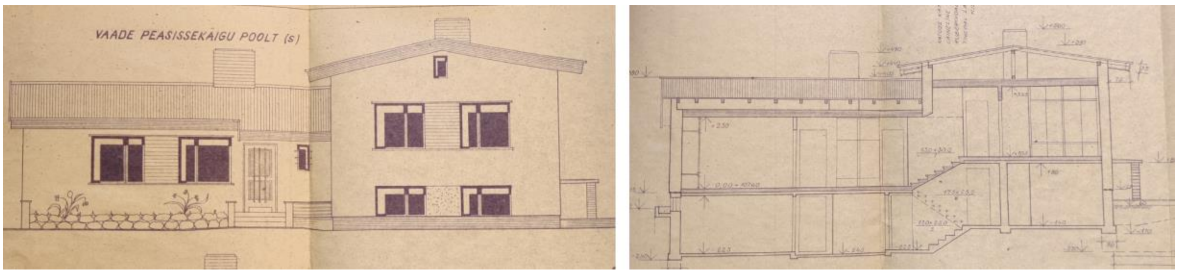


Figure 4.104 *Loode 29 (1978) in Karksi-Nuia (left to right: elevation, section)*

In Pärnu-Jaagupi, most vertically displaced dwellings were found to feature balconies above the garage and main entrance, and low roofs (Figure 4.105).

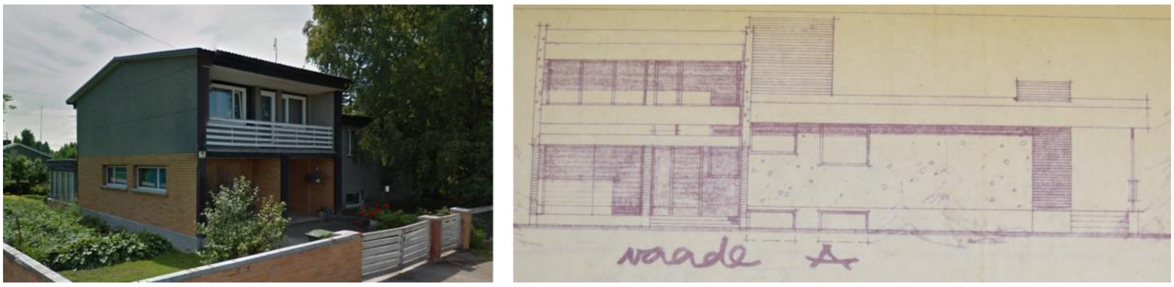


Figure 4.105 *Example of a vertically displaced dwelling (Põik 3, 1971) in Pärnu-Jaagupi (left to right: view, elevation)*

In Karksi-Nuia, two examples with low-pitched gable roofs (Rahumäe 4, Põhja 6) were found to be nearly identical to bungalows in morphology, except for a slight difference in floor level height. Rahumäe 4 was an interesting example of a reconstruction of an older traditional gable-roofed dwelling into a more modern low-roofed bungalow design. Metsa 4 (1982) in Väike-Maarja is another curious example, where the functions between levels have been switched: instead of the usual division, public functions have been elevated and private spaces have been lowered closer to the landscape (Figure 4.106).

Figure 4.106 *Examples of low vertically displaced dwellings (left to right: Rahumäe 4 (1984), Põhja 6 (unknown year) in Karksi-Nuia: Metsa 4 (1982) in Väike-Maarja)*

Separate auxiliary wings appear occasionally (Ülase 4 (unknown year), Karja 6 (1975) in Pärnu-Jaagupi), but generally the nature of this building type assumes that all utility functions can fit under the elevated heated floor level.

Lepa 3 (1973) in Pärnu-Jaagupi and Lõuna põik 5 (1978) in Väike-Maarja are examples of two distinct building volumes joined at the corner, similar to project 81-74 (Figure 4.48), yet display a less monumental morphology with single-sloped roofs (Figure 4.107).

By the end of the 1980's, new compositions appear in Karksi-Nuia utilizing a more complex composition of low gable roofs and less clear division of heated and unheated space (Lõuna 20, 1986 and Uus 14, 1990) (Figure 4.108).

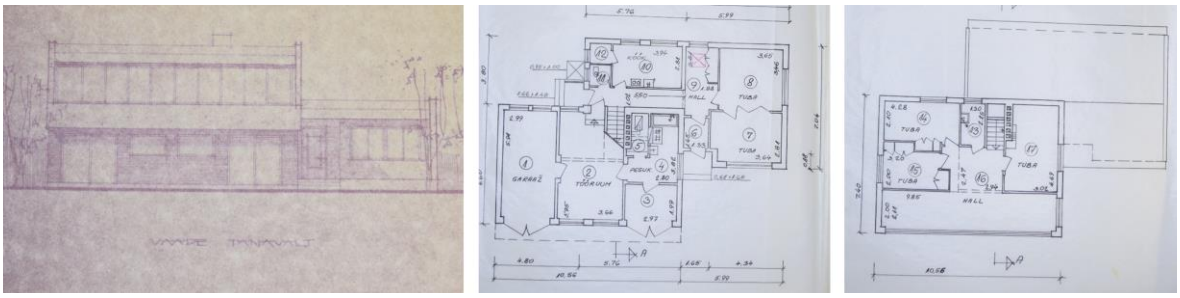


Figure 4.107 *Lepa 3 (1973) in Pärnu-Jaagupi (left to right: elevation, ground floor layout, upper floor layout)*

Figure 4.108 *Examples of more recent vertically displaced dwellings in Karksi-Nuia (left to right: Lõuna 20 (1986) and Uus 14 (1990))*

An example of a reconstruction is Arumäe 17, where an apparent *Toomas* has received a new roof and potential attic floor.

In conclusion, this building type appears as both standardized and individual projects. Alterations to these dwellings seem generally rare. Roof compositions can create either two distinct massings, or join the entire footprint under a shared gable or slope. The elevated levels can be placed either alongside one-another or joined at the corner. Over time, the originally clear division between heated and unheated space becomes more varied by the 1980´s.

4.3.11 The raised bungalow house

Only three examples (Lõuna põik 7 (1976), Energia 21 (1981), Väike-Maarja; Õhtu 15 (unknown year), Pärnu-Jaagupi) of the raised bungalow were found across all three towns, confirming its likely minor proportion within the housing stock (Figure 4.109). According to the original floor plans, the ground floors contain the garage, sauna complex, furnace room, laundry kitchen and other hall or storage spaces. The upper floors have two to three bedrooms, a living room, a kitchen and in the case of one dwelling, an upper WC as well. According to inventory drawings, upper floors seem to have been constructed according to plans, yet the ground floors have been noticeably altered. A number of walls have been either moved or unbuilt entirely, creating a completely different division of space. For this reason, it is unclear whether these ground floors have remained as unheated through the decades or not, especially since Energia 21 seems to have been remodeled during the 2010's.

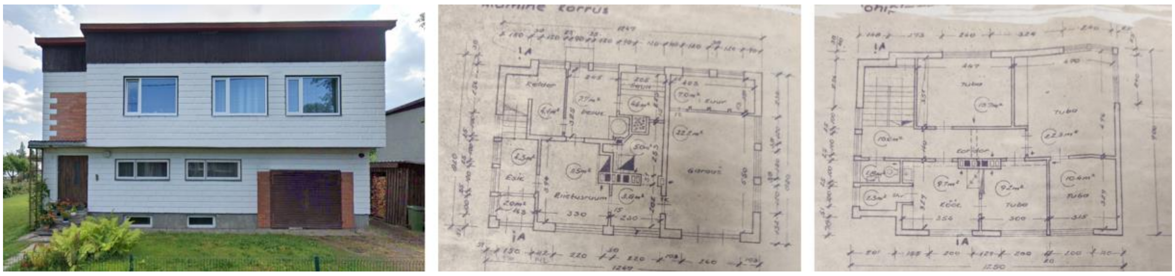


Figure 4.109 *Lõuna põik 7 (1976), example of a raised bungalow in Väike-Maarja (left to right: view, ground floor layout, upper floor layout)*

4.3.12 General construction type prevalence

Within the town of Väike-Maarja, 89 projects were acquired out of the 190 identified soviet era dwellings, leading to 143 verified construction types. Out of 66 traditional gable houses, 37 were inventoried, resulting in 33 verified construction types. From the 19 post-1980 gable dwellings, all but one being a standardized project, five projects were inventoried, resulting in 18 construction types (all standard projects were assumed to share the same construction type). Out of 24 box houses, six were recognized as standard projects and the remaining 18 were inventoried, resulting in 16 suitable data entries. Out of 49 bungalows, 33 were recognized as standard projects and the remaining 15 were inventoried, resulting in 43 suitable data entries. The ten partly two-floored houses were all inventoried, resulting in ten usable data entries. Out of 24 vertically displaced dwellings, 19 were recognized as standard projects and remaining five dwellings were inventoried, resulting in 23 usable construction types (standard projects were assumed to share the same construction type).

It is notable that timber structures (horizontal log, heavy and light wood frame) are the only applied construction methods until the end of the 1950's, when three singular examples of insulated brick walls appear (*Gerard, Nopsa, Harju*) (Figure 4.110). Heavy timber structures are used primarily until the early 1960's and to a limited extent during the second half of the 1960's and early 1970. After this point however, these structures seem to fall out of use. Light timber frame structures continue to be used from the early 1950's up until the mid-1970's, appearing as the more popular wood structure when compared to heavier timber structures. This is mainly supported by the considerably high proportion of light frame structures found among verified construction types. Insulated brick structures remain surprisingly uncommon considering their dominance among recommended wall types in period handbooks. In addition to the aforementioned three examples in 1959, only two more appear in the early 1970's in the form of hollow brick structures. Concrete structures appear during the beginning of the 1970's in the form of oil-shale ash aerated concrete blocks. While concrete structures appear alongside timber and insulated brick structures during the first half of the 1970's, from 1976 onwards, no other structures are used beside aerated concrete blocks. An example of saw-dust concrete was found as well during the first half of the 1970's.

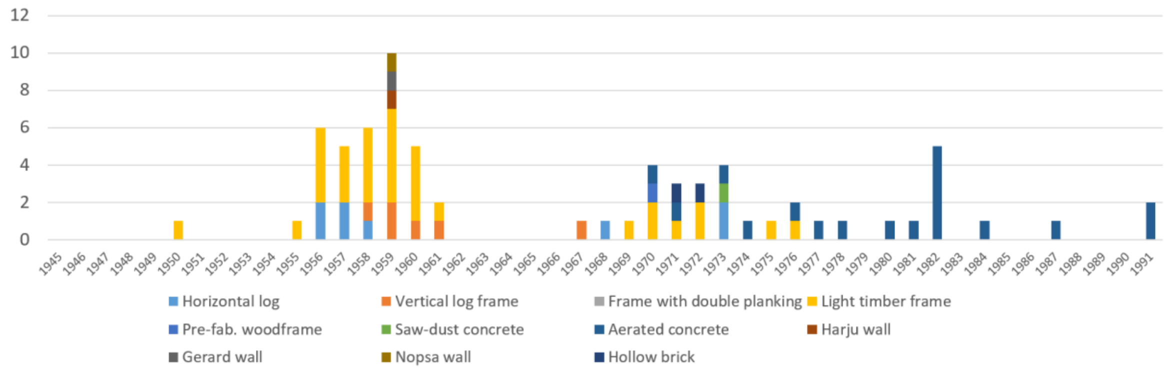


Figure 4.110 *Timeline and proportions of verified construction types in Väike-Maarja*

Within the town of Karksi-Nuia, 135 projects were acquired out of 173 identified soviet era dwellings, leading to 131 verified construction types. Out of 64 traditional gable houses, all 64 were inventoried, however only 50 had suitable data quality for verifying both approval year and construction type. From the 17 post-1980 gable dwellings, seven projects were inventoried, resulting in 17 construction types (all standard projects were assumed to share the same construction type). Out of 42 box houses, three were recognized as standard projects and the remaining 39 were inventoried, resulting in 23 suitable data entries. Out of 36 bungalows, 30 were recognized as standard projects and the remaining 6 were inventoried, resulting in 34 suitable data entries. The partly two-floored houses were all inventoried as well, resulting in three usable data entries. Out of nine vertically displaced dwellings, nine were inventoried, resulting in nine usable construction types.

As seen in Figure 4.111, wood structures are the most dominant. Heavy timber structures like horizontal log and frame structures with vertical log infill were in the minority. These heavy timber structures appear in the early 1950's and remain in use until the early 1960's, with few examples during the early 1970's as well. Light frame wood structures were much more common, accounting for up to 60 % of all construction types, made up of equal parts traditional frame and prefabricated wood frame structures. Traditional light frame structures appear from the mid-1950's up until the first half of the 1970’s, with few examples during the late 1970’s and early 1980’s. Insulated brick structures appear fairly regularly, mostly in the form of Harju walls from the mid 1950’s up until the first half of the 1970’s, accounting for 13 % of all construction types. This was also the highest identified number of insulated brick walls across all three towns. As an exception, a single Nõmme wall appeared in 1983, however such a late example was noticed only in Karksi-Nuia. Aerated concrete structures begin to appear from the beginning of the 1970’s and become the dominant form of construction by the early 1980’s, forming 18 % of all construction types within the town.

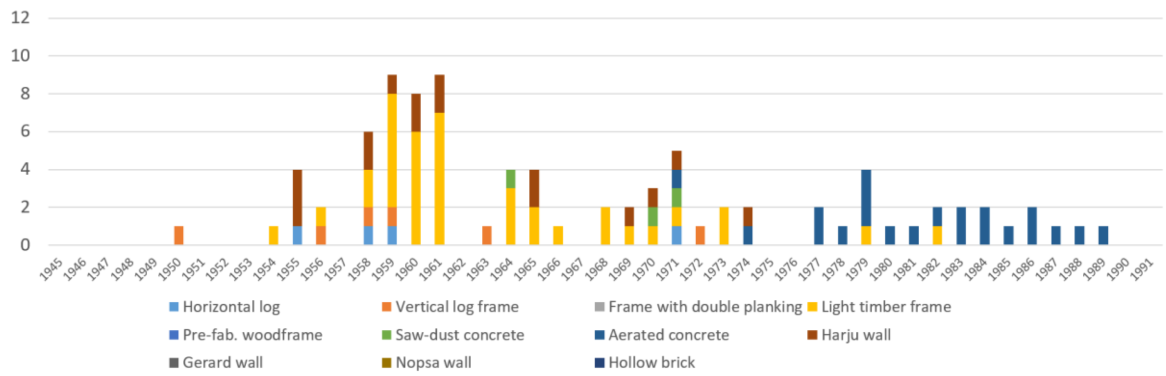


Figure 4.111 *Timeline and proportions of verified construction types in Karksi-Nuia*

Within the town of Pärnu-Jaagupi, 77 projects were acquired out of the 130 identified soviet era dwellings, leading to 61 verified construction types. Out of 82 traditional gable houses, 44 were inventoried, resulting in 39 verified construction types. Out of the two post-1980 gable dwellings, one project was inventoried with one verified construction type. Out of 13 box houses, two were recognized as standard projects and seven were inventoried, resulting in four verified construction types. Out of three partly two-floored dwellings, two were inventoried with two verified construction types. Out of 12 bungalows, 6 projects were inventoried, resulting in two verified construction types. Out of 18 vertically displaced dwellings, 10 were recognized as standard projects with four additional inventoried projects, resulting in 12 verified construction types.

As seen in Figure 4.112, timber structures are by far the most predominant construction method. It can be highlighted that Pärnu-Jaagupi is the only town to feature such a remarkable proportion of heavy timber structures as well, especially heavy timber plank walls, which were not found in the other two towns. These heavier timber structures were generally built from the early 1950’s up until the early 1960’s, with very few later examples. Lighter timber structures continued to be built until the mid-1970’s however, with all further construction done exclusively out of concrete blocks. Insulated brick walls appear rarely, with only three examples of Harju-type walls found between the late 1950's and early 1970's.

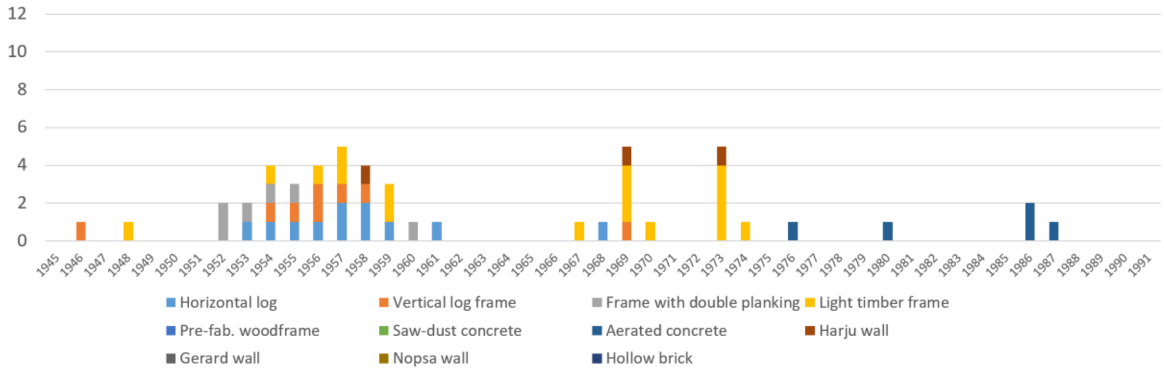


Figure 4.112 *Timeline and proportions of verified construction types in Pärnu-Jaagupi*

In conclusion, a clear transition across all three towns takes place at around the midpoint of the 1970's, where more traditional methods of construction like wood and insulated brick structures are replaced by aerated concrete block structures in all approved projects. The low proportion of insulated brick structures in all three towns is surprising, considering their prevalence in soviet era construction handbooks. The proportion and construction dates of horizontal log structures is notable as well, lasting up until the early 1960's.

4.3.13 Construction characteristics of building types

For traditional gable houses the most common construction type was light timber frame, occurring throughout the entire period (Figure 4.113). In both Pärnu-Jaagupi and Väike-Maarja, the second most common structure was horizontal log walls; in Karksi-Nuia, insulated brick structures, more specifically *Harju* walls were the second most common. The third most common structure across all traditional gable dwellings was heavy timber frame structures with vertical log infill. The less common structures were heavy timber frames with double planking and saw-dust concrete structures, while aerated concrete, and insulated brick walls like *Nopsa*, *Gerard* and even *Harju* walls in Väike-Maarja and Pärnu-Jaagupi were in the absolute minority. External finishings were either wood siding, rendering or brick linings.

All post-1980 gable houses were found to be constructed either from aerated concrete blocks or prefabricated wood frame panels (Figure 4.114). Their external finishing was either painted rendering, brick or occasionally wood siding.

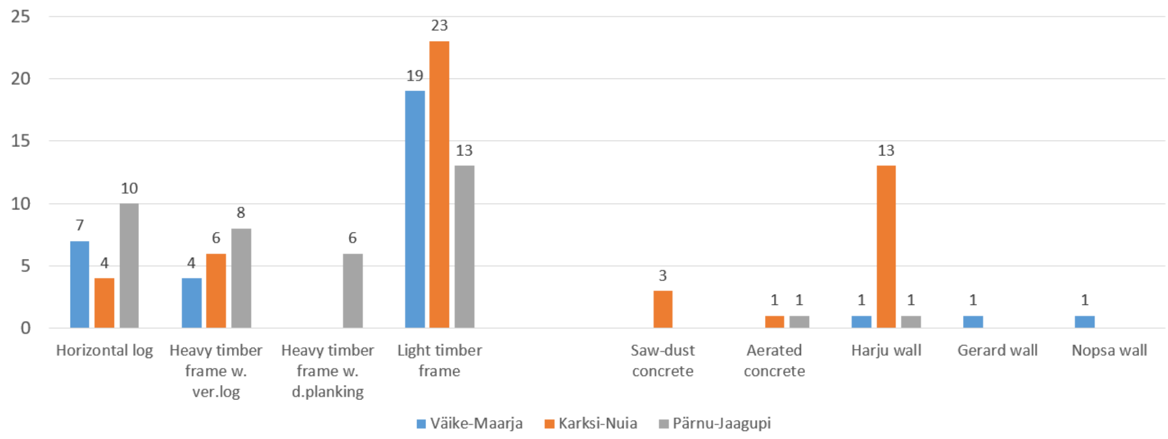


Figure 4.113 *Proportions of verified construction types of traditional gable houses*

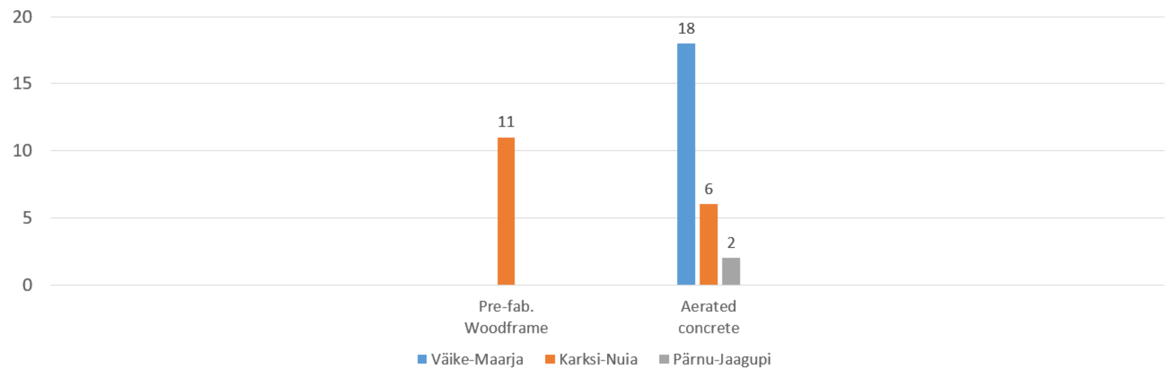


Figure 4.114 *Proportions of verified construction types of post-1980 gable houses*

For box houses in Pärnu-Jaagupi, only four construction types were verified, those being either light wood frames or heavy timber frames with vertical log infill (Figure 4.115). While Karksi-Nuia has a larger amount of light timber frame structures when compared to Väike-Maarja, both exhibit a prevalence towards aerated concrete structures during the 1970's. This is also explained by the fact that box dwellings don't seem to appear in Väike-Maarja until the beginning of the 1970´s, which also coincides with the general shift in construction practice towards concrete structures. Insulated brick structures appear occasionally as well in both Väike-Maarja and Karksi-Nuia until the beginning of the 1970's. External finishings are either brick or rendering, with no verified examples of wood siding. However, more data entries would be needed to make any confident correlations between the box house and construction practice.

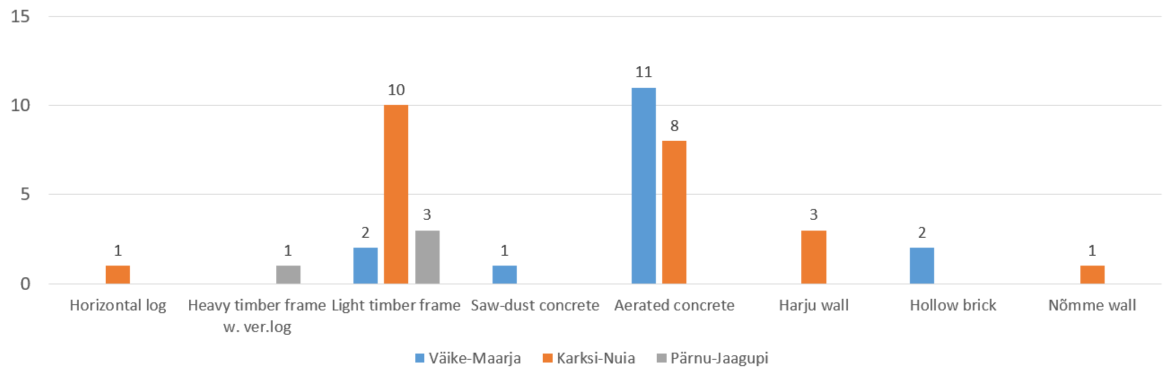


Figure 4.115 *Proportions of verified construction types of box houses*

Partly two-floored dwellings in all three towns feature a variety of construction types (Figure 4.116). As this was one of the less frequently occurring building types, data was limited. In Karksi-Nuia, three separate construction types were identified: one example of light timber frames, one example of insulated brick (*Harju*) and one example of aerated concrete block structures. From Pärnu-Jaagupi, two construction types can be highlighted: horizontal log and insulated brick (*Harju*) structures, with one example each. Väike-Maarja had the largest number examples of this building type across all three towns, with six examples of timber frame structures, one example of heavy timber frame structure with vertical log infill, one curious example of a horizontal log structure from as late as 1973 and one example of an aerated concrete structure. External finishings were either wood siding, rendering or brick, with wood siding appearing only in cases with timber frame structures. As the results show, this can be regarded as a versatile building type that may feature a variety of construction methods and further research is needed to make any solid conclusions about statistical correlations between building and construction type.

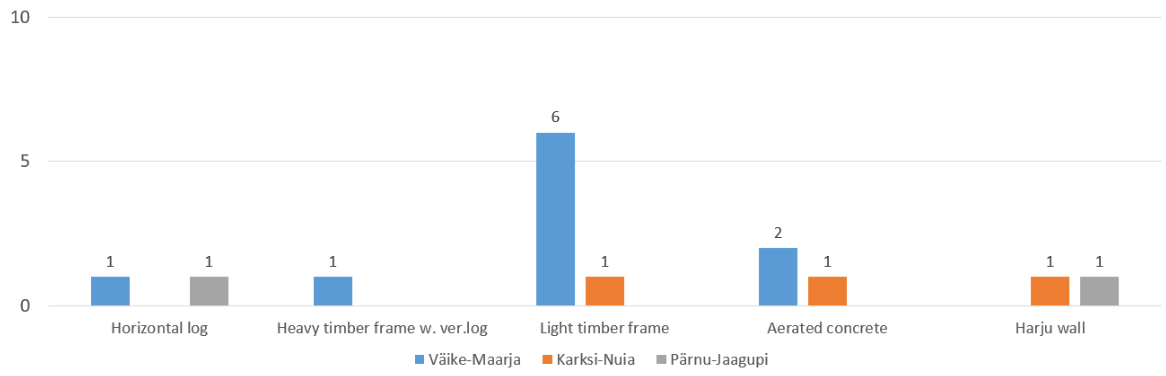


Figure 4.116 *Proportions of verified construction types of partly two-floored houses*

Bungalows in all three towns were constructed from a variety of structures as well (Figure 4.117). In Väike-Maarja, both light and heavy timber frame structures are common during earlier periods, with prefabricated timber frame panels and aerated concrete structures appearing around the 1970's in the form of *EKE* standard projects (prefabricated timber frame: 19123, 10052, E-907; aerated concrete blocks: *Ella*, *Kullipesa*) and individual projects. Both raised bungalows in Väike-Maarja feature aerated concrete structures as well. In Karksi-Nuia, timber frame structures were most common as well in the forms of both prefabricated (E-907, 10052, 19123, T-3) and non-prefabricated timber frame structures. Aerated concrete structures appeared as well. In the case of Pärnu-Jaagupi, all bungalows were found to be from aerated concrete structures, although there were no more than two verified construction types and therefore, these results cannot be regarded as representative. While prefabricated timber frame and aerated concrete structures are the most prevalent, these results are likely dependent on the construction practice and possible locations of standard projects and without further research into this characteristic, conclusions cannot be drawn for the construction types of bungalows in the scope of this study.

Raised bungalows were not studied separately due to their low number.

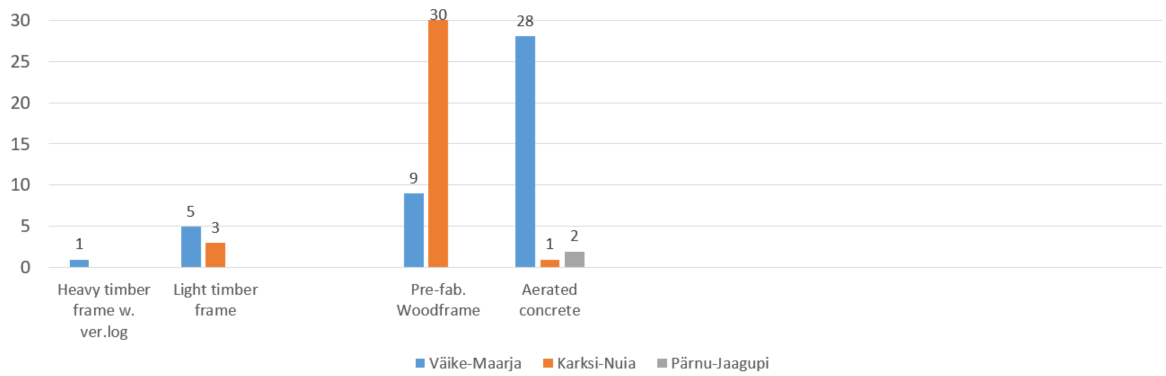


Figure 4.117 *Proportions of verified construction types of bungalow houses*

Vertically displaced dwellings in Karksi-Nuia and Väike-Maarja were constructed from aerated concrete blocks (Figure 4.118). In Pärnu-Jaagupi however, vertically displaced dwellings were found to be also from light timber frames and insulated brick walls (*Harju*) as well as aerated concrete blocks. Therefore while a correlation towards aerated concrete is noticeable, alternative structures are possible as well and further research into the construction types of this building type is necessary.

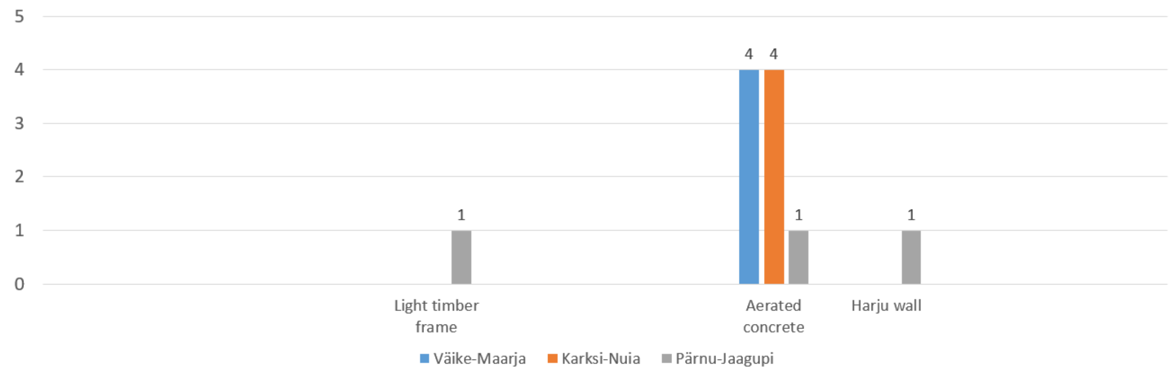


Figure 4.118 *Proportions of verified construction types of vertically displaced houses*

4.4 Proposed energy modeling technique

Previous typologies have established either one or two likely construction types per building type (TABULA); or used an existing data source (*EHR*) for establishing a constrution type (Iliste, 2022). As Building Register data was verified to be questionable in the case of concrete apartment block structures, its accurracy in describing the complexity of soviet-era individual construction types was likely to be even poorer. Conclusions from building and construction type analysis showed that traditional gable houses were the most common and well represented in terms of construction data quality. Therefore, this building type was chosen as a case study for establishing a method for estimating its construction type. All three towns showed different construction types appearing within the same time period within the same building type. Therefore, as no clear correlation between construction year and construction type for the traditional gable house type was found, a statistical top-down method is proposed. By establishing a representative database of verified construction types for each building type, a sample of houses of the same type may be randomly assigned likely construction types based on statistical proportion. For example, if within a hypothetical construction type database 60 % of all construction types are light timber frame, 30 % are insulated brick walls and 10 % are aerated concrete walls, then for a sample of 10 dwellings, six would be assigned as light wood frame, three as insulated brick and one as an aerated concrete structure. This method could function by knowing only a dwelling's basic building type. However, it was hypothesized that facade material or finishing, which can be visually verified, could be another factor to improve the accuracy of the statistical method. For this reason, construction types of traditional gable houses were assembled into a matrix for each town, to compare whether a certain facade material can be correlated to a construction type (Table 4.1; 4.2; 4.3).

Table 4.1 *Matrix of construction types and corresponding facade finishings of traditional gable houses in Väike-Maarja*

	Construction type	Facade external finishing			Brick facade subtypes		
		Wood siding	Rendering	Brick	Brick laid on side	Brick laid flat	Harju pattern
7	Horizontal log	3		4	4		
4	Heavy timber frame with vertical log	1	3				
	Heavy timber frame with double planking						
19	Light timber frame	4	7	8	8		
1	Harju wall		1				
1	Gerard wall		1				
1	Nopsa wall		1				
	Nõmme wall						
	Aerated concrete block						
	Saw-dust concrete						
		8	13	12	12		

Table 4.2 *Matrix of construction types and corresponding facade finishings of traditional gable houses in Karksi-Nuia*

	Construction type	Facade external finishing			Brick facade subtypes		
		Wood siding	Rendering	Brick	Brick laid on side	Brick laid flat	Harju pattern
4	Horizontal log	1		3	3		
6	Heavy timber frame with vertical log	1	2	3	3		
	Heavy timber frame with double planking						
23	Light timber frame	1	11	11	10	1	
13	Harju wall			13			13
	Gerard wall						
	Nopsa wall						
	Nõmme wall						
1	Aerated concrete block			1		1	
3	Saw-dust concrete		3				
		3	16	31	16	2	13

Table 4.3 *Matrix of construction types and corresponding facade finishings of traditional gable houses in Pärnu-Jaagupi*

	Construction type	Facade external finishing			Brick facade subtypes		
		Wood siding	Rendering	Brick	Brick laid on side	Brick laid flat	Harju pattern
10	Horizontal log	5	2	3	3		
8	Heavy timber frame with vertical log	3	2	3	3		
6	Heavy timber frame with double planking	4	1	1	1		
13	Light timber frame	3		10	7	3	
1	Harju wall			1			1
	Gerard wall						
	Nopsa wall						
	Nõmme wall						
1	Aerated concrete block		1				
	Saw-dust concrete						
		15	6	18	14	3	1

It was established that wood siding was utilized only for dwellings with horizontal log, light or heavy timber frame structures, with relatively equal frequency. Facades with rendering could be either horizontal log, light or heavy frame structures, insulated brick structures and even concrete wall types like sawdust-concrete or aerated concrete blocks. However, in the case of Väike-Maarja, 7 examples out of 13 were found to be rendered light timber frame walls. An even stronger proportion was found in Karksi-Nuia, with 11 examples out of 16 being light timber frame walls. In the case of Pärnu-Jaagupi, no examples of rendered light timber frame walls were verified. Brick facades not visually identifiable as insulated brick walls, like *Harju*, *Gerard*, *Nopsa* or *Rolok* walls, could be horizontal log, light or heavy timber frame or aerated concrete structures. In all three towns, a noticeable proportion of examples were once again light timber frame walls, with 11 examples out of 17 in Väike-Maarja, 10 examples out of 17 in Pärnu-Jaagupi and 8 examples out of 12 in Karksi-Nuia.

Every town showed slightly different proportions of construction types and whether these illustrate regional differences or the fact that every town in Estonia is likely to have its own individual variety of construction types is uncertain without further research. Whether based on national or regional characteristics, these results can be potentially assembled into a matrix including building type, external finishing and frequency of occurence. Based on this matrix, a selection of traditional gable houses may be proportionally assigned construction types based on their external finishing when modeling renovation scenarios in a region. On the level of individual buildings, this system is likely to be inaccurate, however on the level of a street or housing district, inaccuracies are likely to average out.

4.4.1 Data analysis of traditional gable house construction type dimensions

For a more exact U-value, the composition of each construction type was evaluated as well. It was noticed that even identical wall structures may not have uniform thicknesses. Internal layers, air cavity thickness and wood frame composition are all impossible to tell without field work, so assumptions were made based on available data.

Light timber frame structures were the most common, appearing in all three towns, across multiple building types from the beginning of the 1950´s up until the mid-1970´s. Light wood frame structures lined with bricks laid flat (lapiti) were within a range of 340 mm to 370 mm (Figure 4.119). Structures lined with with brick laid on its side (serviti) were within a range between 260 mm to 380 mm. Structures lined with wood siding had a thickness between 180 mm and 240 mm, with 200 mm being the most common. Rendered facades are the most difficult to estimate, as there may be insulation or brick lining concealed beneath it. TEP insulation was confirmed to be beneath 6 examples of rendered facades out of the total 16 data entries, ranging between 260 and 310 mm. One example featured a brick facade, laid on its side, with a thickness of 300 mm. All others remain unverified due to inventory descripitions not providing adequate detail, with a range between 220 mm and 350 mm. It is possible, that rendering was applied directly onto an external layer of wood planking, which would explain the narrower 220 mm thickness. However, this cannot be verified without field work.

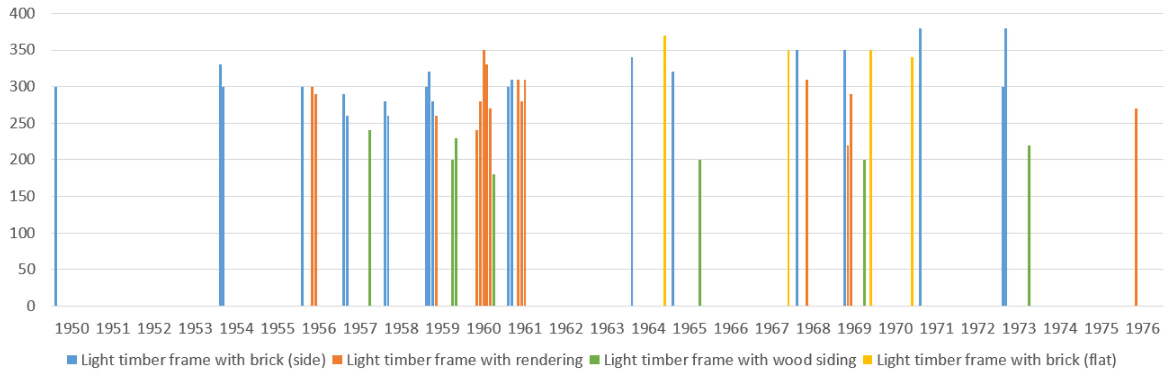


Figure 4.119 *Timeline of light timber frame wall thicknesses depending on facade finishing*

Horizontal log structures with wood siding appeared during earlier periods up until the second half of the 1950's, with an overall thickness between 180 and 210 mm (Figure 4.120). Horizontal log structures lined with bricks laid on their side (*serviti*) appeared from the second half of the 1950's up until the early 1960's with a single example from 1973. These were with a thickness either between 240 and 260 mm, or between 310 and 320 mm. Facades of bricks laid flat *(lapiti*) did not appear at all. Facades with rendering were confirmed to have TEP insulation underneath and appeared during the second half of the 1950's and beginning of the 1960, with a wall thickness between 230 and 270 mm. The sharp general decline of the horizontal log wall after the beginning of the 1960's is clear. In comparison with handbook data, the common thickness for the main horizontal log structure is 150 mm. A common thickness including wood siding is 200 mm, which fits the range that was established with found data. A common thickness including a brick lining (laid on its side), is given as 280 mm, which was not noticed among the analyzed data, and yet remained between the range of found thicknesses. This can be explained by the unidentifiable and variable width of the air cavity between the layers of log and brick or any potential internally added layers. Facades that were rendered were identified as likely having a layer of TEP insulation underneath, which had a standard thickness of 50 mm. The two different found thicknesses can be explained by the option of whether the TEP insulation is placed directly on top of the log structure or with strips of lath in between.

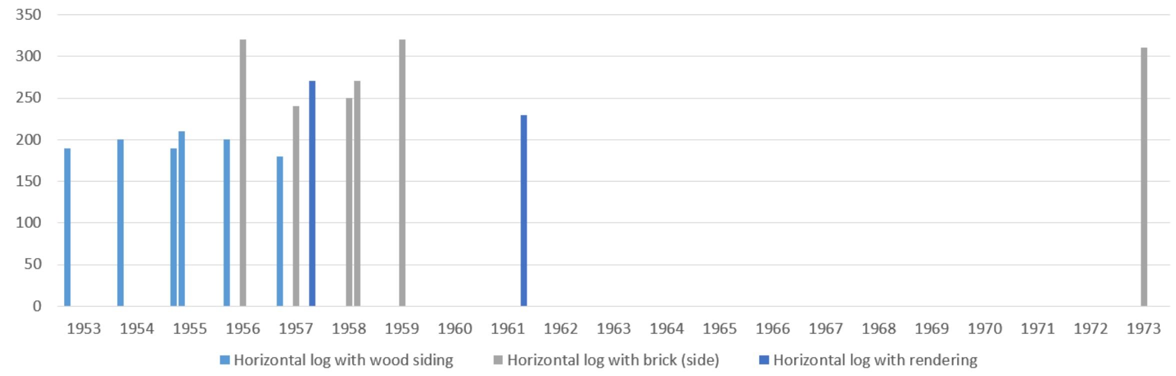


Figure 4.120 *Timeline of horizontal log wall thicknesses depending on facade finishing*

Heavy timber frame walls with vertical log infill and wood siding appeared generally during the second half of the 1950's and had a thickness either around 200 mm or between 260 and 270 mm (Figure 4.121). Facades lined with brick laid on its side (serviti) were common from the second half of the 1950's up until the late 1960's and had a thickness either about 240 mm or more commonly between 270 and 300 mm. Facades with rendering were either 200 mm or between 250 and 270 mm, with an added layer of TEP insulation in the latter case. After the early 1960's, wood siding seems to generally fade away, with only brick and rendered insulated facades remaining in use. Similar to horizontal log structures, heavy timber frame walls with vertical log infill were commonly 150 mm according to handbook data. Structures with wood siding were 200 mm as well, which was found among the data, yet the wider structure between 260 and 270 mm cannot be explained at this time.

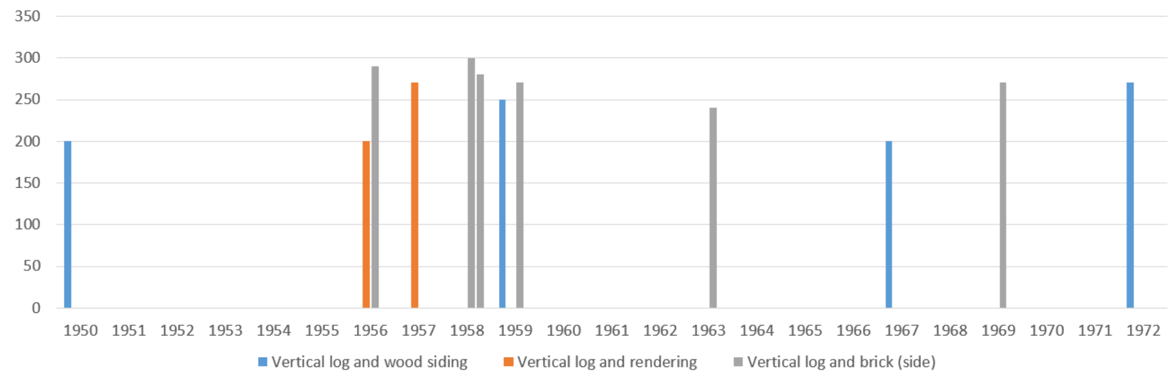


Figure 4.121 *Timeline of vertical log wall thicknesses depending on facade finishing*

Double plank walls appeared only in the town of Pärnu-Jaagupi for a limited period during the 1950's, and might therefore be a regional exception. Walls with wood siding or rendering were between 190 mm and 220 mm thick, while the facade lined with brick laid on its side (*serviti*) was 250 mm.

All *Harju* walls were found to be between 350 and 440 mm wide, with thicknesses around 400 mm appearing most frequently.

In conclusion, all wall type thicknesses can be identified and remain within a certain range, for which an average U-value may be extracted in the future to match with the statistically allocated wall type and finishing. Some construction types are more homogenous in dimension than others. The least varied construction thickness range was found among horizontal log structures with wood siding (180 mm to 210 mm) and the widest gap between rendered light wood frame structures (220 mm to 350 mm). The gap between rendered frame structures can be explained by the unknowable layers concealed by the rendering, which could inculde layers of insulation or bricks. Otherwise, this database may be applicable to a further development of the top-down energy modeling technique, where a wall thickness and resulting U-value may be assigned to a building as well based on external finishing and approximate date of construction.

4.5 Guidelines for evaluating and preserving a building´s architectural features

External insulation solutions, new windows and alterations to original building volumes are all likely to become relevant during the renovation wave for improving both energy efficiency and functionality of living space. Therefore guidelines for these solutions with respect to the building original architectural concept will need to be developed for both home-owners and municipality decision makers to ensure the preservation of visual identity of districts and neighbourhoods.

This typology study proposes a base method for evaluating the effect of renovation measures by establishing a spectrum of renovation solutions from most to least appropriate, for each part of the building defining its architectural character. Using the traditional gable house as an example, building types may be further structured into subcategories for illustrating their architectural aspects. For example, traditional gable houses can be structured based on their facade composition and window designs, based on the design of the verandah, based on the design of the dormer and even the auxiliary wing (Figure 4.122). Windows specifically display a relatively narrow variety of designs and compositions, where the window pane is generally divided into two or three sections. During earlier periods this division is symmetrical, with assymmetrical designs emerging during later decades as well (Figure 4.123). As windows are generally among the first elements of a dwelling to be replaced during renovation works, numerous examples can be highlighted from the three towns analyzed in this study. Examples range from following original divisions to minor alterations to completely disregarding the previous design. Therefore, an example spectrum of window designs may be compiled to illustrate, how designs following original divisions may be ranked higher and less authentic designs lower (Figure 4.124). In this example spectrum, the highest rated variation follows a traditional division, while the second highest has applied a slight alteration in division. The third variation has attempted to establish a traditional division, however the execution is somewhat poor and does not convey traditional proportions. The fourth and last variations have no divisions at all, creating a visual void effect within the facade. This kind of spectrum structure could serve as a tool to assist both home-owners in choosing renovation solutions, as well as decision makers for developing general plans and approving renovation works.

Following this example, a list of characteristic building elements can be compiled for each building type, each defining the original appearance, examples of appropriate renovation solutions and examples of non-recommended solutions or construction practice. This data can also form the base for developing standardized renovation solutions. As architectural quality is generally a qualitative rather than quantitative parameter, a spectrum tool such as this can assist in finding mutual understanding between constituencies when approving or disapproving specific renovation measures. This spectrum would also need to be verified by experts in the field, such as architects and urban planners to ensure a quality outcome.

Figure 4.122 *Examples of characteristic architectural features for the traditional gable house type*

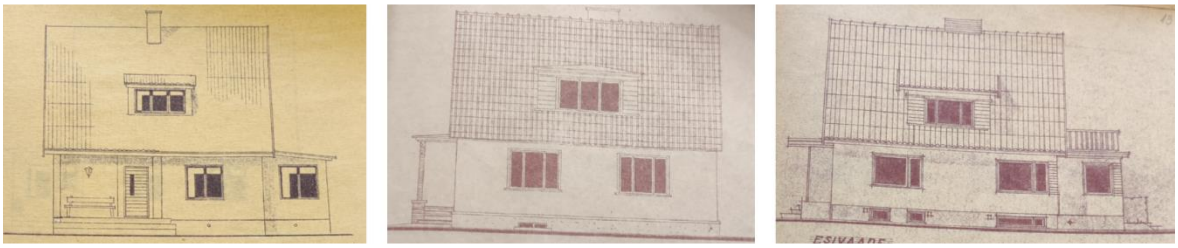


Figure 4.123 *Examples of historically accurate windows divisions*

Figure 4.124 *Spectrum of window solutions ranging from most approporiate (5) to least appropriate (1)*

5 CONCLUSION & FUTURE RESEARCH

With this study, a typology of soviet-era detached houses has been proposed for implementing the renovation wave in Estonia. A baseline situation of the detached housing stock has been described using this typology, which has potential for extrapolating conclusions for other regions of Estonia.

The main function of this typology is to provide structure for the diverse section of detached housing within the Estonian building stock and to make estimations about the properties of buildings without the need to evaluate each building individually.

For this goal, both historical and real building data was analyzed, during which a number of previously unstudied standard project albums were highlighted and included in the study. According to the results, soviet-era detached housing may be divided based on the distribution of heated space within the building volume. The primary division is between either stacking headed floors or placing them alongside one-another. Stacked variations can be further divided based on the characteristics of the upper floor, which can be either an attic floor beneath a high-pitched roof, a complete upper floor or a partial upper floor. Horizontal variations can be divided between remaining on a single level or on two vertically displaced levels. Further subtypes were identified as well, like the post-1980 gable house, the fully two-floored dwelling with heated space above the garage and the raised bungalow. The architectural characteristics concerning massing, roof shape, development of the layout and architectural style were highlighted as well from both standard project albums and real buildings.

Three towns in Estonia (Pärnu-Jaagupi, Väike-Maarja and Karksi-Nuia) were classified, verifiying the functionality of the typology in describing the baseline of the detached housing stock. Altogether 495 dwellings, out of which 301 were studied further using archival Building Register files. Stacked heated space was established as the most common method of heated space division, with the traditional gable house being the most common building type across all three towns. The study showed, that while traditional gable houses with attic floors and „box houses" with full upper floors are generally homogenous in their form, other building types are much more varied in terms of footprint and volume composition across the decades. Variations of each building type were highlighted with possible architectural styles, roof shapes, auxiliary wings and later alterations. No clear regional characteristics were identified apart from some examples, meaning that the described building characteristics may be assumed to representative of other towns in Estonia as well, which would, however, need to be verified with future studies.

The prevalence and timeline of occurence was established for each building type, which confirmed that the traditional gable house and bungalow house were among the earliest building types, as was identified using standard project albums; which were then followed by the box house and partially two-floored house.

Construction methods were studied using period handbook data to establish a selection of possible construction types, which were then verified with archival documentation of the three aforementioned towns. The most notable trend in general construction practice was the shift during the mid-1970’s towards utilizing aerated concrete structures across all building types in all three towns. The general decline of horizontal log structures by the early 1960’s was noticeable, disappearing completely after the beginning of the 1970’s. The general low implementation of insulated brick structures was an unexpected result, considering their prevalence in period construction handbooks. A follow-up study to examine the obtained results using a different town or area within the same county is proposed, in order to compare if any trends noticed in the three examined towns are repeated. The results of the construction type study are also open to interpretation, whether these may be regarded as representative across all of Estonia, or only for smaller towns or rural areas. Potential differences in construction methods between urban and rural areas is another topic so far unstudied, especially considering the unexpected low number of insulated brick structures.

An energy modeling technique has been proposed for establishing the constructive properites of a soviet-era single-family house. Previous typologies have attempted to correlate a singular construction type for every building archetype, yet as was identified in the case of Estonian soviet-era detached houses, a multitude of construction types are possible for the same building type and construction year. Not all construction types are identifiable based on external evaluation either. Assuming modeling is done on a regional basis with a multitude of dwellings, a statistical approach correlated to building type and facade finishing is proposed. Further studies might also reveal correlations to construction year as well, adding to the method's accuracy. The author proposes as the first follow-up study a control group to test the accuracy of the developed typology. Cross-comparisons of verified construction types with Estonian Building Register (*EHR*) data is antoher potential follow-up study to evaluate the Registry´s accuracy and establish any potential trends between reported and verified data. The thicknesses of established construction types will also need to be verified and studied further with fieldwork, as numerous anomalies were noticed among the data, where certain thicknesses did not match the descriptions given within construction handbooks.

A potential application of the typology is guiding the development of renovation solutions and decision-making processes concerning renovation measures by establishing a spectrum of architecturally appropriate renovation solutions for each building type.

A noticeable number of standard projects were identified, highlighting the question, whether standardized or even industrial renovation solutions could be potentially developed for renovating these buildings. For this reason, the prevalence of mass-produced projects deserves to be studied further. Pre-fabricated wood frame dwellings may be more of a challenge, but standard projects from aerated concrete are likely to form a firm base for installing industrial insulation elements.

The novelty of the work compensates the current lack of studies into the comprehensive architectural classification, proportion and physical properties of the Estonian detached housing stock. This is especially relevant throught lens of energy modeling or general renovation strategies, which can be described as baseline specification for planning the renovation wave.

REFERENCES

- Aarmann, K. (1956 February 10). Mõtteid individuaalehitamisest, ehituskruntidest ja projektidest. Sirp ja Vasar, 6.
- Aavik, M. & Tallinna Kultuuriväärtuste Amet. (2014). Sõjajärgne individuaalelamu. Hoonetüübi areng ja säästev uuendamine. Tallinna Kultuuriväärtuste Amet.
- Aavik, M. (2010). Sõjajärgne individuaalelamu Nõmme miljööalal. [Master's thesis, Estonian Academy of Arts, Tallinn, Estonia]. Digiteek. https://digiteek.artun.ee/fotod/loputood/magister/event_id-255.
- Ali, U., Shamsi, M. H., Bohacek, M., Hoare, C., Purcell, K., Mangina, E., & O'Donnell, J. (2020). A data-driven approach to optimize urban scale energy retrofit decisions for residential buildings. Applied Energy, 267, 114861. Retrieved May 11, 2023, from https://doi.org/10.1016/j.apenergy.2020.114861.
- Allikmaa, A. (2013). Eesti väikeelamute iseloomustus ja energiatõhususe parandamine [Master's thesis, TalTech, Tallinn, Estonia].
- Amjärv, A. (1983). Individuaalelamud ´83. Maa-individuaalelamute ja nende juurde kuuluvate majandushoonete projektide illustreeritud kataloog. ENSV Riiklik Ehituskomitee; RPI Eesti Maaehitusprojekt.
- Asszonyi, A. & Amjärv, A. (1981). Individuaalelamud-81. Maale ehitamiseks soovitavate individuaalelamute projektide kataloog. ENSV Ehituskomitee; PI Eesti Maaehitusprojekt.
- Ayyıldız, S., Ertürk, F., Durak, Ş., & Dülger, A. (2017, October). Importance of Typological Analysis in Architecture for Cultural Continuity: An Example from Kocaeli (Turkey). In IOP Conference Series: Materials Science and Engineering (Vol. 245, No. 7, p. 072033). IOP Publishing. Retrieved May 11, 2023, from doi:10.1088/1757-899X/245/7/072033.
- Ballarini, I., & Corrado, V. (2017). A new methodology for assessing the energy consumption of building stocks. Energies, 10(8), 1102. Retrieved May 11, 2023, from https://doi.org/10.3390/en10081102.
- Becher, B. & H. (n.d.). Framework houses. The Metropolitan Museum of Art. Retrieved from https://www.metmuseum.org/art/collection/search/849258.
- Berends, F., Dobrõš, A. (1976). Individuaalelamud. Eesti NSV-s ehitamiseks soovitatavate individuaalelamute projektid. Tallinn.
- Booth, A. T., Choudhary, R., & Spiegelhalter, D. J. (2012). Handling uncertainty in housing stock models. Building and Environment, 48, 35-47. Retrieved May 11, 2023, from https://doi.org/10.1016/j.buildenv.2011.08.016.

- BPIE. (2017). Building Renovation Passports: consumer’s journey to a better home. Retrieved May 11, 2023, from https://www.bpie.eu/publication/building-renovation-passports-consumers-journey-to-a-better-home/.
- BPIE. (2022). Industrial prefabrication solutions for building renovation – Innovations and key drivers to accelerate serial renovation solutions in Europe. Retrieved May 11, 2023, from https://www.bpie.eu/publication/industrial-prefabrication-solutions-for-building-renovation/.
- Bygningsguiden. (n.d.). Renover på boligens egne præmisser. Retrieved May 11, 2023, from https://old.sparenergi.dk/forbruger/vaerktoejer/bygningsguiden.
- Catalina, T., Virgone, J., & Iordache, V. (2011, November). Study on the impact of the building form on the energy consumption. In Proceedings of building simulation (pp. 1726-1729).
- Corona-Martínez, A. (2003). The architectural project (Vol. 6). Texas A&M University Press.
- Csoknyai, T., Hrabovszky-Horváth, S., Georgiev, Z., Jovanovic-Popovic, M., Stankovic, B., Villatoro, O., & Szendrő, G. (2016). Building stock characteristics and energy performance of residential buildings in Eastern-European countries. Energy and Buildings, 132, 39-52. Retrieved May 11, 2023, from https://doi.org/10.1016/j.enbuild.2016.06.062.
- de Vasconcelos, A. B., Pinheiro, M. D., Manso, A., & Cabaço, A. (2015). A Portuguese approach to define reference buildings for cost-optimal methodologies. Applied Energy, 140, 316-328. Retrieved May 11, 2023, from https://doi.org/10.1016/j.apenergy.2014.11.035.
- Directive 2018/844. Directive (EU) 2018/844 of the European Parliament and of the council of 30 May 2018 amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2018.156.01.0075.01.ENG.
- Eensalu, M. & Tallinna Kultuuriväärtuste Amet. (2013). Funktsionalistlik maja. Eramu ja väike kortermaja. Tallinna Kultuuriväärtuste Amet.
- Eesti Arhitektuurimuuseum. (n.d.). Eramu Tallinnas Neeme tn, hoone vaade. Arhitekt Edgar Kuusik. EAM Fk 2430. Retrieved from https://www.muis.ee/museaalview/2632956.
- Eesti Filmi Andmebaas. (1961 May 15). Ahtme Ehitusmaterjalide Kombinaat. Ringvaade “Nõukogude Eesti”, 15. Retrieved from https://www.efis.ee/et/filmiliigid/film/id/4888.

- Eesti Rahva Muuseum. (1962). Kolhoosnik Teesalu pooleliolev individuaalelamu. Vana-Antsla v, Urvaste khk. ERM Fk 1313:251. Retrieved from https://www.muis.ee/museaalview/738955.
- Ehitisregister. (n.d.). https://livekluster.ehr.ee/ui/ehr/v1
- EKE Külatare. (n.d.-a). Ühepereelamu B-2-2/73. Elamud maaelamukooperatiividele.
- Elefante, C. (n.d.). The greenest building… is the one that is already built. Retrieved May 11, 2023, from https://carlelefante.com/insights/the-greenest-building-is/.
- Energistyrelsen. (n.d.). Bygningsguide. Retrieved from https://old.sparenergi.dk/forbruger/vaerktoejer/bygningsguiden.
- ENSV MN Riiklik Ehituse ja Arhitektuuri Komitee. (1959). Individuaalelamu projekt, E-20 - E-42.
- ENSV Põllumajanduse Ministeerium. (1954). Kolhoosielamute projekte. Tallinn: Eesti Riiklik Kirjastus.
- ENSV Põllumajanduse Ministeerium. (1958). Individuaalelamu projekt, E-1 - E-19.
- ENSV Riiklik Ehituskomitee. (1986). Eesti NSV-s ehitatavate individuaalelamute (eramute) ehitusprojektide koostamise, kooskõlastamise ja kinnitamise juhend. Tallinn.
- ERR. (2023). Galerii: Kotzebue tänava lammutamisjärgus hoonel avati EKA vabaõhunäitus. Retrieved from https://kultuur.err.ee/1608901844/galerii-kotzebue-tanava-lammutamisjargus-hoonel-avati-eka-vabaohunaitus#lg=1&slide=14.
- European Commission. (2020, October 14). Communication from the Commission to the European parliament, the Council, the European economic and social committee and the Committee of the regions: A Renovation Wave for Europe - greening our buildings, creating jobs, improving lives (COM/2020/662 final). Retrieved May 11, 2023, from https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020DC0662.
- European Commission. (n.d.-a). Energy performance of buildings directive. Retrieved May 11, 2023, from https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficient-buildings/energy-performance-buildings-directive_en.
- European Commission. (n.d.-b). A European Green Deal. Retrieved May 11, 2023, from https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en.
- Grauen, A. & Alver, V. (1936). Tulekindel ehitusviis “Nopsa”. Tallinn.

- IEE TABULA. (n.d.-a). TABULA Typology Structure - Concept. Retrieved May 11, 2023, from https://episcope.eu/building-typology/tabula-structure/concept/.
- IEE TABULA. (n.d.-b). TABULA Building Typologies - Country Pages. Retrieved May 11, 2023, from https://episcope.eu/building-typology/country/.
- Iliste, E. (2022). Ehitisregistri andmete alusel elamupiirkonna energiatõhususe hindamise alused [Master's thesis, TalTech, Tallinn, Estonia]. Digikogu. https://digikogu.taltech.ee/et/Item/db8623c0-7686-4c0e-9cca-c076543344a6.
- Jürgenson, L. (1949). Elamuehitus 1. Ehitusfüüsika ja -ökonoomika, -materjalid ja põhitarindid. Tartu: RK Teaduslik Kirjandus.
- Kalm, M. (2001). Eesti 20. sajandi arhitektuur. The History of Estonian 20th Century Architecture. Tallinn: Prisma Print.
- Kalm, M. (2013a). Individuaalelamu. 100 sammu läbi 20. sajandi Eesti arhitektuuri. 100 Steps Through 20th Century Estonian Architecture. Tallinn: Eesti Arhitektuurimuuseum.
- Kalm, M. (2013b). Maaelamukooperatiiv. 100 sammu läbi 20. sajandi Eesti arhitektuuri. 100 Steps Through 20th Century Estonian Architecture. Tallinn: Eesti Arhitektuurimuuseum.
- Kammal, U. (1966). Individuaalelamu kaasaegsest ehituslaadist. Ehitus ja Arhitektuur, 2.
- Kann, T. (1988 September 8). Kes kaitseb maad? Kodumaa on kodude summa. Maaleht, 36(50).
- Karro, H. (1959 January 8). Individuaalelamute ehitamisest. Punane Täht: EKP Rakvere Rajoonikomitee ja Rakvere Rajooni RSN häälekandja, 4.
- Kõre, J., Ainsaar, M. & Hendrikson, M. (1996). Eluasemepoliitika Eestis 1918-1995. Akadeemia, 10(91), 2133-1265.
- Kragh, J., & Wittchen, K. B. (2014). Development of two Danish building typologies for residential buildings. Energy and Buildings, 68, 79-86. Retrieved May 11, 2023, from https://doi.org/10.1016/j.enbuild.2013.04.028.
- KredEx. (2017). Liginullenergia eluhooned. Väikemajad. KredEx. https://kredex.ee/sites/default/files/2019-03/Liginullenergia_eluhooned_Vaikemaja_juhend.pdf.
- KredEx. (n.d.).Väikeelamute rekonstrueerimistoetus 2022-2023. Retrieved May 11, 2023, from https://kredex.ee/en/majaduueks.
- Kruusa, L. (2020). Kolhooside elamuehitus endises Halinga vallas Libatse, Pärnu-Jaagupi ja Vahenurme näitel [Master's thesis, Estonian Academy of Arts, Tallinn, Estonia]. Digiteek. https://digiteek.artun.ee/fotod/loputood/magister/event_id-280.

- Leppik, E. (1999). Kultuurilooline Väike-Maarja. Kohtla-Järve.
- Leppik, H. (1980). Kolhoosiehitus Nõukogude Eestis. Tallinn: Valgus.
- Lim, H., & Zhai, Z. J. (2017, October). Review on stochastic modeling methods for building stock energy prediction. In Building Simulation (Vol. 10, pp. 607-624). Tsinghua University Press. Retrieved May 11, 2023, from https://doi.org/10.1007/s12273-017-0383-y.
- Loga, T., & Diefenbach, N. (2010). Use of building typologies for energy performance assessment of national building stocks. Existent experiences in European Countries and common approach. First TABULA synthesis report.
- Lorbek, M. (2018). Idealizations of the Kleinhaus: On the Typology of the Small Single-Family House in Germany, 1920s–1960s. Architectural Histories, 6(1). Retrieved May 11, 2023, from https://doi.org/10.5334/ah.243.
- Martin, A. & Tallinna Kultuuriväärtuste Amet. (2011). Lenderi maja. Hoonetüübi areng ja säästev uuendamine. Tallinna Kultuuriväärtuste Amet.
- Masso, T. (1990). Väikemajad. Tallinn: Valgus.
- Masso, T. (2012). Ehitusfüüsika ABC. Soojus, niiskus, müra. Tallinn: Ehitame.
- Masso, T. (2022). Vanade väikemajade tarindid. Tallinn: Ehitame.
- Metslang, J. (2012). Vana maamaja käsiraamat. Tallinn: Tammeraamat.
- Moles, A. A. & Rohmer, E. (1990). Les sciences de l'imprécis. Paris: Seuil.
- Muinsuskaitseamet. (n.d.). Restaureerimise käsiraamat. Retrieved May 11, 2023, from https://www.muinsuskaitseamet.ee/et/kasiraamat.
- Nägeli, C., Camarasa, C., Jakob, M., Catenazzi, G., & Ostermeyer, Y. (2018). Synthetic building stocks as a way to assess the energy demand and greenhouse gas emissions of national building stocks. Energy and Buildings, 173, 443-460. Retrieved May 11, 2023, from https://doi.org/10.1016/j.enbuild.2018.05.055.
- Parmas, H. (1980). Eesti ühepereelamu (areng, tunnusjooni). [Unpublished manuscript].
- Pasichnyi, O., Wallin, J., Levihn, F., Shahrokni, H., & Kordas, O. (2019). Energy performance certificates—New opportunities for data-enabled urban energy policy instruments?. Energy Policy, 127, 486-499. Retrieved May 11, 2023, from https://doi.org/10.1016/j.enpol.2018.11.051.
- Peterson, A. (1964). Tüüpprojektide kasutamisest maaelamuehituses 1953.-1962. aastani. Etnograafiamuuseumi aastaraamat, 19, 76-89.
- Peterson, A. (1965). Asunike elamute ehitamisest kodanlikus Eestis. Etnograafiamuuseumi aastaraamat, 20, 184-209.
- Peterson, A. (1966). Võru rajooni kaasaegne maaelamu. Etnograafiamuuseumi aastaraamat, 21, 47-79.

- PI EKE Projekt. (1975a). Põrgupõhja Lahemaa rahvuspargi tingimustes. Üheperekonnaelamute seeria.
- PI EKE Projekt. (1975b). Silikaltsiitdetailidest maaelamute projektide kataloog. Tallinn.
- PI EKE Projekt. (n.d.-a). Silikaltsiitdetailidest ühepereelamu Ants-4.
- PI EKE Projekt. (n.d.-b). Pereelamu Raja-1.
- PI EKE Projekt. (n.d.-c). EEK Eksperimentaalne ühepereelamu Peeter-2. Tööprojekt 181-EKE 84-2E.9.
- PI EKE Projekt. (n.d.-d). 6-toaline majandustiivaga, keldrita ühepereelamu Muri 1. Projekt 143-EKE 88-1.
- PI EKE Projekt. (n.d.-e). Silikaltsiittoodetest ühepereelamu Madis-7. Projekt 183-EKE 83-7.
- PI EKE Projekt. (n.d.-f). Puitkilpidest ühepereelamu 10052 variant IV.
- PI EKE Projekt. (n.d.-g). EEK eksperimentaalne ühepereelamu Peeter-2, tööprojekt 181-EKE 84-E2.
- PI EKE Projekt. (n.d.-h). Ühepereelamu Kristiina-4. Seeria EKE 70 Projekt 183-EKE 70-1.
- PI EKE Projekt. (n.d.-i). Silikaltsiitdetailidest ühepereelamu 183 EKE 83-4, Maali-4.
- PI EKE Projekt. (n.d.-j). Silikaltsiitdetailidest ühepereelamu Tõnn-4. Töödokumentatsioon 183-EKE 70-3.1.
- PI EKE Projekt. (n.d.-k). Silikaltsiitdetailidest maaindividuaalelamute seeria EKE 30. 5-toaline ühepereelamu projekt 183-EKE 30-2 Toomas-5.
- PI EKE Projekt. (n.d.-l). Seeria EKE 30 silikaltsiittoodetest ühepereelamu. 6-toaline elamu Toomas 131. Tööprojekt 183-EKE 30-8.
- Pozas, B. M., & González, F. J. N. (2018). Housing building typology definition in a historical area based on a case study: The Valley, Spain. Cities, 72, 1-7. Retrieved May 11, 2023, from https://doi.org/10.1016/j.cities.2017.07.020.
- Puustusmaa, R. (2020, October 23). Raiko Puustusmaa: hoonete rekonstrueerimisest tehase abiga. https://www.err.ee/1150502/raiko-puustusmaa-hoonete-rekonstrueerimisest-tehase-abiga.
- Reidla, T. (2019). Nii kole maja! Postmodernistlikud elamud ja nende väärtustamisproblemaatika [Master's thesis, Estonian Academy of Arts, Tallinn, Estonia]. Digiteek. https://digiteek.artun.ee/fotod/loputood/magister/event_id-217.
- Riisalo, J. (1966). Karksi. Tallinn: Eesti Raamat.
- Roopalu, H. (1967). Uutest individuaalelamute tüüpprojektidest. Ehitus ja Arhitektuur, 1.

- RPI Eesti Maaehitusprojekt. (1977). 1977. a. maaelamud ja ühiskondlikud hooned. Eesti NSV-s kasutamiseks soovitatavate maaelamute ja ühiskondlike hoonete projektide illustreeritud kataloog. Tallinn: ENSV Põllumajanduse Ministeerium.
- RPI Estongiprogorstroi. (1956). Individuaalelamute projektide album, osa 3. Tallinn: Riiklik Ehituse ja Arhitektuuri Komitee.
- RPI Estonprojekt. (1965). Individuaalelamud 1965. Tallinn: Eesti Riiklik Ehituskomitee.
- Schaefer, A., & Ghisi, E. (2016). Method for obtaining reference buildings. Energy and buildings, 128, 660-672. Retrieved May 11, 2023, from https://doi.org/10.1016/j.enbuild.2016.07.001.
- Seeland, S. (1991). Pärnu-Jaagupi alevi hoonestus 1532-1990. Pärnu-Jaagupi Kultuurifond.
- Statistikaamet. (2021). Eluruumid ja eluruumidega hooned. Rahvaloendus 2021. https://rahvaloendus.ee/et/tulemused/eluruumid-ja-eluruumidega-hooned.
- Swan, L. G., & Ugursal, V. I. (2009). Modeling of end-use energy consumption in the residential sector: A review of modeling techniques. Renewable and sustainable energy reviews, 13(8), 1819-1835. Retrieved May 11, 2023, from https://doi.org/10.1016/j.rser.2008.09.033.
- TABULA Webtool. (n.d.). Retrieved from https://webtool.building-typology.eu/#bm.
- Talk, T. (2018, March 23). Vana maja soojustamisest. Muinsuskaitseamet. https://www.muinsuskaitseamet.ee/et/uudised/vana-maja-soojustamisest.
- Tallinna Linnamuuseum. (n.d.) TLM F 10144:42.
- TalTech & Majandus- ja Kommunikatsiooniministeerium (MKM). (2020). Hoonete rekonstrueerimise pikaajaline strateegia.
- TalTech. (2023, March 15). Kuidas viia Eestis sujuvalt läbi renoveerimislaine?
- Tamm, F. & Jomm, G. (1949). Abiks individuaalelamute ehitajaile. Tallinn: Rakendustrükiste kirjastus.
- Tarvas, P. (1949). Uusi elamute tüüpprojekte. ENSV Arhitektide Almanahh, 3, 36-48.
- Toss, H. (1974). Individuaalelamute projektide konkurss. Ehitus ja Arhitektuur, 3.
- Tuominen, P., Holopainen, R., Eskola, L., Jokisalo, J., & Airaksinen, M. (2014). Calculation method and tool for assessing energy consumption in the building stock. Building and Environment, 75, 153-160. https://doi.org/10.1016/j.buildenv.2014.02.001.

- Tuominen, P., Holopainen, R., Eskola, L., Jokisalo, J., & Airaksinen, M. (2014). Calculation method and tool for assessing energy consumption in the building stock. Building and Environment, 75, 153-160. Retrieved May 11, 2023, from https://doi.org/10.1016/j.buildenv.2014.02.001.
- Valga Muuseum. (1957). Kolhoosi "Esimene Mai" uus individuaalelamu. VaM F 349. Retrieved from https://www.muis.ee/museaalview/2138538.
- Vendach, F. (1946). Individuaalehitus. ENSV Arhitektide Almanahh, 1, 35-40.
- Veski, A. (1969). Individuaalelamute ehitamine. Tallinn: Valgus.
- Veski, A., Aarmann, K. & Niine, A. (1959). Individuaalehitaja käsiraamat. Tallinn: Eesti Riiklik kirjastus.
- Villa, O. & ENSV Kohaliku Majanduse Ministeerium. (1960). Elamumajanduse seadusandluse kogumik.
- Võrumaa Muuseum. (1957). Foto. Uued individuaalelamud Põlvas märtsis 1957.a. VK F 970:71 F. Retrieved from https://www.muis.ee/museaalview/1098731.
- VPI Estonprojekt. (1954). Individuaalelamute projektide album, osa 1-2. Tallinn: ENSV Arhitektuuri Valitsus.
- Wikipedia contributors. (2023). Exterior insulation finishing system. Wikipedia. Retrieved from https://en.wikipedia.org/wiki/Exterior_insulation_finishing_system#/media/File:W%C3%A4rmed%C3%A4mmverbundsystem_(WDVS)_teilweise_auf_Altbau..JPG.
- Wittkower, R. (1967). Architectural Principles in the Age of Humanism. London.
- X-GIS 2.0 [core]. (n.d.). https://xgis.maaamet.ee/xgis2/page/app/core.
- X-GIS 2.0 [core_aluskaardid]. (n.d.). https://xgis.maaamet.ee/xgis2/page/app/core_aluskaardid.

APPENDICES

APPENDIX 1 Inventoried addresses and properties of Väike-Maarja

APPENDIX 2 Inventoried addresses and properties of Karksi-Nuia

APPENDIX 3 Inventoried addresses and properties of Pärnu-Jaagupi

APPENDIX 4 Thesis presentation boards

Appendix 1 Inventoried addresses and properties of Väike-Maarja

					Projekt			Inventuur	
Aasa tn					Kinnitusaa	tarind	paksus	tarind	paksus
5	108025390	RA, LVMA.889.1.27420	Bungalow house	E-2	1959	x	200	Light timber frame	270
6			Traditional gable house						
7	108041737	RA, LVMA.889.1.27660	Traditional gable house		x	x	x	x	x
9			Traditional gable house						
11	108025437	RA, LVMA.889.1.27443	Partly two-floored house		1970	Light timber frame	300	Light timber frame	300
Aia tn									
9	108025327	RA, LVMA.889.1.27390	Traditional gable house		1959	x	x	Horizontal log	x
10a	108025472	RA, LVMA.889.1.27463	Box house		1972	nõmme	300	Aerated concrete block	450
15	108025160	RA, LVMA.889.1.27253	Traditional gable house		1956	x	x	Light timber frame	300
19			Traditional gable house						
24	108025351	RA, LVMA.889.1.27402	Traditional gable house		1957	Light timber frame	x	Light timber frame	240
26	108025163	RA, LVMA.889.1.27254	Traditional gable house	TP-45	1958	Harju	400	Vertical log	x
28			Traditional gable house						
32	108025322	RA, LVMA.889.1.27387	Traditional gable house		1967	Vertical log	250	Vertical log	200
Energia tn									
3	108025478	RA, LVMA.889.1.27466	Box house		1972	Hollow brick	400	Light timber frame	420
5	108025177	RA, LVMA.889.1.27261	Box house		1972	Harju	400	Light timber frame	400
7	108025492	RA, LVMA.889.1.27477	Box house		1974	Hollow brick	380	Aerated concrete block	430
8	108025505	RA, LVMA.889.1.27487	Partly two-floored house		1971	Light timber frame	400	Light timber frame	340
9	108025489	RA, LVMA.889.1.27475	Box house		1973	Saw-dust concrete	300	Saw-dust concrete	380
10	108025417	RA, LVMA.889.1.27434	Traditional gable house	TP-38	1958	Light timber frame	200	Light timber frame	280
11	108025485	RA, LVMA.889.1.27472	Partly two-floored house		1973	x	260	Horizontal log	340
13			Box house	TP 5-06-81					
14	108025388	RA, LVMA.889.1.27419	Traditional gable house	TP-46	1958	Light timber frame	200	Light timber frame	x
15			Box house	TP 85-74					
16	108025507	RA, LVMA.889.1.27489	Traditional gable house		1976	Aerated concrete block	270	Light timber frame	270
16a	108025612	RA, LVMA.889.1.27572	Bungalow house	TP 17421-2	x	x	x	Light timber frame	350
17			Box house	TP 85-74					
18	108025353	RA, LVMA.889.1.27404	Bungalow house	TP 32	1958	Light timber frame	200	Light timber frame	220
19			Box house						
20	108025362	RA, LVMA.889.1.27407	Traditional gable house		1959	Horizontal log	200	Light timber frame	300
21	108025548	RA, LVMA.889.1.27515	Box house		1981	Aerated concrete block	300	Aerated concrete block	350
22			Bungalow house	TP Taru					
24	108025555	RA, LVMA.889.1.27520	Bungalow house	TP Taru	x	x	x	Aerated concrete block	350
26			Bungalow house	TP Taru					
28			Bungalow house	TP Taru					
29	108025512	RA, LVMA.889.1.27494	Box house		1980	Aerated concrete block	350	x	x
30	108025569	RA, LVMA.889.1.27531	Bungalow house		1987	x	x	x	380
31	108025664	RA, LVMA.889.1.27637	Bungalow house		1993	Aerated concrete block	420	x	x
36			Bungalow house	Ella					
J. Liivi tn									
10a			Bungalow house	TP 19123					
12	108025185	RA, LVMA.889.1.27266	Traditional gable house		1955	Light timber frame	x	Light timber frame	x
14			Traditional gable house						
16			Traditional gable house						
18			Traditional gable house						
Kesk tn									
2	108025358	RA, LVMA.889.1.27406	Traditional gable house		1958	x	x	Horizontal log	180
3			Box house	E-19					
4	108025375	RA, LVMA.889.1.27413	Bungalow house	TP 9	1959	Gerard	510	Vertical log	200
8			Traditional gable house						
10	108025178	RA, LVMA.889.1.27262	Traditional gable house		1960	Vertical log	200	Vertical log	x
Koidu tn									
1	108025428	RA, LVMA.889.1.27439	Traditional gable house	TP-22	1959	Light timber frame	250	Vertical log	250
2	108025181	RA, LVMA.889.1.27264	Traditional gable house		1956	Light timber frame	200	Light timber frame	x
3			Bungalow house	TP 10052					
Kolde tn									
1			Bungalow house	Ella					
2			Bungalow house	Kullipesa					
3			Bungalow house	Ella					
4			Bungalow house	Kullipesa					
5			Bungalow house	Kullipesa					
6			Bungalow house	Kullipesa					
7			Bungalow house	Kullipesa					
8			Post-1980 gable house	Ants					
9	108025631	RA, LVMA.889.1.27592	Post-1980 gable house	Ants	x	x	x	Aerated concrete block	350
10			Post-1980 gable house	Ants					
11			Post-1980 gable house	Ants					
12			Post-1980 gable house	Ants					
14			Vertically displaced house	Toomas					
15			Post-1980 gable house	Ants					
16			Vertically displaced house	Toomas					
18			Vertically displaced house	Toomas					
19			Vertically displaced house	Toomas					
20			Vertically displaced house	Toomas					
21			Vertically displaced house	Toomas					
22	108025644	RA, LVMA.889.1.27612	Post-1980 gable house	Talu-4	x	x	x	Aerated concrete block	450
23			Vertically displaced house	Toomas					
25			Vertically displaced house	Toomas					
Kuuse tn									
4			Bungalow house	TP 19123					

Lõuna tn									
3	108025468	RA, LVMA.889.1.27460	Partly two-floored house		1970	Harju	380	Light timber frame	330
4	108025469	RA, LVMA.889.1.27461	Box house		1970	Harju	400	Aerated concrete block	350
5	108025481	RA, LVMA.889.1.27469	Box house		1971	Light timber frame	380	Hollow brick	380
6	108025560	RA, LVMA.889.1.27525	Vertically displaced house		1984	Aerated concrete block	380	Aerated concrete block	350
7	108025585	RA, LVMA.889.1.27541	Box house		1982	Aerated concrete block	380	Aerated concrete block	450
7a			Bungalow house	Ella					
8	108025470	RA, LVMA.889.1.27462	Bungalow house		1971	x	250	Aerated concrete block	360
Lõuna põik									
3	108025510	RA, LVMA.889.1.27492	Box house		1978	Aerated concrete block	300	Aerated concrete block	330
4	108025484	RA, LVMA.889.1.27471	Partly two-floored house		1973	Aerated concrete block	310	Aerated concrete block	360
5	108026457	RA, LVMA.889.1.27638	Partly two-floored house		x	x	x	Aerated concrete block	x
6			Box house	TP 91-74					
7	108025499	RA, LVMA.889.1.27482	Box house		1976	Aerated concrete block	250	Aerated concrete block	280
8	108025607	RA, LVMA.889.1.27566	Partly two-floored house		1975	Harju	380	Light timber frame	330
10	108025536	RA, LVMA.889.1.27507	Box house		1982	Aerated concrete block	380	x	x
Metsa									
1			Bungalow house	Ella-5					
2	108028199	RA, LVMA.889.1.27607	Vertically displaced house	TP 81-74	1982	unknown	510	Aerated concrete block	x
4	108025566	RA, LVMA.889.1.27529	Vertically displaced house		1982	Aerated concrete block	380	Aerated concrete block	380
5	108032469	RA, LVMA.889.1.27389	Bungalow house	Pere-4	1983	Nõmme	300	x	x
6	108025565	RA, LVMA.889.1.27528	Box house		1982	Aerated concrete block	380	Aerated concrete block	420
8	108025544	RA, LVMA.889.1.27512	Vertically displaced house	TP 81-74					
9			Bungalow house						
10			Box house	TP 85-74					
Nurme									
1	108025188	RA, LVMA.889.1.27268	Traditional gable house		1956	Horizontal log	x	Light timber frame	x
3			Traditional gable house						
5	108033709	RA, LVMA.889.1.27599	Post-1980 gable house	villi-6	1991	Aerated concrete block	360	x	x
Oru tn									
2			Post-1980 gable house	Talu-5					
4	108041589	RA, LVMA.889.1.27621	Post-1980 gable house	Talu-5	x	x	x	x	x
Pikk tn									
21			Vertically displaced house	Toomas					
Jaama tn									
6	108025479	RA, LVMA.889.1.27467	Box house		1972	x	x	Light timber frame	370
11			Traditional gable house						
13			Traditional gable house						
15			Traditional gable house						
15a	108025529	RA, LVMA.889.1.27504	Bungalow house	TP 19123	x	x	x	Light timber frame	x
17			Traditional gable house						
19a			Traditional gable house						
Põhja tn									
1	108025365	RA, LVMA.889.1.27409	Bungalow house		1957	Light timber frame	x	Light timber frame	280
4			Bungalow house	TP 19123					
5	108025245	RA, LVMA.889.1.27357	Traditional gable house		1960	Light timber frame	200	Light timber frame	280
6			Bungalow house	TP 19123					
7	108025422	RA, LVMA.889.1.27436	Traditional gable house		1950	Light timber frame	x	Light timber frame	300
8			Traditional gable house						
9	108025408	RA, LVMA.889.1.27430	Traditional gable house	TP 46	1959	Light timber frame	200	Light timber frame	320
11	108025482	RA, LVMA.889.1.27470	Traditional gable house		1973	Horizontal log	300	Horizontal log	310
Pähkli tn									
3	108025563	RA, LVMA.889.1.27527	Bungalow house	TP 19123	1970	Pre-fab. wood frame	185	Pre-fab. wood frame	320
Põllu tn									
1			Traditional gable house						
2	108025259	RA, LVMA.889.1.27363	Traditional gable house		1957	x	x	Light timber frame	x
3	108038319	RA, LVMA.889.1.27595	Post-1980 gable house	kindlasti hilj	1992	Aerated concrete block	300	x	x
4			Traditional gable house						
6				ERAND					
8			Post-1980 gable house	Villi-6					
Rahu tn									
1	108025257	RA, LVMA.889.1.27362	Traditional gable house		1956	Horizontal log	x	Horizontal log	x
2	108025438	RA, LVMA.889.1.27444	Bungalow house	TP 19123	x	x	x	Pre-fab. wood frame	220
3	108025434	RA, LVMA.889.1.27441	Traditional gable house		1956	Vertical log	**120**	Horizontal log	320
4			Traditional gable house						
5	108025329	RA, LVMA.889.1.27392	Traditional gable house		1956	x	x	Light timber frame	x
6	108025413	RA, LVMA.889.1.27432	Traditional gable house		1968	Horizontal log	x	Horizontal log	180
Ravi tn									
5	108025355	RA, LVMA.889.1.27405	Partly two-floored house		1961	Light timber frame	x	Light timber frame	320
7			Bungalow house	TP 17421-4					
Renne tee									
2			Bungalow house	Kullipesa					
4			Bungalow house	Ella					
6			Bungalow house	Ella					
8			Bungalow house	Ella					
10			Bungalow house	Ella					
Soo tn									
3	108025480	RA, LVMA.889.1.27468	Box house		1972	Hollow brick	380	Hollow brick	400
6a	108041590	RA, LVMA.889.1.27484	Box house		1977	Harju	380	x	x
Säde tn									
4	108025502	RA, LVMA.889.1.27485	Bungalow house		1977	Harju	400	Aerated concrete block	380
6			Bungalow house	E-907					

Tare tn									
1			Bungalow house	Kullipesa					
2			Bungalow house	Ella					
3			Bungalow house	Kullipesa					
4			Bungalow house	Kullipesa					
5			Bungalow house	Kullipesa					
6			Bungalow house	Kullipesa					
7			Post-1980 gable house	Ants					
8			Bungalow house	Kullipesa					
9			Post-1980 gable house	Ants					
11			Post-1980 gable house	Ants					
15			Vertically displaced house	Toomas					
19			Vertically displaced house	Toomas					
21			Post-1980 gable house	Talu-4					
23			Post-1980 gable house	Talu-4					
Tare põik									
1			Bungalow house	Kullipesa					
2			Bungalow house	Kullipesa					
Uus tn									
4			Traditional gable house						
6			Traditional gable house						
7			Traditional gable house						
8	108025297	RA, LVMA.889.1.27378	Traditional gable house	TP-46	1959	Light timber frame	200	Horizontal log	200
9	108025306	RA, LVMA.889.1.27382	Traditional gable house		1957	x	x	Horizontal log	x
10	108025302	RA, LVMA.889.1.27380	Traditional gable house		x	x	x	Light timber frame	x
11	108025395	RA, LVMA.889.1.27423	Traditional gable house	TP-22	1960	Light timber frame	250	Light timber frame	240
12	108025372	RA, LVMA.889.1.27411	Partly two-floored house		1960	Brick	300	Light timber frame	300
13	108025304	RA, LVMA.889.1.27381	Traditional gable house		1959	Nopsa	500	Nopsa	600
14			Traditional gable house						
15			Traditional gable house						
16	108025352	RA, LVMA.889.1.27403	Partly two-floored house		1961	Light timber frame	200	Vertical log	260
17	108025374	RA, LVMA.889.1.27412	Traditional gable house		1958	Horizontal log	200	Vertical log	160
18	108025311	RA, LVMA.889.1.27384	Traditional gable house						
20	108025331	RA, LVMA.889.1.27393	Traditional gable house	E-3	1960	x	200	Light timber frame	180
21	108025474	RA, LVMA.889.1.27464	Traditional gable house		1959	Gerard	510	Gerard	500
22	108025339	RA, LVMA.889.1.27397	Traditional gable house	E-8	1959	Gerard	510	Harju	440
23	108025662	RA, LVMA.889.1.27636	Vertically displaced house		1991	Aerated concrete block	380	x	x
24	108025333	RA, LVMA.889.1.27394	Traditional gable house	E-6	1959	200	x	Light timber frame	230
26	108025313	RA, LVMA.889.1.27385	Traditional gable house		1958	Light timber frame	x	Light timber frame	x
Välja tn									
1			Vertically displaced house	Toomas					
2			Vertically displaced house	Toomas					
3			Vertically displaced house	Toomas					
4			Vertically displaced house	Toomas					
5	108025606	RA, LVMA.889.1.27565	Post-1980 gable house	tõnu	x	x	x	Aerated concrete block	380
6			Vertically displaced house	Toomas					
7			Post-1980 gable house	tõnu					
8			Vertically displaced house	Toomas					
10			Vertically displaced house	Toomas					
12			Vertically displaced house	Toomas					
Võidu tn									
5	108025325	RA, LVMA.889.1.27388	Traditional gable house		1957	x	x	Horizontal log	180
6			Traditional gable house						
8			Traditional gable house						
9	108025430	RA, LVMA.889.1.27440	Traditional gable house		1969	x	300	Light timber frame	220

Appendix 2 Inventoried addresses and properties of Karksi-Nuia

Aasa tn					project			Inventory	
2	117003552		Post-1980 gable house	standard					
4	117003556	RA, EAA.M-909.1.2003	Post-1980 gable house	standard	x	x	x	Pre-fab. wood panel	320
6	117003337		Post-1980 gable house	standard					
8	117003559		Post-1980 gable house	standard					
10	117003410		Post-1980 gable house	standard					
12	117003558		Post-1980 gable house	standard					
14	117003557		Post-1980 gable house	standard					
16	117007069		Post-1980 gable house	standard					
18	117007392		Post-1980 gable house	standard					
20	117007506		Post-1980 gable house	standard					
Aia tn									
1	117003530	RA, EAA.M-909.1.2016	Traditional gable house		1958	Vertical log	250	Vertical log	280
2	117003629	RA, EAA.M-909.1.2017	Traditional gable house		1961	Harju	380	Light timber frame	310
3	117003504	RA, EAA.M-909.1.2018	Traditional gable house		1959	x	230	Harju	350
5	117003502	RA, EAA.M-909.1.2020	Traditional gable house		1959	x	200	Vertical log	270
6	117003625	RA, EAA.M-909.1.2021	Traditional gable house		1961	x	300	Light timber frame	280
7	117003623	RA, EAA.M-909.1.2022	Traditional gable house		1961	x	250	Light timber frame	310
8	117003343	RA, EAA.M-909.1.2023	Traditional gable house	E-25	1961	x	200	Light timber frame	300
9	117003621	RA, EAA.M-909.1.2024	Traditional gable house		1961	x	250	Light timber frame	310
Arumäe tn									
3	117003860	RA, EAA.M-909.1.2029	Traditional gable house		1956	x	200	Light timber frame	290
5	117003874	RA, EAA.M-909.1.2031	Box house		1969	America wall	350	x	x
8	117007125	RA, EAA.M-909.1.2034	Traditional gable house		1970	Saw-dust concrete	380	x	x
12	117003470	RA, EAA.M-909.1.2038	Traditional gable house		1949	x	x	Vertical log	170
17	117003868	RA, EAA.M-909.1.2042	Vertically displaced house		x	x	x	x	x
Eha tn									
1	117003310	RA, EAA.M-909.1.2043	Box house		1971	Harju	380	Aerated concrete block	350
2	117006564	RA, EAA.M-909.1.2045	Traditional gable house		1955	x	250	Harju	410
2a	117003838	RA, EAA.M-909.1.2044	Box house		1971	Vertical log	340	horizontal log	280
J. Kivistiku tn									
7	117003617	RA, EAA.M-909.1.2063	Traditional gable house		1965	Harju	380	Harju	400
9	117003259	RA, EAA.M-909.1.2065	Traditional gable house		1965	Harju	380	Harju	400
11			Bungalow house	standard					
13	117003497	RA, EAA.M-909.1.2069	Bungalow house	standard	x	x	x	Pre-fab. wood panel	270
15			Bungalow house	standard					
17			Bungalow house	standard					
19			Bungalow house	standard					
21			Bungalow house	standard					
23			Bungalow house	standard					
25			Bungalow house	standard					
27			Bungalow house	standard					
Kaare tn									
1a	117003760	RA, EAA.M-909.1.2089	Box house		1974	x	380	x	x
4	112025390	RA, EAA.M-909.1.2092	Traditional gable house	E-11	1960	x	200	Light timber frame	280
5	117003499	RA, EAA.M-909.1.2093	Bungalow house		1961	x	320	Light timber frame	x
8	117003276	RA, EAA.M-909.1.2096	Box house		1961	Light timber frame	230	Harju	340
10	117003348	RA, EAA.M-909.1.2098	Traditional gable house		1961	x	300	Harju	440
14	117006623	RA, EAA.M-909.1.2099	Box house		1960	x	350	Light timber frame	300
Kalda tn									
1	117003544	RA, EAA.M-909.1.2102	Box house		1959	Light timber frame	230	Light timber frame	350
1a	117003848	RA, EAA.M-909.1.2103	Partly two-floored house		1973	Light timber frame	200	Light timber frame	280
3	117003487	RA, EAA.M-909.1.2105	Box house		1959	America wall	230	Light timber frame	300
5	117003445	RA, EAA.M-909.1.2106	Box house		1959	Harju	380	Harju	380
7	117006504	RA, EAA.M-909.1.2110	Box house		1966	Light timber frame	420	Light timber frame	360
9	117003749	RA, EAA.M-909.1.2111	Box house		1961	Light timber frame	250	Light timber frame	300
Kooli tn									
4			Partly two-floored house						
Lilli tee									
12	117003452	RA, EAA.M-909.1.2150	Traditional gable house		1959	x	350	x	x
Loode tn									
3	117007137	RA, EAA.M-909.1.2156	Post-1980 gable house		1983	Aerated concrete block	320		
5	117003604	RA, EAA.M-909.1.2157	Traditional gable house		1970	Harju	400	Harju	410
7	117003603	RA, EAA.M-909.1.2158	Traditional gable house		1974	horizontal log	380	Aerated concrete block	380
9	117003365	RA, EAA.M-909.1.2159	Traditional gable house		1958	x	500	Harju	400
11a	117003639	RA, EAA.M-909.1.2161	Bungalow house		1979	Aerated concrete block	420	Aerated concrete block	360
15	117003658	RA, EAA.M-909.1.2164	Post-1980 gable house		1988	Aerated concrete block	x		
15a	117007663	RA, EAA.M-909.1.2165	Post-1980 gable house		1987	Aerated concrete block	420	x	x
19	112026970	RA, EAA.M-909.1.2168	Box house		x	x	x	x	x
25	112031539	RA, EAA.M-909.1.2169	Bungalow house		1978	Light timber frame	300	x	x
29	117003384	RA, EAA.M-909.1.2335	Vertically displaced house	TP nr. 70	1978	Aerated concrete block	360	Aerated concrete block	350

Lõuna tn									
6	117003333	RA, EAA.M-909.1.2184	Post-1980 gable house		1986	Aerated concrete block	400	x	x
7	112030518	RA, EAA.M-909.1.2185	Box house		1976	Aerated concrete block	380	x	x
8	117003462	RA, EAA.M-909.1.2186	Post-1980 gable house		1986	Aerated concrete block	360	x	x
10	117003781	RA, EAA.M-909.1.2188	Traditional gable house		1972	Vertical log	280	Vertical log	270
13	117003553	RA, EAA.M-909.1.2190	Box house		1980	Aerated concrete block	380	x	x
15	117003655	RA, EAA.M-909.1.2191	Box house		1977	Aerated concrete block	380	x	x
17	117007403	RA, EAA.M-909.1.2192	Box house		x	x	x	x	x
19	117003822	RA, EAA.M-909.1.2194	Post-1980 gable house		1982	x	x	Aerated concrete block	x
20	112024521	RA, EAA.M-909.1.2195	Vertically displaced house		1986	x	x	x	x
21	117003478	RA, EAA.M-909.1.2196	(excluded)		x	x	x	x	x
23	117007651	RA, EAA.M-909.1.2197	Box house		1979	Aerated concrete block	390	x	x
25	117007473	RA, EAA.M-909.1.2198	Partly two-floored house		x	x	x	x	x
29	117003745	RA, EAA.M-909.1.2199	Box house		1977	x	x	Aerated concrete block	x
33	117003397	RA, EAA.M-909.1.2201	Box house		1977	Brick	510, 380	Aerated concrete block	x
Lepiku tn									
1	117003606	RA, EAA.M-909.1.2125	Traditional gable house		1959	x	300	Light timber frame	260
1a	117003277	RA, EAA.M-909.1.2124	Box house		1973	Light timber frame	380	Light timber frame	370
2	117003324	RA, EAA.M-909.1.2126	Bungalow house		1960	x	300	Light timber frame	300
3	117003363	RA, EAA.M-909.1.2127	Traditional gable house		1969	Harju	380	Light timber frame	290
4	117003608	RA, EAA.M-909.1.2128	Traditional gable house		1960	x	300	Light timber frame	350
5	117003609	RA, EAA.M-909.1.2129	Traditional gable house		1968	America wall	310	Light timber frame	350
7	117003359	RA, EAA.M-909.1.2131	Traditional gable house	E-8	1971	Saw-dust concrete	350	x	x
9	117003615	RA, EAA.M-909.1.2133	Traditional gable house		1971	Harju	380	unknown	x
13	117003592	RA, EAA.M-909.1.2136	Vertically displaced house		1979	unclear	510	Aerated concrete block	330
15	117007053	RA, EAA.M-909.1.2138	Box house		1981	Aerated concrete block	370	x	x
16	117003354	RA, EAA.M-909.1.2139	Bungalow house		x	x	x	Light timber frame	270
17	117007490	RA, EAA.M-909.1.2140	Box house		x	x	x	x	x
19	117003856	RA, EAA.M-909.1.2142	Box house		x	x	x	x	x
21			Box house						
22	117003598	RA, EAA.M-909.1.2145	Bungalow house		x	x	x	Light timber frame	270
23	117003597	RA, EAA.M-909.1.2146	Box house		1983	Nõmme	350	Nõmme	360
Metsa tn									
2	117003817	RA, EAA.M-909.1.2203	Bungalow house		1958	x	200	Light timber frame	250
Niine tn									
8/1´	117006703	RA, EAA.M-909.1.2218	Traditional gable house		1969	x	x	Light timber frame-error	400
Nurme tn									
1	117003375	RA, EAA.M-909.1.2219	Traditional gable house	E-11	1965	America wall	300	Light timber frame	320
2	117003465	RA, EAA.M-909.1.2220	Traditional gable house		x	x	x	x	x
4	117003815	RA, EAA.M-909.1.2221	Traditional gable house		x	x	x	x	x
6	117003448	RA, EAA.M-909.1.2223	Traditional gable house		x	x	x	x	x
8	117003446	RA, EAA.M-909.1.2224	Traditional gable house		x	x	x	x	x
10	117003613	RA, EAA.M-909.1.2225	Box house		1971	Nõmme	380	x	x
12	117003647	RA, EAA.M-909.1.2226	Traditional gable house		x	x	x	Harju	400
Oru tn									
1a	117003880	RA, EAA.M-909.1.2228	Box house		1970	America wall	370	x	x
3	112031518	RA, EAA.M-909.1.2230	Box house		1970	Light timber frame	360	Light timber frame	360
Põhja tn									
2	112031511	RA, EAA.M-909.1.2269	Box house		1971	Harju v America wall	370	Harju	x
4	117003762	RA, EAA.M-909.1.2270	Box house		1971	Harju	380	Harju - error	360
6	117007666	RA, EAA.M-909.1.2271	Vertically displaced house		x	x	x	x	x
Pärnu mnt									
25	117003832	RA, EAA.M-909.1.2308	Traditional gable house		1954	x	x	Light timber frame	300
Põllu tn									
1	117003811	RA, EAA.M-909.1.2272	Bungalow house		x	x	x	x	x
Piiri tn									
1	117003373	RA, EAA.M-909.1.2231	Traditional gable house	E-6	1960	x	200	Light timber frame	330
2	117003490	RA, EAA.M-909.1.2232	Traditional gable house		x	x	x	x	x
3	117003590	RA, EAA.M-909.1.2233	Traditional gable house		1974	x	x	Harju	400
4	117003866	RA, EAA.M-909.1.2234	Traditional gable house		1964	x	x	x	x
5	117003588	RA, EAA.M-909.1.2235	Traditional gable house	E-8	1964	Gerard	510	Saw-dust concrete	350
6	117007293	RA, EAA.M-909.1.2236	Box house		x	x	x	x	x
7	117003587	RA, EAA.M-909.1.2237	Traditional gable house	E-11	1963	Vertical log	300	Vertical log	240
9	117003319	RA, EAA.M-909.1.2238	Traditional gable house	E-8	1964	Gerard	510	Light timber frame	370
9a	117003586	RA, EAA.M-909.1.2239	Traditional gable house		1965	Vertical log	290	Light timber frame	200
11	117003371	RA, EAA.M-909.1.2240	Traditional gable house		1964	Light timber frame	310	Light timber frame	340
17/1´	117003777	RA, EAA.M-909.1.2242	Traditional gable house		x	x	x	Light timber frame	x
19	117003754	RA, EAA.M-909.1.2244	Traditional gable house		x	x	x	Light timber frame	x
21	117003529	RA, EAA.M-909.1.2245	Post-1980 gable house		x	x	x	Pre-fab. wood panel	320
47			Bungalow house	standard					
49			Bungalow house	standard					
51	117003219	RA, EAA.M-909.1.2250	Bungalow house	standard	x	x	x	Pre-fab. wood panel	270
53			Bungalow house	standard					
55			Bungalow house	standard					
57			Bungalow house	standard					
59			Bungalow house	standard					
61			Bungalow house	standard					
63			Bungalow house	standard					
65	117003275	RA, EAA.M-909.1.2260	Bungalow house	standard					
Rahumäe									
4	117003253	RA, EAA.M-909.1.2317	Vertically displaced house		1984	Aerated concrete block	350	x	x
8a	117003743	RA, EAA.M-909.1.2322	Box house		1964	America wall	300	Light timber frame	320
14	112030622	RA, EAA.M-909.1.2332	Partly two-floored house		1983	Aerated concrete block	380	x	x
16	117003454	RA, EAA.M-909.1.2329	Box house		1985	Aerated concrete block	400	Aerated concrete block	400
18	117003881	RA, EAA.M-909.1.2331	Box house		x	x	x	x	x

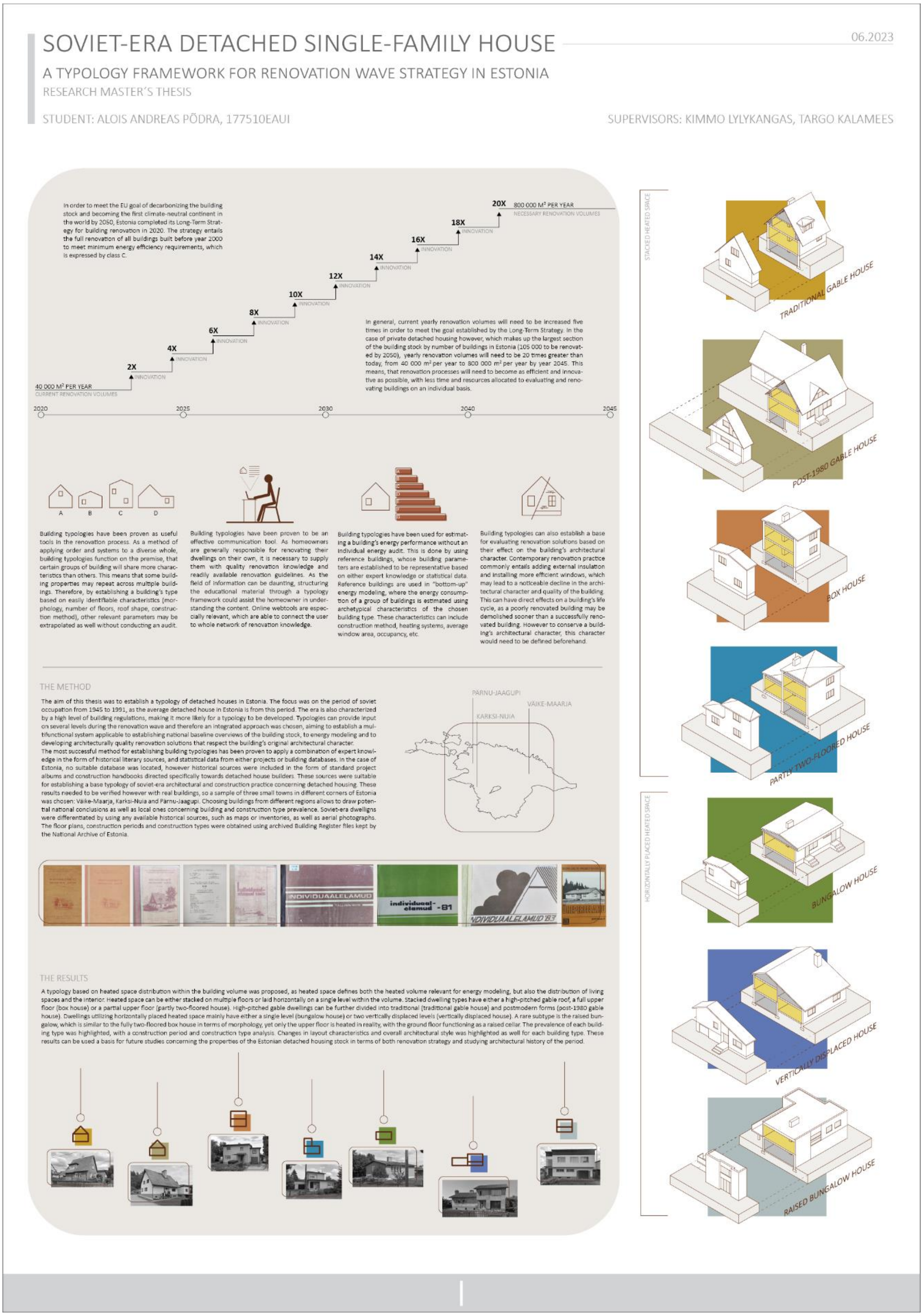
Tartu mnt									
9	117006465	RA, EAA.M-909.1.2344	Traditional gable house		1955	x	200	Harju	410
11	117003407	RA, EAA.M-909.1.2346	Traditional gable house		1959	x	300	Light timber frame	280
15	117003380	RA, EAA.M-909.1.2349	Traditional gable house		1950	Vertical log	200	Vertical log	200
16	117003796	RA, EAA.M-909.1.2350	Box house		1959	x	200	x	250
44	117003279	RA, EAA.M-909.1.2372	Box house		1984	Aerated concrete block	370	x	x
46	117003805	RA, EAA.M-909.1.2374	Traditional gable house		1956	Light timber frame	x	Vertical log	200
47	117003525	RA, EAA.M-909.1.2375	Traditional gable house		1960	x	300	Harju	390
48	117007123	RA, EAA.M-909.1.2117	Traditional gable house		1958	x	200	horizontal log	270
55	117003801	RA, EAA.M-909.1.2378	Box house		1959	x	250	Light timber frame	260
57	117003764	RA, EAA.M-909.1.2379	Traditional gable house		1958	x	300	Harju	400
59	117003271	RA, EAA.M-909.1.2380	Traditional gable house		1958	x	200	Light timber frame	260
61	117003758	RA, EAA.M-909.1.2058	Box house		1975	Harju	370	x	x
Veetorni tn									
4	117003879	RA, EAA.M-909.1.2333	Traditional gable house		1951	x	200	Vertical log	200
Umb tn									
1	117003779	RA, EAA.M-909.1.2402	Traditional gable house		1959	x	200	horizontal log	320
Uus tn									
1	117003411	RA, EAA.M-909.1.2404	Traditional gable house		1955	x	250	horizontal log	160
3	117003858	RA, EAA.M-909.1.2405	Traditional gable house		1955	x	300	Nõmme-error	380
4	117003480	RA, EAA.M-909.1.2406	Box house	TP 91-74	x	Brick	510/380	x	x
5	117006934	RA, EAA.M-909.1.2407	Traditional gable house		1955	x	200	horizontal log	210
7	117003840	RA, EAA.M-909.1.2408	Traditional gable house		1958	x	200	Light timber frame	x
9	117003854	RA, EAA.M-909.1.2409	Traditional gable house		1968	Harju	380	x	x
10	112030527	RA, EAA.M-909.1.2410	Box house						
11	117003390	RA, EAA.M-909.1.2411	Traditional gable house		1971	Harju	380	Light timber frame	380
12	117003759	RA, EAA.M-909.1.2412	Vertically displaced house		1989	Aerated concrete block	370	x	x
13	117007433	RA, EAA.M-909.1.2413	Traditional gable house		1968	Vertical log	250	Light timber frame	310
14	117007723	RA, EAA.M-909.1.2414	Vertically displaced house		x	x	x	x	x
Väike-aia tn									
1	117003537	RA, EAA.M-909.1.2438	Box house		1982	Light timber frame	380	Light timber frame	320
2			Bungalow house	standard					
3	117003886	RA, EAA.M-909.1.2440	Vertically displaced house		x	x	x	x	x
4			Bungalow house	standard					
väike tn									
2	117003870	RA, EAA.M-909.1.2435	Traditional gable house		1960	x	200	Light timber frame	270
4	117007167	RA, EAA.M-909.1.2436	Partly two-floored house		1960	x	300	Harju	400

Appendix 3 Inventoried addresses and properties of Pärnu-Jaagupi

Kalli mnt					Projekt			Inventuur	
4			Traditional gable house						
11	RA,	EAA.P-1184.2.2292	Traditional gable house		1969	x	250	Vertical log	270
13	RA,	EAA.P-1184.2.2293	Bungalow house	TP 17421-3	1980	Aerated concrete block	x	Aerated concrete block	x
15	RA,	EAA.P-1184.2.2294	Traditional gable house	TP-38	1969	Harju	350	Light timber frame	350
17	RA,	EAA.P-1184.2.2295	Traditional gable house		1956	x	200	Horizontal log	200
19	RA,	EAA.P-1184.2.2296	Traditional gable house		1953	x	x	Horizontal log	190
21	RA,	EAA.P-1184.2.2297	Traditional gable house		1946	Vertical log	x	Vertical log	x
Karja tänav									
6	RA,	EAA.P-1184.2.2311	Vertically displaced house		1976	x	x	Aerated concrete block	350
8	RA,	EAA.P-1184.2.2312	Vertically displaced house		1973	x	x	Light timber frame	x
Kergu mnt									
3	RA,	EAA.P-1184.2.2315	Box house		1966	Vertical log	x	Vertical log	290
8	RA,	EAA.P-1184.2.2319	Traditional gable house		1952	x	x	Double planking	190
10	RA,	EAA.P-1184.2.2320	Traditional gable house		1959		200	Light timber frame	x
12	RA,	EAA.P-1184.2.2322	Traditional gable house		1954	x	350	Vertical log	x
13	RA,	EAA.P-1184.2.2323	Traditional gable house		1969	Harju	400	Harju	x
14	RA,	EAA.P-1184.2.2324	Traditional gable house		1953	x	x	topelplank	250
16	RA,	EAA.P-1184.2.2325	Traditional gable house		1957	Horizontal log	150	Horizontal log	190
17	RA,	EAA.P-1184.2.2326	Traditional gable house		1948	x	x	Light timber frame	x
18	RA,	EAA.P-1184.2.2327	Traditional gable house	TP-23	1958	x	200	Horizontal log	270
19	RA,	EAA.P-1184.2.2328	Box house		1974	x	x	Light timber frame	370
21	RA,	EAA.P-1184.2.2330	Partly two-floored house		1968	Light timber frame	300	Horizontal log	350
22	RA,	EAA.P-1184.2.2331	Traditional gable house		1961	Horizontal log	150	Horizontal log	230
22b			Bungalow house	TP 10052					
23	RA,	EAA.P-1184.2.2334	Box house		1970	x	370	x	320
30	RA,	EAA.P-1184.2.2336	Traditional gable house		ei ole selge		250	Light timber frame	260
32	RA,	EAA.P-1184.2.2337	Traditional gable house		1960	x	200	Double planking	220
34	RA,	EAA.P-1184.2.2338	Traditional gable house		1969	Light timber frame	300	Light timber frame	350
36	RA,	EAA.P-1184.2.2340	Traditional gable house		1973	x	400	Light timber frame	300
40	RA,	EAA.P-1184.2.2341	Post-1980 gable house		1986	Aerated concrete block	x	x	x
42			Post-1980 gable house						
71	RA,	EAA.P-1184.2.2346	Traditional gable house		1958	x	290	Horizontal log	250
81	RA,	EAA.P-1184.2.2353	Box house		1959	Light timber frame	x	Light timber frame	310
84	RA,	EAA.P-1184.2.2355	Bungalow house		1974	Light timber frame	300	x	x
85	RA,	EAA.P-1184.2.2356	Traditional gable house		1945	Horizontal log	x	x	x
86	RA,	EAA.P-1184.2.2357	Traditional gable house		1956 / 197	x	x	Aerated concrete block	310
96	RA,	EAA.P-1184.2.2363	Traditional gable house		1952	x	x	Double planking	x
98	RA,	EAA.P-1184.2.2364	Traditional gable house		1957	x	x	Vertical log	270
102	RA,	EAA.P-1184.2.2367	Traditional gable house		1955	x	x	Vertical log	x
Kooli tn									
5	RA,	EAA.P-1184.2.2371	Partly two-floored house		1958	Harju	400	Harju	400
8	RA,	EAA.P-1184.2.2373	Traditional gable house		1955	Double planking	x	x	x
Lepa tn									
3	RA,	EAA.P-1184.2.2379	Vertically displaced house		1973	x	300	Harju	350
5	RA,	EAA.P-1184.2.2380	Vertically displaced house		1978	Aerated concrete block	x	x	x
Lõuna tn									
5	RA,	EAA.P-1184.2.2382	Traditional gable house		1954	x	x	Double planking	200
8	RA,	EAA.P-1184.2.2383	Traditional gable house		1973		380	Light timber frame	220
10	RA,	EAA.P-1184.2.2384	Vertically displaced house						
Männi tee									
1a	RA,	EAA.P-1184.2.2386	Bungalow house		1971	x	400	x	x
1	RA,	EAA.P-1184.2.2385	Box house		1969	Light timber frame	400	Light timber frame	350
4	RA,	EAA.P-1184.2.2388	Traditional gable house		1967	Harju	370	Light timber frame	350
6	RA,	EAA.P-1184.2.2400	Traditional gable house		1966	Harju	370	Harju	370
9	RA,	EAA.P-1184.2.2390	Traditional gable house		1954	x	x	Light timber frame	330
11	RA,	EAA.P-1184.2.2392	Traditional gable house		1956	x	x	Vertical log	290
12	RA,	EAA.P-1184.2.2393	Traditional gable house		1968	Harju	370	Light timber frame	370
14	RA,	EAA.P-1184.2.2394	Traditional gable house		1968	x	280	Light timber frame	x
16	RA,	EAA.P-1184.2.2395	Traditional gable house	TP-46	1957	x	200	Horizontal log	290
18	RA,	EAA.P-1184.2.2396	Traditional gable house	TP-51	1958	Light timber frame	300	Vertical log	300
20	RA,	EAA.P-1184.2.2397	Traditional gable house		1956	x	200	Vertical log	x
22			Traditional gable house						
Pargi tee									
1	RA,	EAA.P-1184.2.2403	Traditional gable house		1956	x	200	Light timber frame	300
3	RA,	EAA.P-1184.2.2405	Traditional gable house		1969	Light timber frame	220	Light timber frame	200
Pikk tn									
5	RA,	EAA.P-1184.2.2411	Traditional gable house		1954	x	230	Vertical log	x
6	RA,	EAA.P-1184.2.2412	Bungalow house	TP 10052					
7	RA,	EAA.P-1184.2.2413	Traditional gable house		1957	x	x	Horizontal log	240
8	RA,	EAA.P-1184.2.2412	Bungalow house	TP 10052					
12	RA,	EAA.P-1184.2.2417	Traditional gable house		1973	x	270	Light timber frame	380
20	RA,	EAA.P-1184.2.2420	Bungalow house		1973	x	x	x	x
30	RA,	EAA.P-1184.2.2424	Traditional gable house	T-11-P	1954	Light timber frame	200	Horizontal log	200
Põhja tn									
2	RA,	EAA.P-1184.2.2426	Traditional gable house	erandlik viil	1955	x	x	Horizontal log	190
3	RA,	EAA.P-1184.2.2427	Traditional gable house		1970	x	x	Light timber frame	340
Põik tn									
1	RA,	EAA.P-1184.2.2431	Traditional gable house		1957	x	x	Light timber frame	260
3	RA,	EAA.P-1184.2.2432	Vertically displaced house		1971	x	400	x	400
4			Vertically displaced house						
Põllu tn									
1	RA,	EAA.P-1184.2.2434	Traditional gable house		1955	x	x	Double planking	190
9	RA,	EAA.P-1184.2.2438	Box house		1979	Light timber frame	350	x	x

Pärnu mnt										
1		RA,	EAA.P-1184.2.2441	Vertically displaced house	suvi				Aerated concrete block	
3		RA,	EAA.P-1184.2.2444	Vertically displaced house	suvi				Aerated concrete block	
3a		RA,	EAA.P-1184.2.2443	Vertically displaced house	suvi				Aerated concrete block	
5		RA,	EAA.P-1184.2.2446	Partly two-floored house						
8a				Bungalow house	äkki E-907?					
15				Traditional gable house						
19				Traditional gable house						
49				Traditional gable house						
51				Traditional gable house	ei näe					
Suigu tee										
4				Traditional gable house						
Uus tn										
1		RA,	EAA.P-1184.2.2510	Traditional gable house		1959	x	300	Horizontal log	x
2c		RA,	EAA.P-1184.2.2511	Bungalow house		1987	Aerated concrete block	x	x	x
2d				Bungalow house						
3				Traditional gable house						
4				Bungalow house	Ella?					
5				Traditional gable house						
8				Traditional gable house						
10				Traditional gable house						
11				Traditional gable house						
13				Traditional gable house						
14				Traditional gable house						
15				Box house						
16				Box house	E-17					
17				Traditional gable house						
21				Traditional gable house						
23				Traditional gable house						
25				Traditional gable house						
27				Traditional gable house						
29				Traditional gable house						
30				Traditional gable house						
31				Bungalow house						
33				Traditional gable house						
35				Traditional gable house						
55				Traditional gable house						
57				Traditional gable house						
59				Traditional gable house						
Valistre tee										
2				Traditional gable house						
3				Traditional gable house						
4				Traditional gable house						
5				Traditional gable house						
7				Traditional gable house	lisaehitusega					
11				Traditional gable house						
Õhtu tn										
7				Traditional gable house						
15				Raised bungalow house	TP 90-74					
Ülase tn										
1		RA,	EAA.P-1184.2.2564	Vertically displaced house	suvi				Aerated concrete block	
2				Box house						
3		RA,	EAA.P-1184.2.2566	Vertically displaced house	suvi				Aerated concrete block	
4				Vertically displaced house						
6		RA,	EAA.P-1184.2.2568	Box house		1977	x	400	x	x
8				Box house						
10				Box house						
12				Vertically displaced house						
14		RA,	EAA.P-1184.2.2576	Traditional gable house		1971	x	220	x	x
16				Traditional gable house						
Sinilille tn										
1		RA,	EAA.P-1184.2.2490	Vertically displaced house	suvi				Aerated concrete block	
3		RA,	EAA.P-1184.2.2491	Vertically displaced house	suvi				Aerated concrete block	
5		RA,	EAA.P-1184.2.2492	Vertically displaced house	suvi				Aerated concrete block	
7		RA,	EAA.P-1184.2.2493	Vertically displaced house	suvi				Aerated concrete block	
9		RA,	EAA.P-1184.2.2494	Vertically displaced house	suvi				Aerated concrete block	

Appendix 4 Thesis presentation boards



SOVIET-ERA DETACHED SINGLE-FAMILY HOUSE

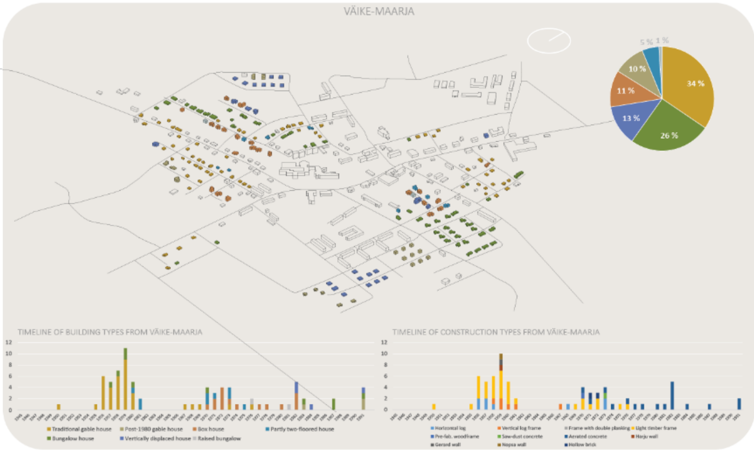
06.2023

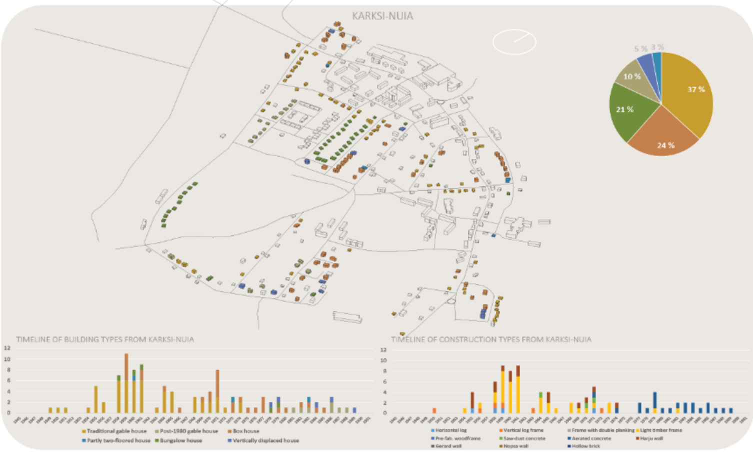
A TYPOLOGY FRAMEWORK FOR RENOVATION WAVE STRATEGY IN ESTONIA

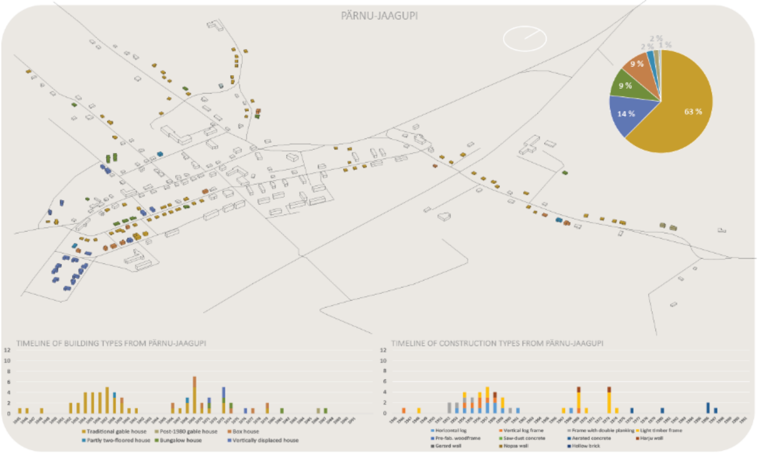
RESEARCH MASTER´S THESIS

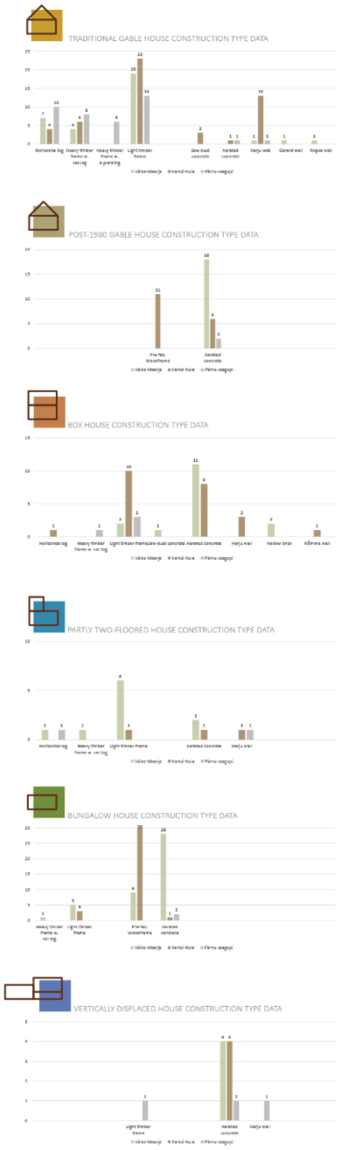
STUDENT: ALOIS ANDREAS PÕDRA, 177510EAUI

SUPERVISORS: KIMMO LYLYKANGAS, TARGO KALAMEES

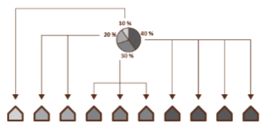








Construction types of building types were highlighted, however no clear correlation between specific construction method and building type was established. As soviet-era construction methods are difficult to determine without project documentation and close inspection, an entirely "bottom-up" energy modeling technique may not be applicable. For this reason, a statistical approach is proposed, where by establishing a database of construction type proportions for each building type, a group of buildings are assigned a construction method based on statistical proportion to represent an average sample of the chosen building type.



II