# Sustainable Historic Architecture in Rural Areas – Concept for a sustainable and low carbon retrofit of a Bavarian farmhouse

**Natalie Essig[1,2] and Alicia Maria Davis[1]**

[1] Dep. of Architecture, Munich University of Applied Sciences (MUAS), Karlstrasse 6, 80333 Munich, Germany
[2] natalie.essig@hm.edu

**Abstract:** The paper will show a real case project that has been retrofitted in a sustainable and energy efficient way to promote sustainable development in rural areas. The historical farm house "H14" (built up in 1858 and located in North Bavaria) is a typical Franconian three-sided building. The building has been vacant for over 30 years and the renovation was founded by the Bavarian Federal Office for the Preservation of Monuments and Historical Buildings. The paper will give an overview about the retrofit of the historical farm house into a two-family house with event and seminar rooms and its integration into the rural environment. The renovation concept pursued the following goals: low carbon retrofit and renewable energy solutions, resource efficiency, use of existing, historic and renewable building materials, life-cycle costs, buildings physics as well as integrating regional flora and fauna.

**Keywords:** Historic buildings renovation, energy retrofitting.

## 1. Introduction

The traditional historic architecture in rural areas is a key factor for sustainable development in the social, ecological and economic sense. Up to 60% of buildings in rural areas are "historic", but most of them are not in use and are increasingly decaying. In contrast to this, lots of new housing areas with single family units have emerged in the last years. The main aspect that was not considered in this development is that especially historic buildings are the basis of sustainable development in rural areas – not new ones. The preservation of historic buildings have several positive effects: use of the existing infrastructure, limitation of land use changes, decrease of rural depopulation, promotion of sustainable tourism and as one of the main effects, they reduce the ecological footprint [1]. It will only be possible to reach the ambitious climate targets and preserve the cultural landscape in rural areas if the regions and the people that are living there intensify their efforts in the valorisation and sustainable use of the historic buildings and understand this task as a mission for the whole civil society.

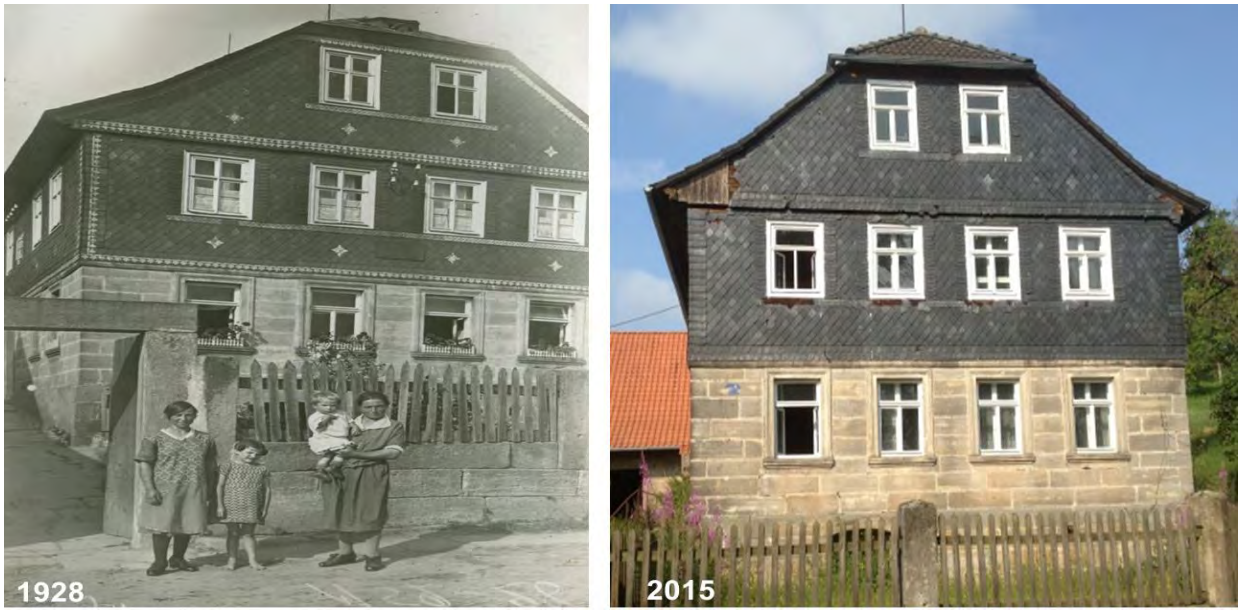


Image 1: Farmstead “H14” in 1928 and 2015 (pre-renovation)

## 2. Pre-Intervention Status

Prior to the start of the renovation an inventory was conducted in order to assess the building condition and develop coordinated renovation actions. In close coordination with the monument protection authority and specialist companies, the following measures were performed: building deformation survey, restoration report, roombook, dendrochronology, archival research, static report, building physics report, action plan, and construction cost estimate.

Image 2: Status quo “H14” (prior to the planning)

Image 3: Sustainability Goals “H14”

*2.1. Ensemble and Outdoor Complex*

The homestead “H14” is a typical Franconian three-sided building, which is composed of a residential building, a stable and a barn with an auxiliary building. The property is accessed next to the former cottage garden by a gate made of sandstone. The traditional “Sandsteintried” (sandstone ramp) guides one from the entry port to the main building and to the stable. A further entrance is located at the backside of the Farmstead and leads to the site of the former existing machine hall, which however collapsed in the past. Beyond the buildings used to be a meadow with fruit trees, fishing lakes and pastureland for the livestock. The complete property was overgrown and out of use for several of years.

*2.2. Main Building*

The main building was erected in 1858 and is located at the sight of a former farmhouse, which was built in 1774. A dendrochronological assessment revealed that various building materials of the preceding building were reused in the existing construction. The two-storied building is partly built with a cellar, which is made of sandstone. The ground floor as well is a massive sandstone construction, whereas the upper and attic floor are framework constructions with infills made of clay and which are clad with slates on the outside. The ground floor is accessible by the central entrance hall and is divided in three sections: the former living room, the kitchen and the former stable. The internal walls are made of framework filled with clay and sandstone blocks. Besides two new pumice stone walls from the 1960s in the former living room and in the stable as well as the construction of a new wooden staircase in the entrance area, no structural changes have been made. The wooden stairs lead to the upper floor which is divided in various small rooms, originally serving as bedrooms and servants chambers. The internal walls are typically made of framework filled with clay. Wooden stairs in the main hallway provide access to the attic floor with its preserved roof beams from 1858, which were reused from the preceding building from 1774. In the 1970s, the concrete tile roofing was renewed. All ceilings in the entire main building are wood-beamed ceilings. Whereas the kitchen on the ground floor and the entire rooms on the upper floor are equipped with Franconian wooden floors

and the entrance area is furnished with terrazzo flooring, the initially laid sandstone tiles in the former stable were replaced by a concrete floor. Unlike the well preserved ground floor, the upper and attic floor were in a poor condition and in danger of collapsing. Due to penetrating humidity numerous wooden beams in the roof and the walls were destroyed and suffered severe damage.

*2.3. Stable*

In 1873 a single-storey stable made of sandstone blocks was attached to the main building. The stable is accessed from the courtyard and used to consist of a feed storage chamber, a cowshed with a Prussian coved vault and a smokehouse with a water well. The outer walls as well as the gable walls are built with sandstone blocks, as the internal walls are made of quarry and sandstone on the ground floor and half-timbered constructions with quarry stone infills on the attic floor. While the historic roof beams from 1873/74 were preserved, the tile roofing over the stable was renewed in the course of a roof renovation in the 1990s. Furthermore the roof truss above the feed storage chamber was renewed and the intermediate ceiling was removed, however the original static structure was not restored. In addition, the coved vault made of bricks ad collapsed on several points.

Image 4: Sustainability Concept “H14”

## 3. Renovation Sustainability Concept and Goals

The farmstead "H14" in northern Bavaria is a typical Franconian three-sided building. The buildings of the farmstead (residential building, stable and barn) are arranged around a paved courtyard, which is reached entering the gateway. The residential building is a two-story, gable-fronted building with a hipped roof towards the street. The solid ground floor is made of sandstone, whereas the upper floor is a framework construction with slate cladding on the outside. After 30 years of vacancy, the farmstead "H14", built in 1858, has become outdated and was supposed to be retrofitted in an energy- and resource efficient manner. In addition to the residential building, a multifunctional room for seminars and events was created.

With the support of the district of Lower Franconia, the Bavarian State Foundation and the support from the compensation fund of the Bavarian State Ministry for Science and Art, a comprehensive renovation was implemented. The aim was to create a sustainable monument by means of a renovation concept suitable for historical monuments, renewable energies and the reuse of existing and regional

materials. Under the motto of the holistic renovation approach "ecology, economy and social aspects" and "efficiency (better), consistency (different) and sufficiency (less)", the following planning goals were the priorities in the course of the renovation:

- Preservation and promotion of building culture in rural areas: "Learning from the past"
- Resource efficiency: use of historic, regional and regenerative building materials
- Energy efficiency: Resource efficiency: renewable energies, an energy concept tailored to the building and energy storage
- Integral planning: sustainable living and working in historic walls
- Economic efficiency and life cycle costs
- Revitalization of the cultural landscape: the overall ensemble (buildings and outdoor complex)
- Promotion of floraaund fauna: biodiversity
- New mobility concepts for rural areas: e-mobility

## 4. Description of the implemented Sustainability Measures

*4.1. Ensemble and Outdoor Complex*

The main objective of the planning was to keep the farmstead "H 14" in its original function. The main objective of the planning was to keep the courtyard "H 14" in its original function. The exterior and interior building measures that were added in the 1960s and 1970s were carefully dismantled so that the original state could be restored. The barns and stables from 1823 were statically upgraded and the former cottage garden on the street side was newly laid out. The collapsed machine hall behind the three-sided farmhouse was torn down and used again as land for pasture and garden. In order to integrate the building ensemble into its natural cultural landscape and to promote the biodiversity, breeds of domestic livestock were resettled on the heavily overgrown meadow with fruit trees and at the fishing lakes. In doing so, "traditional and endangered" breeds of domestic animals, such as the "Coburger Fuchsschaf", a sheep with the colour of a fox, were used, in order to revive the natural resource cycles.

*4.2. Architectural Measures*

*4.2.1.Main Building: Living*

As part of the future use of the "H14" estate, the main building was retained in its original use as a residential building, which however can be divided into two residential units in the future. The "Sandsteintried" (sandstone ramp) remains the main access. In addition, the main building can be accessed from the garden with another entrance. The technical areas are located in the rear part on the ground floor. The entrance to the cellar made of sandstone was re located in the former kitchen of the main building and restored. The cellar area was drained and serves as a storage chamber for food and wine. No changes were made to the historical floor plan of the ground floor. The living room was restored to its original function as a kitchen, dining and lounge area and the pumice stone wall that was added in the 1970s, was removed. The former kitchen at the end of the entrance area was converted into a wardrobe and guest toilet. The stable section on the ground floor will be used in the future as a living room with a work and music area. The pumice stone wall, which was added to the former stable at a later date, was statically impaired and therefore removed, and the historic wooden structure of the stable (beams and pillars) was statically restored using a steel construction. The upper floor remains accessible via the wooden staircase. No floor plan changes were planned here either. The upper floor serves as a bedroom, children's room and guest room. The bathroom was arranged on the first floor above the former kitchen on the ground floor. For the time being the attic remains

unfinished and serves as a storage space. The former feed storage chamber of the attached stable is assigned to the residential building as a second residential unit, both on the ground as in the attic floor. All building services and storage rooms of the building were accommodated here, as well as an open room with a gallery. Another bathroom and the kitchen were situated on the attic floor of the former feed storage chamber.

*4.2.2.Stables: Multifunctional Room for Events*

The former stables were refurbished as a multifunctional event room for exhibitions and seminars. The objective is here to create a centre for sustainable building in rural regions. The main entrance is via the courtyard, however the event room is also accessible from the garden area. The former floor plan is retained. The sanitary rooms were integrated into the former feed storage chambers, from where the future event room is also connected to the main building. Next to the event room, a kitchen for accommodation/catering is planned in the former smokehouse. For this purpose, an opening was made from the smokehouse to the former stables. The kitchen can be accessed form the courtyard, as well as from the garden. For the time being, the attic floor above the event room remains unfinished and serves as storage space.

Image 5: Photovoltaic concept in cooperation with the monument protection authority

*4.3. Energy-efficient, Constructional and Technical Measures*

Within the scope of the renovation of the farmstead „H 14“, besides the preservation of the building's history and building culture, particular attention was paid to the constructional, energy efficient and sustainable retrofitting of the building as well as the use of renewable energies. The following planned measures were synchronized:

*4.3.1.Drinking Water and Sewage*

So far the construction project "H14" has no connection to the public drinking-water or sewage supply. Solely, in the courtyard remains of a outside toilet were found close to the dung hole pit. The initial concept intended to use the buildings own water well for service water, however due to poor water quality, the building now relies on public drinking-water supply and the well provides water for the garden irrigation. Furthermore, rainwater is collected in a cistern in the garden. The historic drainage in the courtyard directs the excess rainwater to the adjacent river.

*4.3.2.Building Services*

The renovation's aim was to significantly reduce the energy demand of the building. Heating with renewable energies was at the forefront, in particular with wood as the farmstead has the right to cut wood in the neighbouring community forest. The energy concept purposes a combination of an air-

water heat pump for the base load and the use of multiple wood-burning stoves (partially water bearing). The operation of the air-water heat pump is supported by the electricity generated by a photovoltaic plant, which is hidden and integrated in the roof of the former dove cote (annex of the barn). The concept of the installation of the PV system was coordinated with the office for the preservation of monuments beforehand (see Image 5). In the future, battery storages and e-mobility are to be integrated.

*4.3.3.Thermal Component Activation*

The residential building is heated by a component activation in terms of the installation of wall heating on the outer walls on the ground and upper floor and floor heating in addition. The event room as well as the kitchen area are equipped with floor heating, which is integrated into the screed. Furthermore the main building can be heated with additional fireplaces. The existing fireplaces were refurbished. As a large section of the building does not have a cellar and was used as stables (salinization of the walls) and as there were no protective measures made against rising damp from the floor area, a thermal component activation on the basis of the tempering method as a horizontal barrier by Großeschmidt was applied [2]. At the level of the base plate, an entire heating pipe was laid on the ground floor (see Image 6), which is heated all year round in order to prevent humidity from rising. With the software programme WUFI ® (Wärme Und Feuchte Instationär) different variants were simulated, in order to determine the moisture content in the sandstone masonry and in the lime plaster and to define the layout of the heating pipes (see Image 6 and 7):

- Variant 1: without additional heat source
- Variant 2: heat source in sandstone
- Variant 3: heat source in lime plaster

Variant 3 was executed, as it was the easiest option to implement in terms of building construction. Furthermore, the thermal component activation is to be reassessed by a future monitoring.

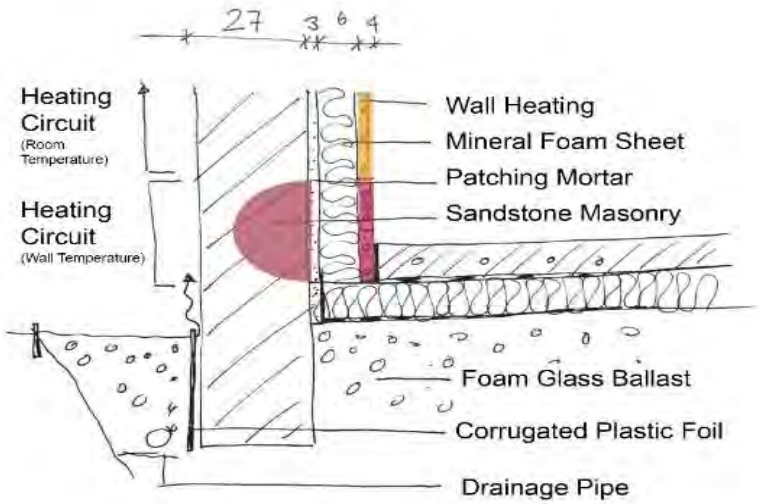



Image 6: Concept idea on building part tempering for protection against ascending humidity as per Großeschmidt

*4.3.4.Building Physics and Building Envelope*

Monument protection and building culture play an important role in the energetic renovation of the "H 14" estate. The object is to make the building as energy-efficient as possible in the context of careful and preservation-friendly handling of the building envelope (e.g. interior insulation).
The exterior facade and the structure of the building are completely retained, i.e. the sandstone facade on the ground floor and the slate façade on the upper floor retain their historical structure. In the context of the energetic concept, a distinction is made between the using of the premises. The

energetic renovation of the building envelope of the residential building is carried out on the exterior walls with the installation of interior insulation made of mineral foam panels on the historic plaster on all floors. Care is taken to ensure that these are retained to the greatest extent possible. The wall heating is attached to the interior insulation, as well as the lime plaster. All connections (ceilings, interior walls) were planned and professionally implemented by the means of thermal bridges calculations. The energetic concept of the event room (formerly stable) is based on different standards. The focus here is on the function and its former use. Due to the temporary use, the exposed sandstone outer walls are solely re-grouted (airtightness).

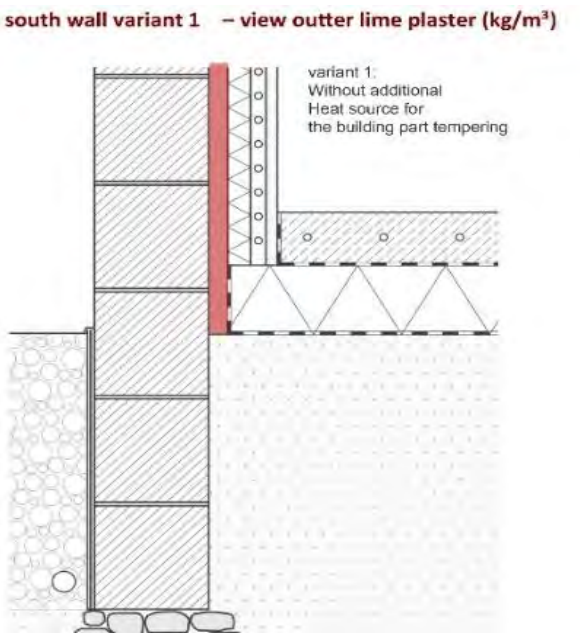


Image 7: Building part tempering variant 1 for protection against ascending humidity

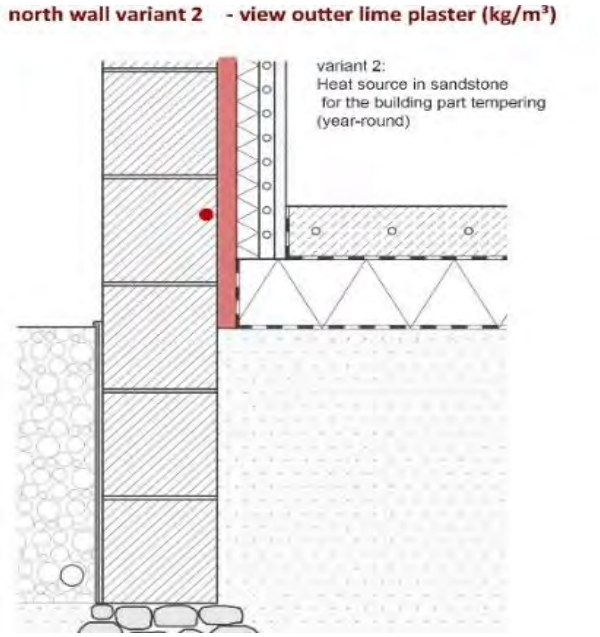


Image 8: Building part tempering variant 2 for protection against ascending humidity

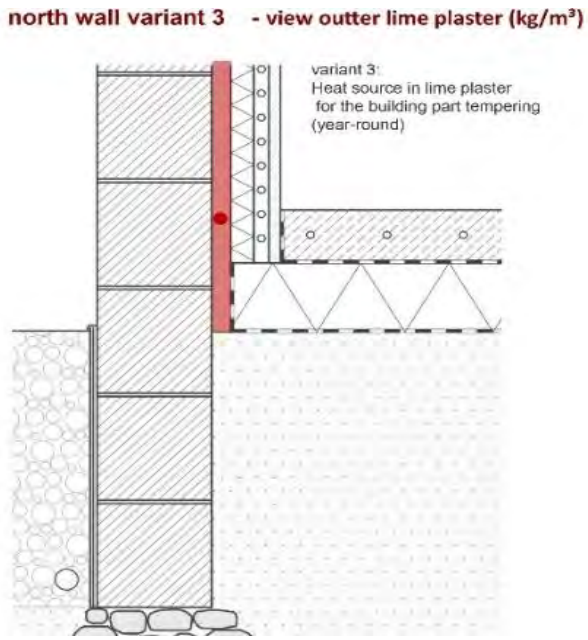


Image 9: Building part tempering variant 3 for protection against ascending humidity

The basement ceiling on the ground floor is insulated in the living area and in the former stables with foam glass gravel, on which the exposed concrete and the restored wooden ceilings were applied. All ceilings from the first floor to the attic and the main roof of the former stables (including the smokehouse and the feed storage chamber) were filled with hemp insulation between and below the rafters to ensure thermal comfort within the building.

In the main house, all historic outside windows are preserved and renovated. The inner box-type windows installed in the 80s were removed, as the building physics requirements were not met here, and they were professionally re-installed with double insulating glazing made of wood (also as box-type windows). Particular care was taken to ensure that there were no thermal bridges in the reveals. The former stable buildings had no windows so far. Windows with double insulating glass made of wood were installed here. The historic entrance door of the main building has been energetically upgraded.

*4.4. Resource Efficiency Measures*

For the renovation of the "H14" project, existing, historic and renewable resources were be used. A static report as well as the constructional assessment formed the basis for the further measures. The examination of the roof structure revealed major damages to the construction of the collar beam roof. Most of the wood originated from a preceding building out of the 18th century. The roof structure of the residential building had to be upgraded, so that as many components as possible could be preserved for reasons of monument protection. After the old roofing was removed, it was found that numerous rafters had to be replaced or reinforced. Carpenters reinforced the entire roof structure with steel beams. In large areas, the base of the collar beam roof as well as the tops of the ends of the centering beams were replaced or supplemented. Also the collar beams had to be renewed or reinforced. The half-timbered walls were supplemented and plastered with clay wraps on all stories, as well as all the ceilings were renewed with clay. All historic wooden floors on the upper floor have been restored and reinstalled.

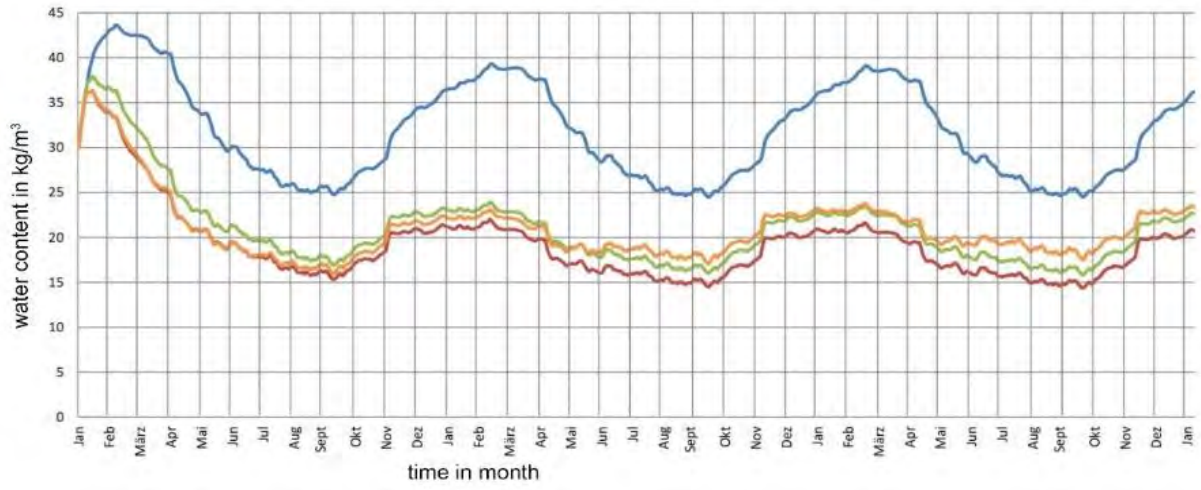



Image 10: Humidity simulation of the different variants of building part tempering

The facade of the upper half-timbered stories was re-slated, largely using the old, rhombic shaped stones. In addition, the decorations on the slates were applied to the slate stones according to a historic template. Since this is an old craftsmanship and no specialist company could be found for the implementation, the client, together with restorers, newly acquired the craft. Appropriate patterns were cut out of tin foil and placed on the slate stones with a mixture of linseed oil. In earlier times, lead silver alloy was our tinfoil of today. Today it is a thin, rolled tin foil.

Image 11: Renewal of the slates

Literature:
[1] Bundesinstitut für Bau-, Stadt- und Raumforschung 2017 Themenheft „Gebäudetechnik“ *Energieeffiziente Gebäudetechnik im Baudenkmal. Wissenschaftliche Begleitung der Modellvorhaben „Gebäudebestand (Energieeffizienz, Denkmalschutz)“ in der Umsetzungsphase*; cf. https://www.bbsr.bund.de/BBSR/DE/forschung/programme/weitere/ekf/ModellvorhabenGebaeudebestand/ekf-themenheft.pdf?__blob=publicationFile&v=1 (12.01.2021)
[2] Großeschmidt H 2004 *Das temperierte Haus: Sanierte Architektur – behagliche Räume – “Großvitrine”* cf. https://www.initiative-denkmalschutz.at/images/2011/03/Henning_Das_temperierte_Haus_lang.pdf (10.05.2020)



# Sustainable Historic Architecture in Rural Areas – Concept for a sustainable and low carbon retrofit of a Bavarian farmhouse

**Prof. Dr.-Ing. Natalie Essig (Architect)**
Hemmendorf (Germany), May 30th 2021
Contact: natalie.essig@hm.edu

HOCHSCHULE FÜR ANGEWANDTE WISSENSCHAFTEN MÜNCHEN

# Frankonian Homestead „H14“



**Project „H14“ (North Baveria Germany)**
**Franconian homestead (1868)**

# Sustainable „Monument“ – Is it possible?

Resource efficiency:
use of existing, historic and
regenerative building materials

E-mobility

Building culture
and historic preservation

Flora and fauna:
Nature conservation

Life Cycle Costs

Integral planning:
Modern living
in old farm

Plus energy standard,
energy efficiency and
renewable energies

# Planning process before starting

## Building Inventory

- Complex site measurements
- Restauration expertise
  - Room book
  - Dendrochronology
  - Archive recherche
- Expertise of:
  - Static Engineer
  - Building Physics Engineer
- Catalogue of measures
- Determination of building costs

## Further:

- Architect: Prof. Dr. Natalie Essig
- Regional Companies
- Timeframe: 2016 to 2021
- Strong coorporation with monument protection authority and community
- Supported by German compensation found

# Homestead „H14“

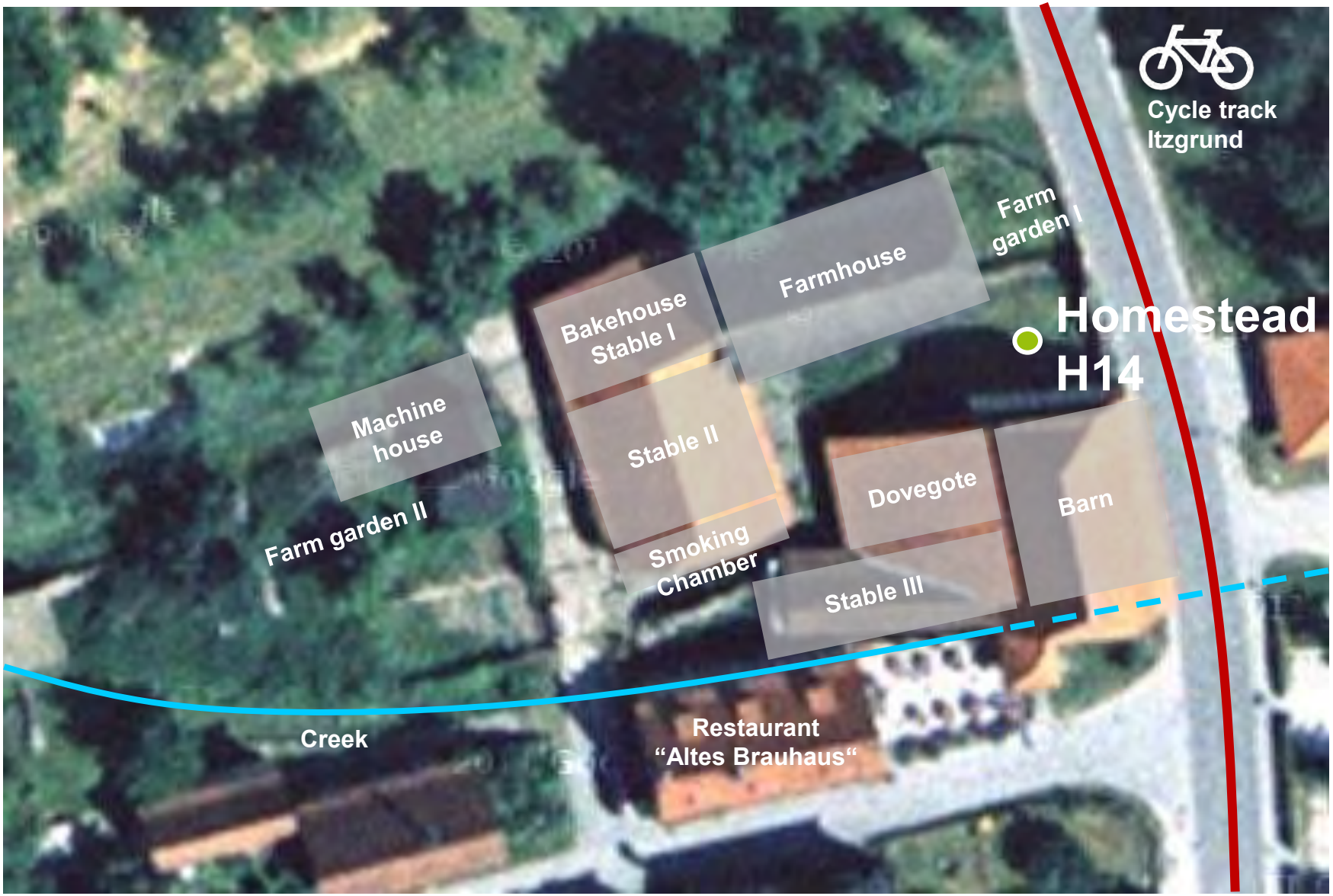
## Siteplan: 18th Century


Source: Staatsarchiv Bamberg A 240 R473

# Homestead „H14“


Source: Familie Herbig

# Homestead „H14“: Use before renovation



# Homestead „H14“: Use after renovation

# Planning and Energy Concept „H14“

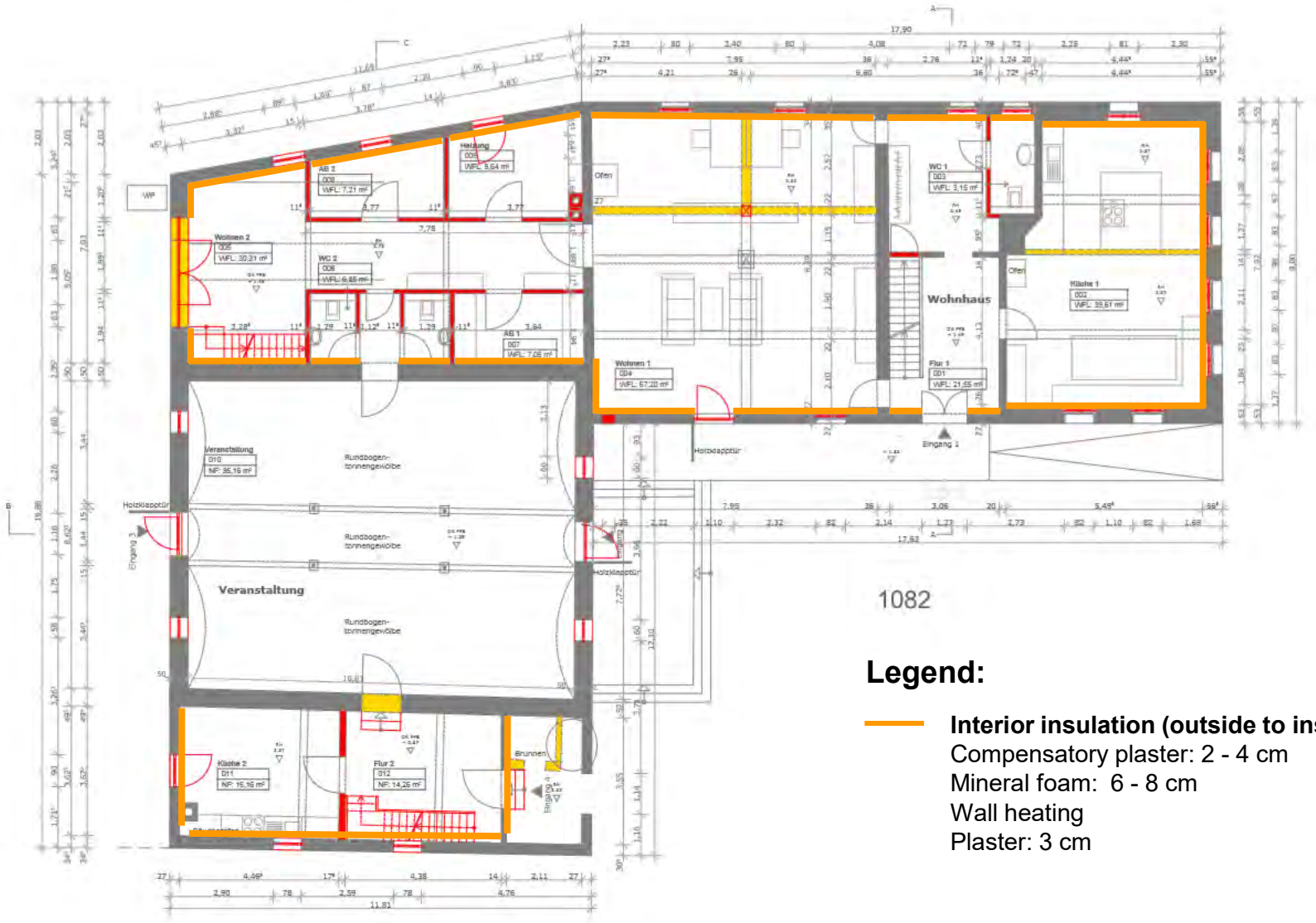
## Planning concept:

- Living Area:
  - Residential and office (2 units): 280 sqm
  - Guests appartement: 30 sqm
  - Seminar rooms: 120 sqm
  - Stables and barns: > 200 qm

## Energy concept:

- Heating with renewable energies: heat pump and four wood fired ovens (one for hot water loading)
- Natural ventilation by windows
- Photovoltaic plant (10 kWp) for energy production
- Thermal activation with floor and wall heating
- Horizontal barrier by mass activation of the wall
- Preliminary setup: battery and E-Mobility
- Smart Home
- Interior insulation with sustainable building materials

# Building Envelope Concept „H14“: Interior Insulation

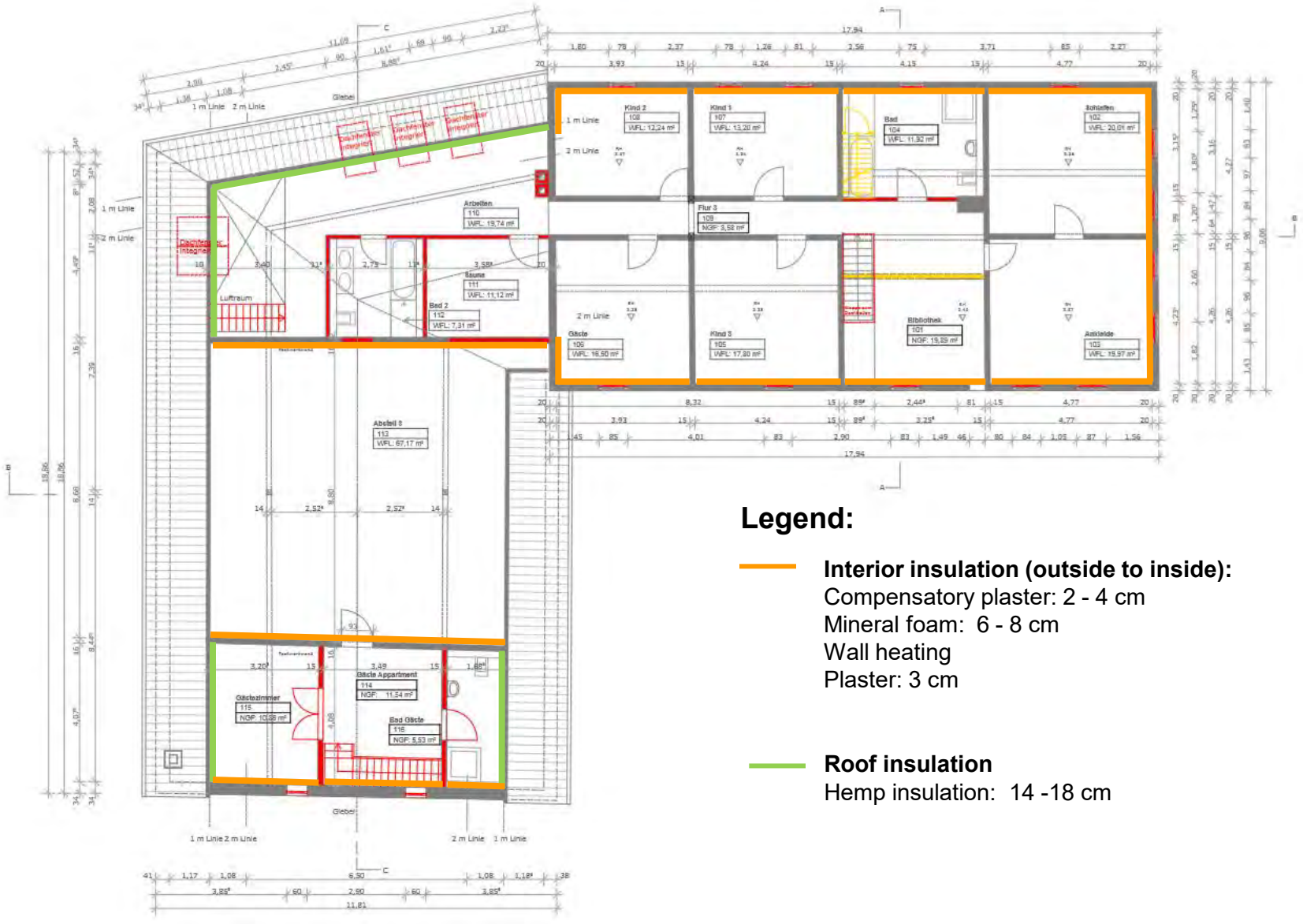



## Legend:

**Interior insulation (outside to inside):**
Compensatory plaster: 2 - 4 cm
Mineral foam: 6 - 8 cm
Wall heating
Plaster: 3 cm

**Floor plan: ground level**

# Building Envelope Concept „H14“: Interior Insulation




## Legend:

**Interior insulation (outside to inside):**
Compensatory plaster: 2 - 4 cm
Mineral foam: 6 - 8 cm
Wall heating
Plaster: 3 cm

**Roof insulation**
Hemp insulation: 14 -18 cm

**Floor plan: 1st level**

# Building Envelope Concept „H14“: Interior Insulation


## Legend:

**Interior insulation (outside to inside):**
Compensatory plaster: 2 - 4 cm
Mineral foam: 6 - 8 cm
Wall heating
Plaster: 3 cm

**Floor insulation:**
Ground floor:
Foarm glas insulation: 20 – 30 cm
Historic wood floor or concrete
Top floor:
Hemp insulation: 8 -10 cm

## Section Main Building

# Homestead „H14“

**Foam glass insulation (seminar rooms)**

# Homestead „H14“

**Mineral foam insulation (living roams)**

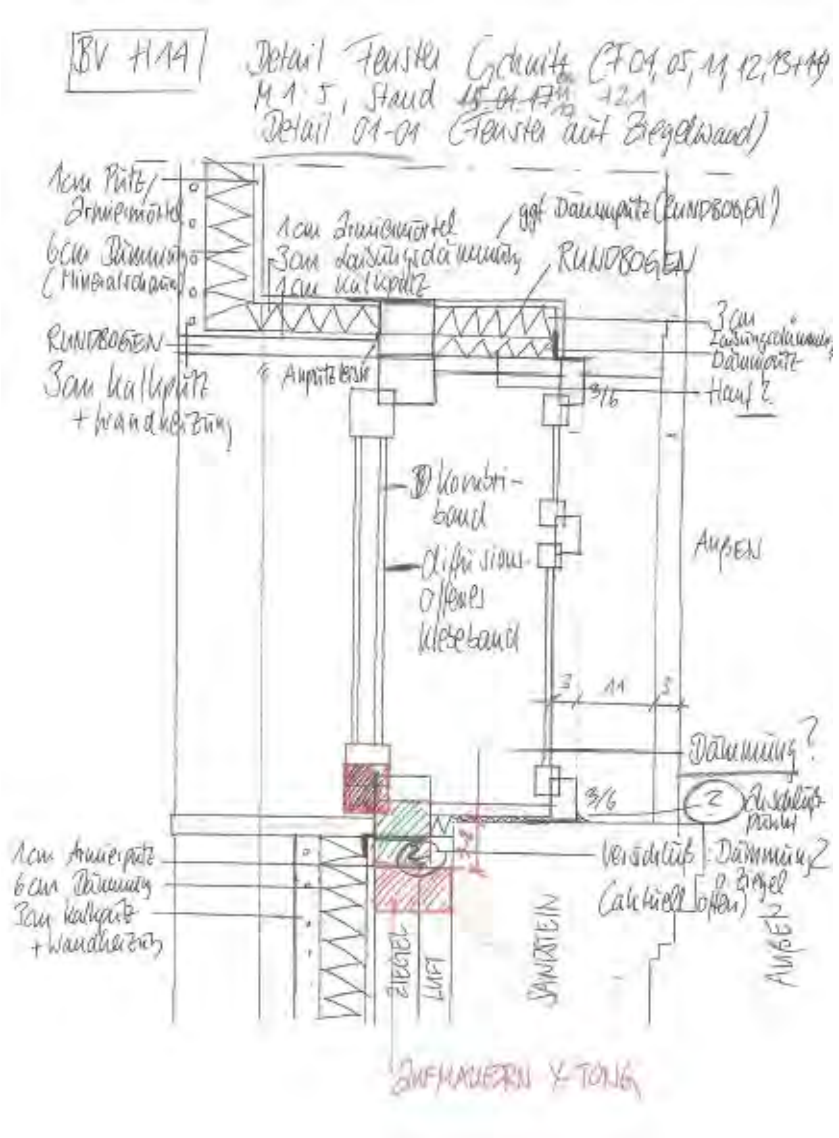
# Homestead „H14“

**Mineral foam insulation (living roams) and holders for wall heating pipes**

# Homestead „H14“

**Mineral foam insulation (living roams) and wall heating pipes**

# Homestead „H14“




**Important: Detailed planning to avoid thermal bridges**

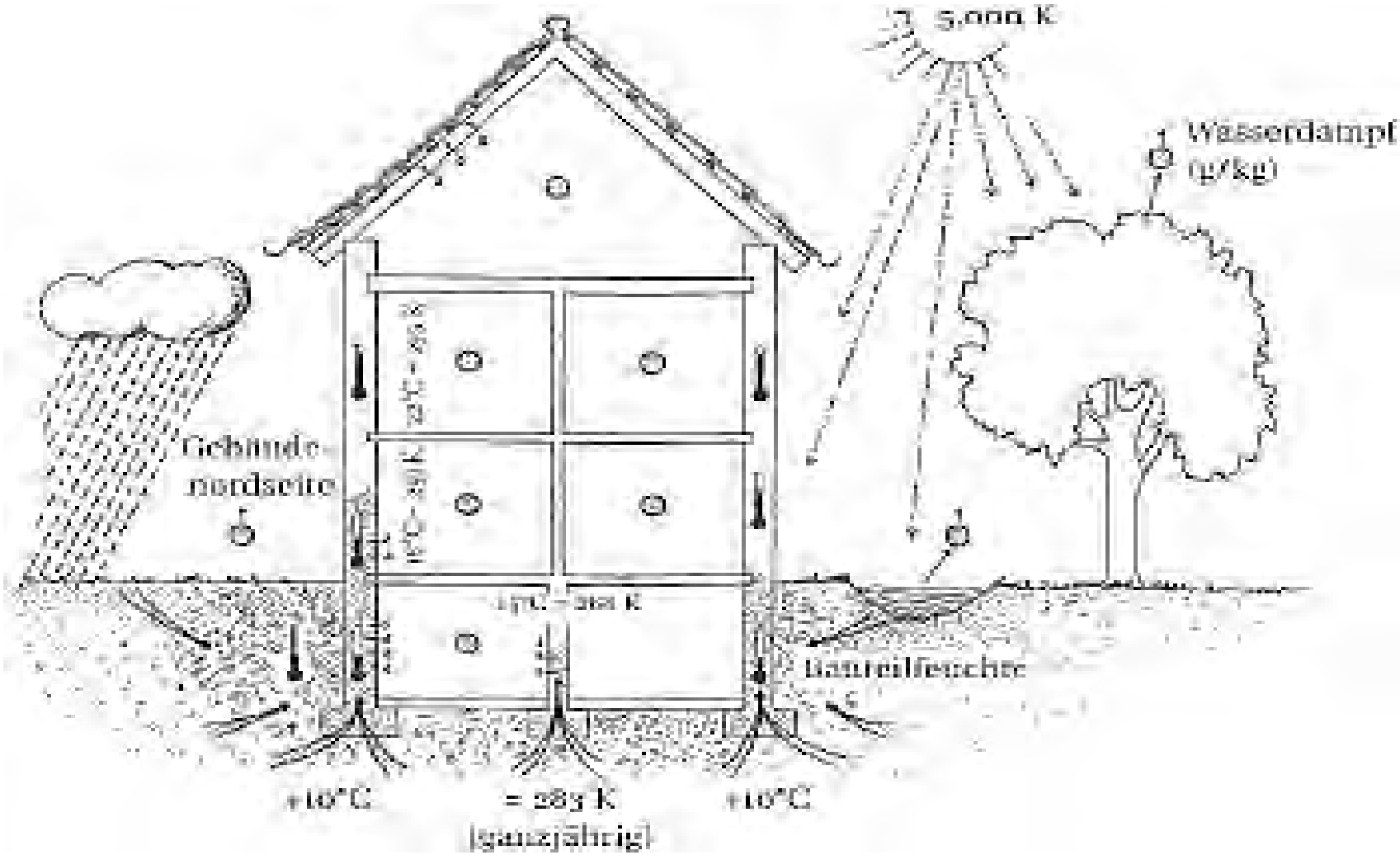
# Photovoltaic „H14“


**Conzepts for the Integration of the photovoltaic in cooperation with the conservation authorities**

# Photovoltaic „H14“

# Photovoltaic „H14“

# Konzept der Gebäudehülle „H14“: Bauteilfeuchte




**Bauteilfeuchte und fehlende Horizontalsperren im Altbau**

# Konzept der Gebäudehülle „H14“: Bauteilfeuchte


**H14 (Ansicht West): nicht unterkellert, zum Teil Versalzung der Wände (ehemalige Stallnutzung)**

**Horizontalsperre durch Injektion?**

**Horizontalsperre durch Einschneiden?**

# Konzept der Gebäudehülle „H14“: Bauteilfeuchte

**Gestein Nr. 106**

## NEUBRUNNER SANDSTEIN

**Klastische Sedimentgesteine,**
**Sandsteine, Keuper**

**Handelsname:** Neubrunner Sandstein

**Abbauort:** Neubrunn, Haßberge, 12km östlich von Haßfurt, Unterfranken.

**Geologische Kurzbeschreibung:** heller, bunt gepünktelter, fein- bis mittelsandiger Sandstein (»Weiller Mainsandstein«).

**Geologisches Alter:** Mittlerer Keuper (Sandsteinkeuper, Baunsandsteinstufe).

**Petrographische Beschreibung:**

***Megaskopischer Überblick:*** heller, chamoiser, fein- bis mittelsandiger Sandstein; grüngrau, braunrot und schwarz gepünktelt. Erzkörner und Hellglimmer neben chloritisierten und fleischfarbenen Feldspäten gut erkennbar.

*Gesamtfarbe:* weiß (10 YR 8/1 bis 5 Y 8/1).

*Struktur:* fein- bis mittelkörnig; mäßig sortiert; feinporig homogen.

*Textur:* homogen ungeschichtet.

***Mikroskopisches Beispiel:***
Komponenten 83%, Bindemittel 5%, sichtbarer Porenraum 12%.

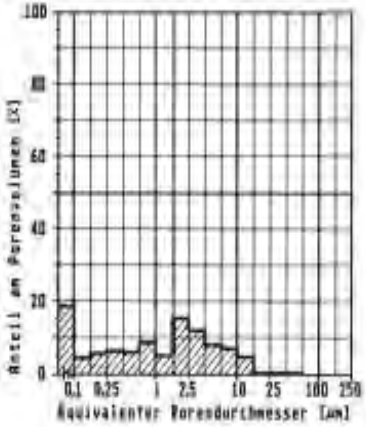
*Komponenten:* Quarz 65%, Gesteinsbruchstücke 14%, Alkalifeldspat 12%, Plagioklas 7%, Akzessorien 2% (Hornblende, Muscovit, Turmalin, Rutil, Zirkon, Apatit, opakes Erz). –
Quarz: undulös auslöschend; meist schwach angerundet; partiell Schwermineraleinschlüsse. Gesteinsbruchstücke: grauschwarze metamorphe Bruchstücke, Tonschiefer, Chert, Polyquarz. Alkalifeldspat: häufig nur im Achsenbild zu erkennen; teils Mikroklingitterstruktur.

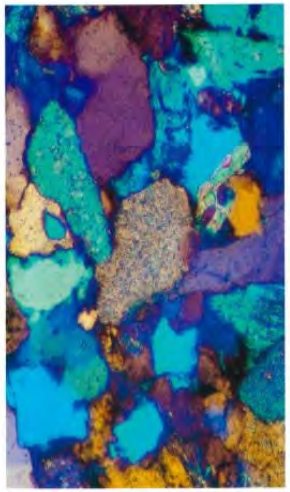
*Bindemittel:* kieselige Kornbindung über länglichen und konkaven Kontakt. Quarzanwachssäume nicht erkennbar; teilweise tonig-chloritische Bindung, vor allem in Kornzwickeln, aber auch als

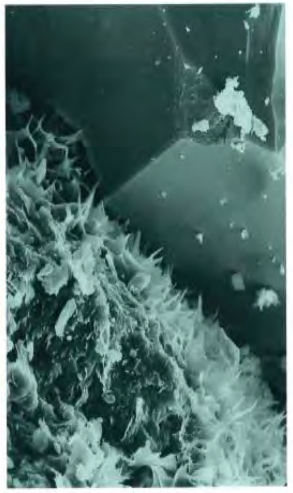
**Gesteinsdichte, Porenraum, Porenfüllung:**

| | | | |
|---|---|---|---|
| – Dichte, rein | (g/cm³) | : | 2.64 |
| – Dichte, roh | (g/cm³) | : | 2.25 |
| – Porosität | (Vol. %) | : | 14.73 |
| – Wasseraufnahme unter Atmosphärendruck | (Gew. %) | : | 4.29 |
| – Wasseraufnahme unter Vakuum | (Gew. %) | : | 6.55 |
| – Sättigungsgrad | (—) | : | 0.66 |
| – Spezifische Oberfläche | (m²/g) | : | 3.34 |

*Porendurchmesser-Verteilung*

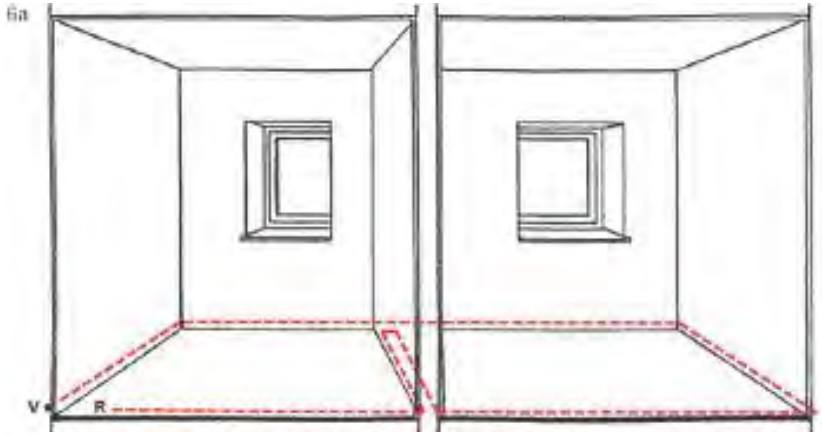


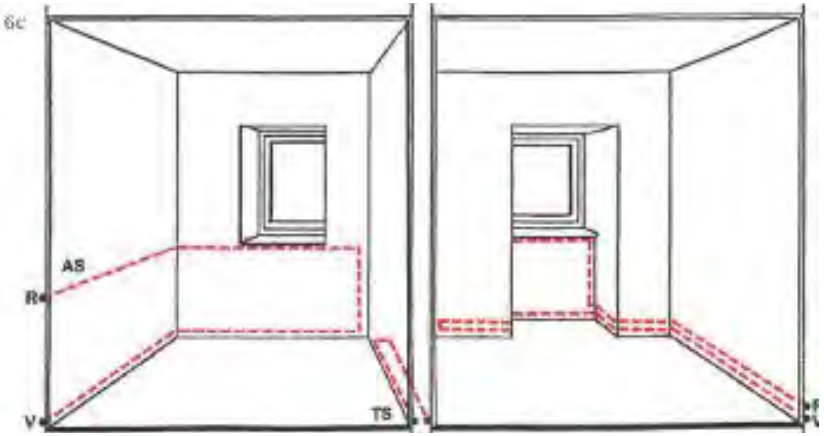


**Recherche Mauerwerk Sandsteine**

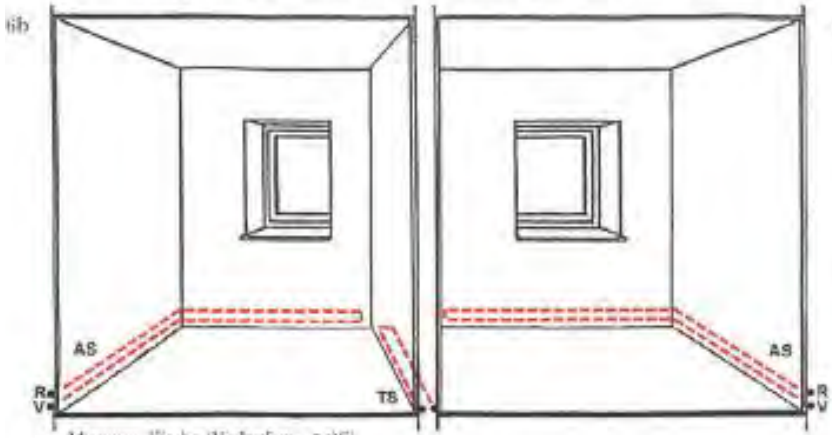
# Konzept der Gebäudehülle „H14“: Bauteilfeuchte



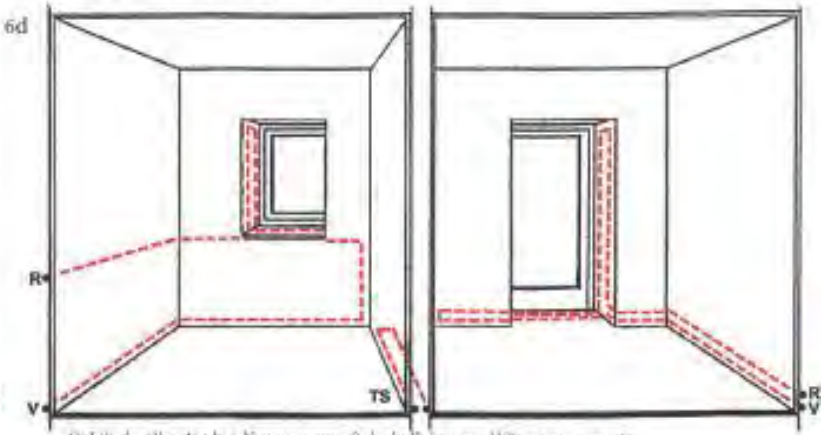

- Konservierung von Bausubstanz und Raumausstattung (Baudenkmäler, Exponatgebäude, Freilichtmuseen; Vorlauf: 30$^0$C )
- Feuchtesanierung und Beheizung von Kellern; Vorlauf: 30-40$^0$C)




- Museen mit höherem Temperaturanspruch (Vorlauf: 30-55$^0$C )
- Wohngebäude (Wandstärken zwischen 30 und 60 cm; Vorlauf: 30-65$^0$C)




- Museen, Kirche (Vorlauf: 30-55$^0$C )
- Wohngebäude (Wandstärken ab 60 cm; Vorlauf: 30-65$^0$C)




- Gebäude aller Art bei Nutzung von Solarkollektoren, Wärmepumpe etc.
- Wohngebäude (Leichtbau, Fachwerk, Glasfassaden; Vorlauf: 30-65$^0$C)

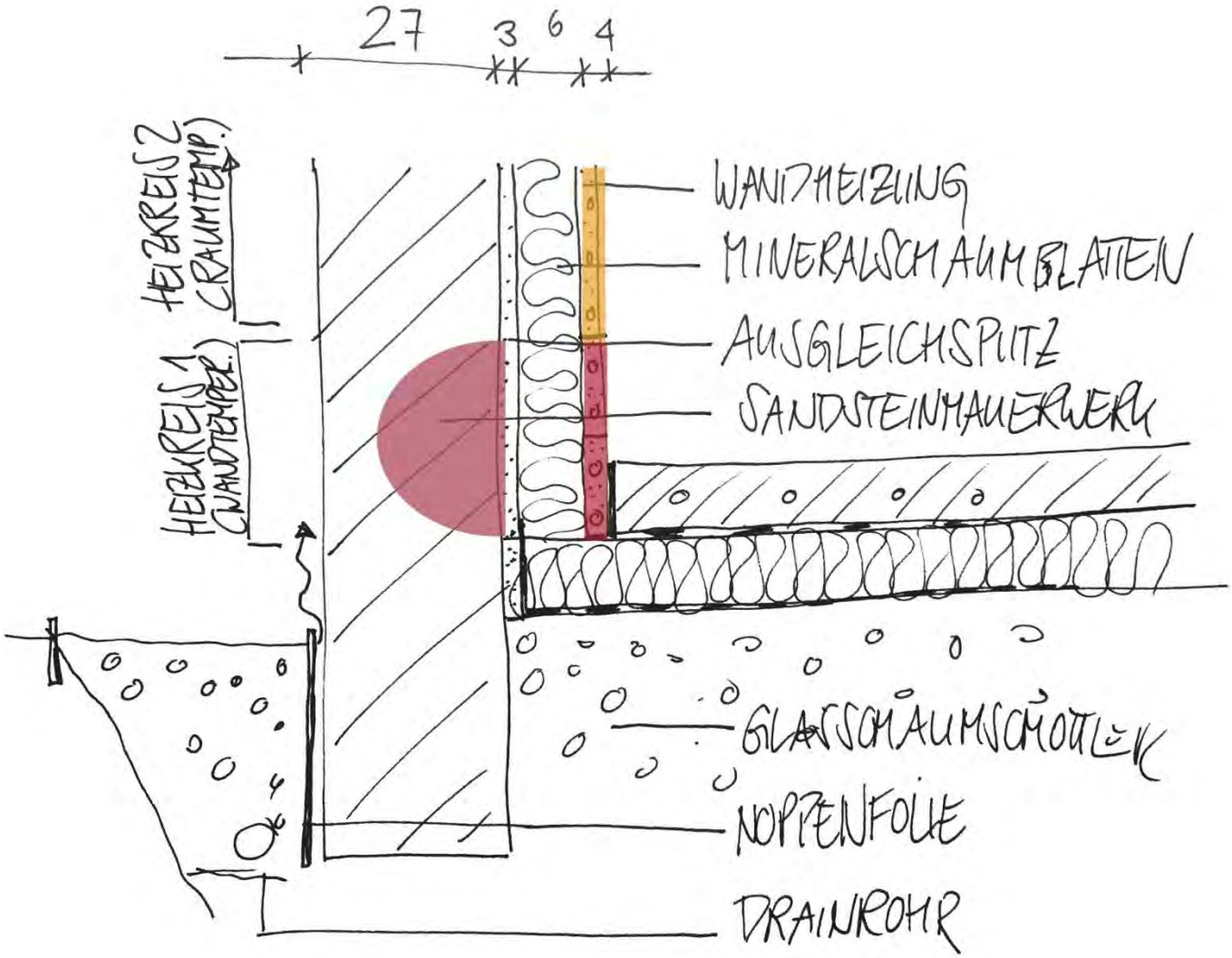
## Temperierung nach Großeschmidt

# Konzept der Gebäudehülle „H14“: Bauteilfeuchte und Temperierung

**Maßnahmen:**

- **Bauteilaktivierung durch Fußbodenheizung in Sichtbetondecke (Industrieboden)**
- **Temperierung durch Wand- und Sockelheizung**

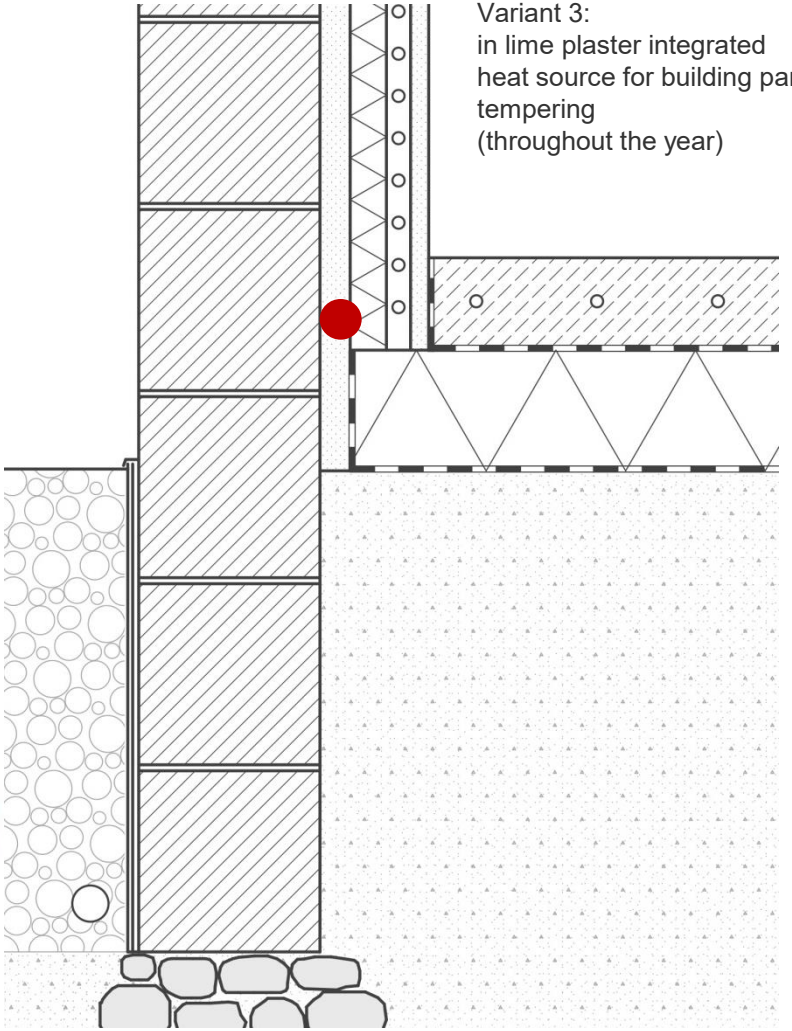
# Building Envelope Concept „H14“: Interior Insulation & Temperature Control




**Building component moisture: lacking horizontal barriers in old buildings**
**New Concept: Tempering of building components based on Großeschmidt**

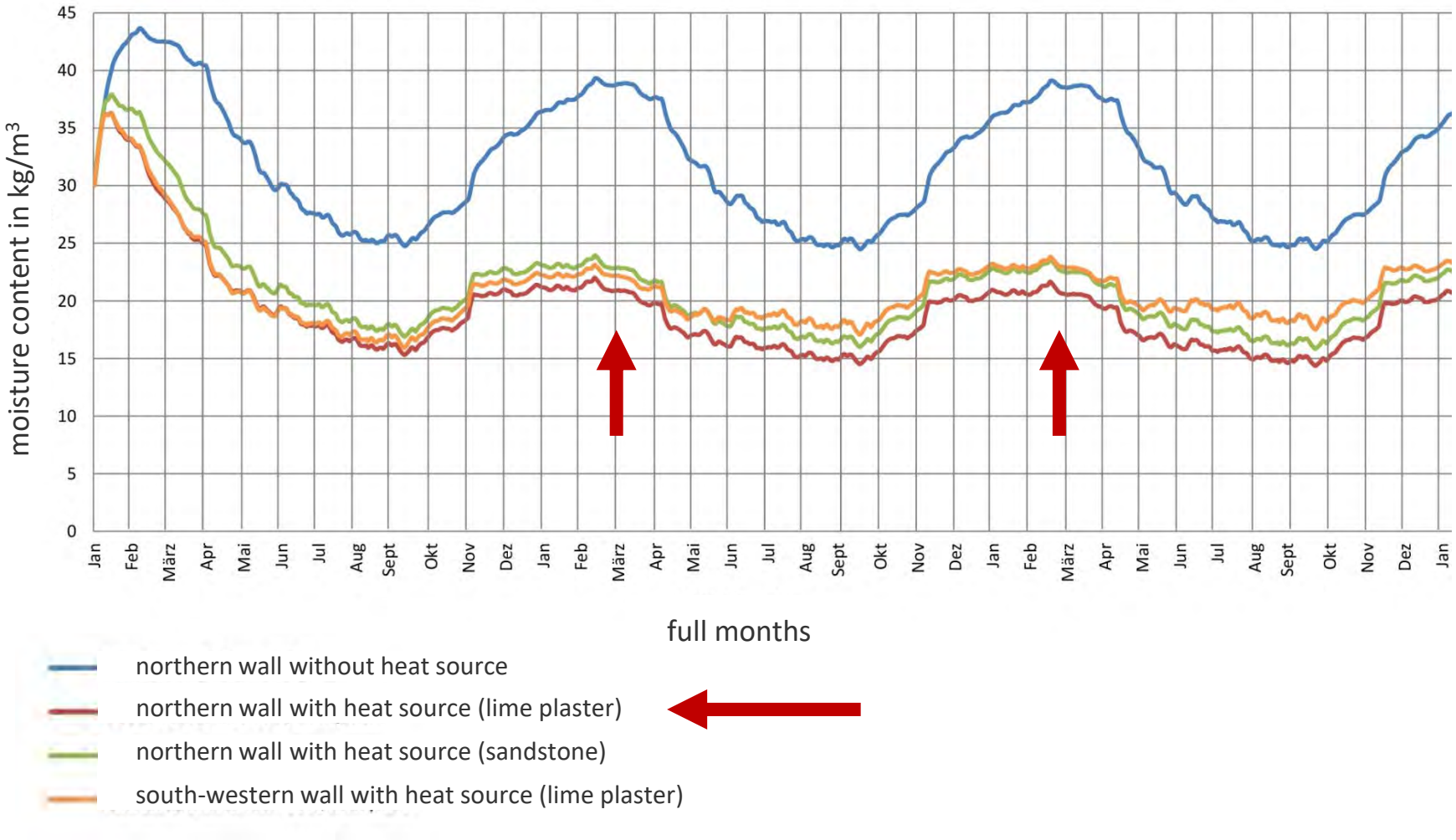
# Building Envelope Concept „H14“: Moisture Simulation

## Northern Wall (Variant 3): Review exterior lime plaster (kg/m³)




# Building Envelope Concept „H14“: Moisture Simulation

## Cariants in comparison: moisture content in exterior lime plaster (kg/m³)



# Homestead „H14“

# Homestead „H14“

# Homestead „H14“

**Major damages of the foundation**

# Homestead „H14“

**Major damages of the roof structure**

# Homestead „H14“

**Renovation of the roof and the facade**

# Homestead „H14“


**Renovation of the roof and the facade**

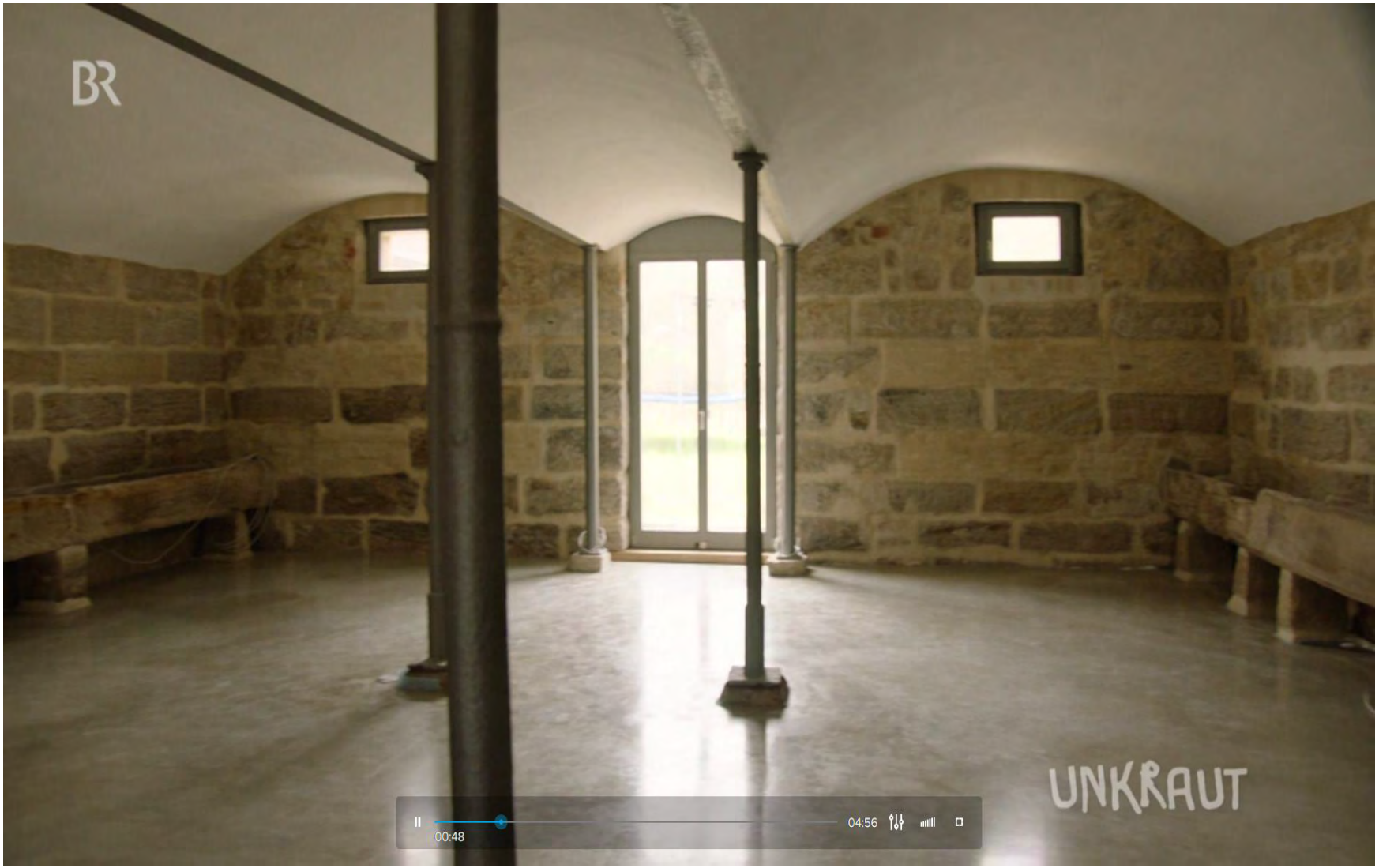
# Homestead „H14“

**Renovation the shales facade and the historic painting (staniol and boiled linseed oil)**

# Homestead „H14“

**Seminar rooms before renovation**

# Homestead „H14“




**Seminar rooms after renovation**

# Homestead „H14“

**Seminar rooms during renovation**

# Homestead „H14“

**Kitchen before renovation**

# Homestead „H14“

**Kitchen before renovation**

# Homestead „H14“

**Kitchen during renovation**

# Homestead „H14“

**Kitchen during renovation**

# Homestead „H14“

**Kitchen after renovation**

# Homestead „H14“

**Living room before renovation**

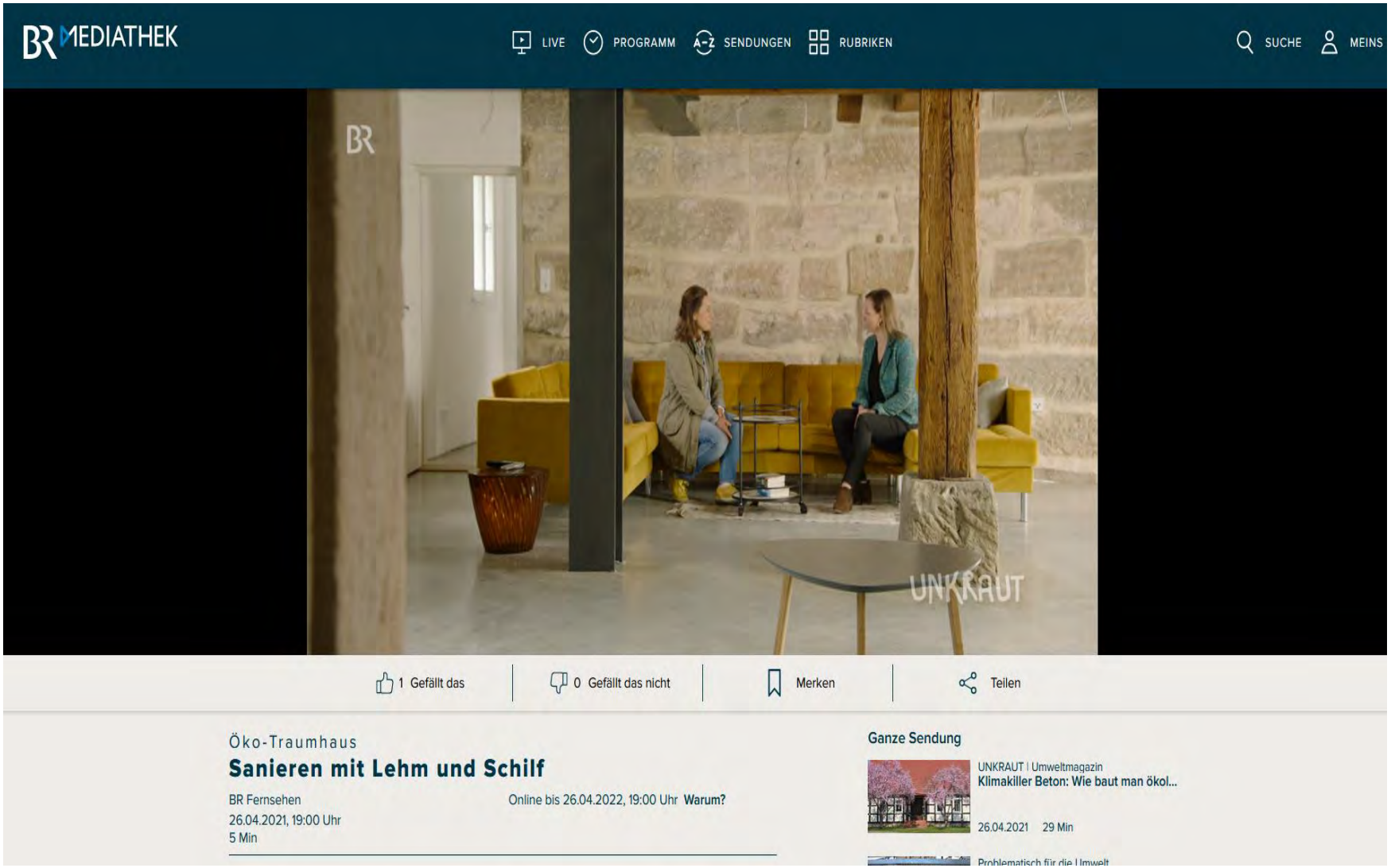
# Homestead „H14“

**Living room during renovation**

# Homestead „H14“

**Living room during renovation**

# Homestead „H14“




**Living room after renovation**

# Homestead „H14“

**Office rooms before renovation**

# Homestead „H14“

**Office rooms during renovation**

# Homestead „H14“

**Office rooms before renovation**

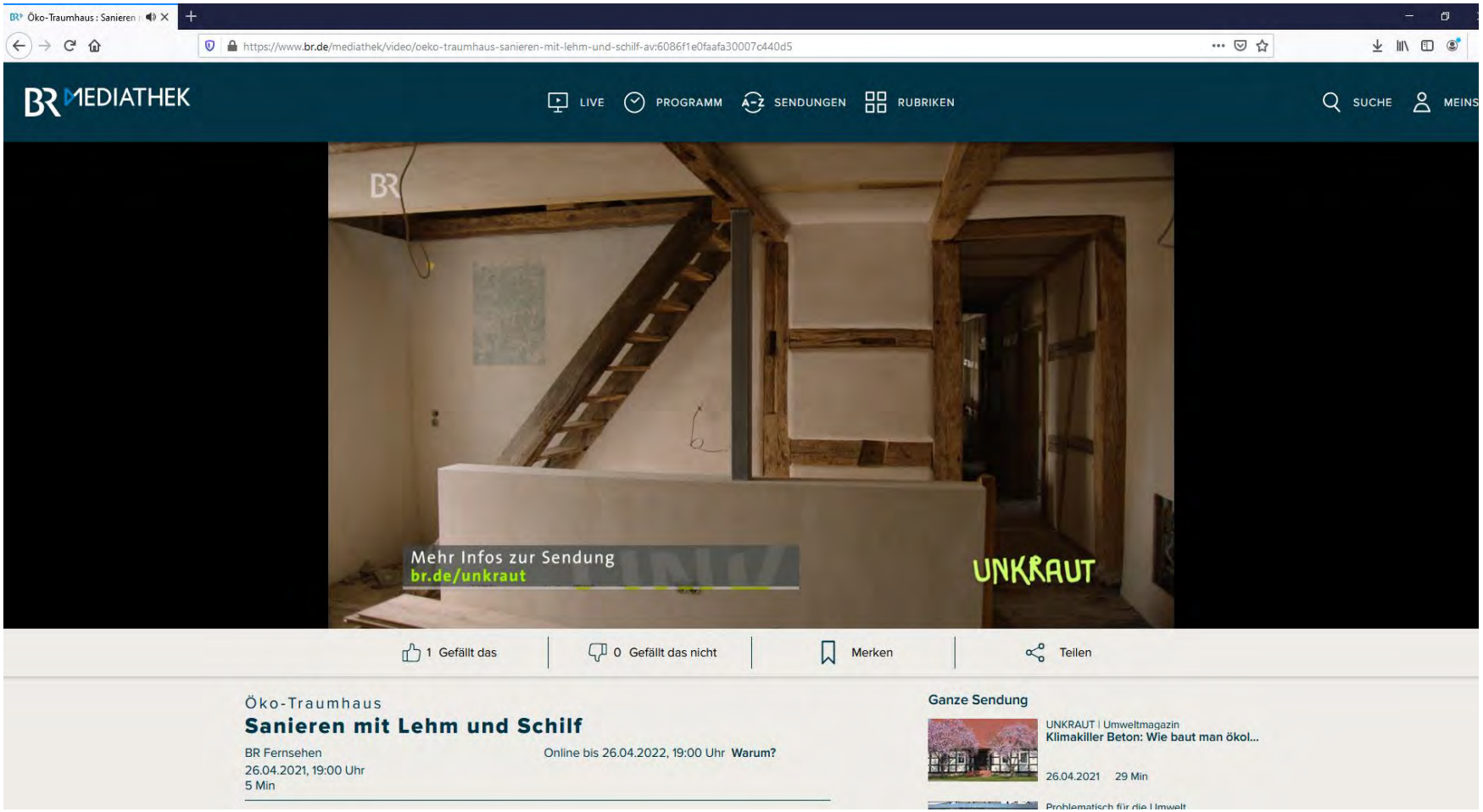
# Homestead „H14“

**Office rooms during renovation**

# Homestead „H14“

**Views in the nature before starting the working day….**

# „H14“: More on Mediathek




**Link:**
https://www.ardmediathek.de/video/unkraut/sanieren-mit-lehm-und-schilf/br-fernsehen/Y3JpZDovL2JyLmRlL3ZpZGVvLzBhZTVkNDRiLWI4NTItNDI2ZC05ZjA5LTI5OGIyYjc1MGZmNw/

https://www.youtube.com/watch?v=S6-7Ia9EOUk

3.2019
März
ISSN 0944-5749
14,80 €

Organ von
HOLZBAU DEUTSCHLAND
BUND DEUTSCHER ZIMMERMEISTER

Förderpartner
DEUTSCHER HOLZBAU

SHORTLIST 2018
FACHMEDIUM DES JAHRES
Beste Fachzeitschrift bis 1 Mio.

# mikado

Unternehmermagazin für Holzbau und Ausbau

DENKMALSCHUTZ
## Flockige Füllung

ARBEITSSICHERHEIT
## Endlich aufatmen

Privater Wohnbau
# ENERGIE FÜRS LEBEN

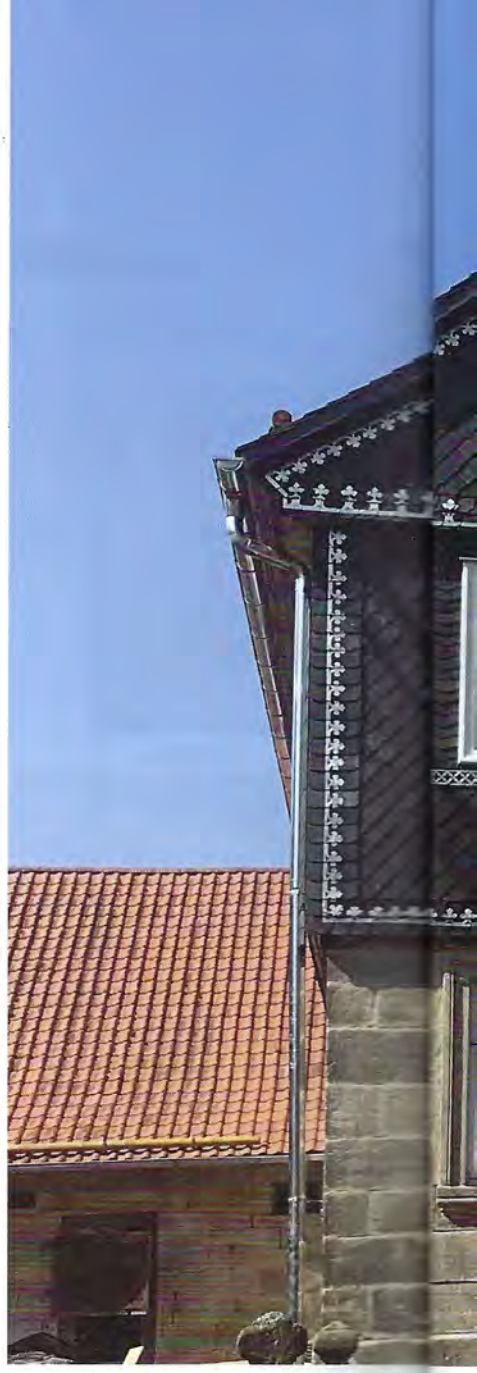
Denkmalpflege

# Viele Biber für ein Dach

**Eine Dachsanierung mit Biberschwanzziegeln konnte eine alte Hofanlage in Unterfranken wiederbeleben und schuf eine neue Nutzung der Räume unterm Dach.**

ALLE FOTOS: BRAAS

◂ Für die Sanierung sollten im Wesentlichen vorhandene historische und nachwachsende Rohstoffe eingesetzt werden



▸ Die oberen Geschosse wurden an der Fassade mit alten rautenförmigen Steinen wieder neu verschiefert

Die Hofanlage H14 in Itzgrund ist ein typischer fränkischer Dreiseithof. So stehen die Gebäude des Gehöftes um einen gepflasterten Hof. Das Wohnhaus mit der sogenannten guten Stube befindet sich neben der Einfahrt. Das Wohngebäude ist ein zweigeschossiger, giebelständiger Bau mit einem zur Straßen abgewalmten Dach. Auf einem massiven Untergeschoss aus Sandstein wurde ein verschiefertes Fachwerkobergeschoss aufgesetzt.

Nachdem die Anlage aus dem Baujahr 1868 deutlich in die Jahre gekommen war, fand sich eine Bauherrenschaft, die das denkmalgeschützte Objekt energie- und ressourceneffizient sanieren wollte. Neben dem Wohnhaus wird so auch ein multifunktionaler Veranstaltungs- und Seminarraum geschaffen. Die Bauherrenschaft, eine Professorin für Baukonstruktion und Bauklimatik sowie ihr Partner, Geschäftsführer des Bau-Instituts für Ressourceneffizientes und Nachhaltiges Bauen (BiRN GmbH), will mit der Sanierung der denkmalgeschützten Hofanlage den Nachweis führen, dass durch integrale Planung auch in alten Gemäuern modernes Wohnen und Arbeiten entstehen kann. Durch die Unterstützung des Bezirks Unterfranken, der Bayerischen Landesstiftung und die Förderung durch den Entschädigungsfonds des Bayerischen Staatsministeriums für Wissenschaft und Kunst konnte eine umfassende Sanierung umgesetzt werden. Ziel der Sanierungsplanung war es, mit erneuerbaren Energien und Energieeffizienz nahezu den Plusenergiestandard zu erreichen. Das bedeutet, dass im Gebäude mehr Energie erzeugt wird, als durch die Nutzung verbraucht wird. Auch die Aufgabe der E-Mobilität soll zukünftig in das Energiekonzept mit eingebunden werden. Das Thema der Ressourceneffizienz beschäftigt die Bauherrenschaft nicht nur beruflich, sondern auch am eigenen Objekt in der Praxis. So sollten für die Sanierung im Wesentlichen vorhandene historische und nachwachsende Rohstoffe eingesetzt werden. Für das Energiekonzept sah die Bauherrenschaft eine Kombination aus Luftwasserwärmepumpe, einem Holzscheitofen und dem

◂◂ Für den Dachziegel liegt eine Umweltprodukterklärung vom Institut Bauen und Umwelt e.V. vor

◂ Die Verlegung der Biberreihen geht schnell von der Hand

▸ Der materialgerechte Dachdurchgang wird regensicher und winddicht durch die Dachkonstruktion geführt

◂ Die Tragkonstruktion musste umfassend erneuert und verstärkt werden

▴ Kräftige Überzüge und Stahlträger ergänzen das statische System

klassischen Bauernofen in der Stube vor, da alte Holznutzungsrechte vorliegen.

In enger Zusammenarbeit mit der Deckmalschutzbehörde und der Gemeinde wurde ein verformungsgerechtes Aufmaß als Grundlage für das restauratorische Gutachten mit Raumbuch und dendrochronologischen Untersuchungen (Holzaltersbestimmung) erstellt. Ein statisches Gutachten sowie auch die bauphysikalische Beurteilung waren für die Architektin Basis der weiteren Maßnahmen. Die Untersuchung des Dachtragwerks ergab große Schäden an der Konstruktion des einfach stehenden Kehlbalkenstuhls. Die Hölzer stammten zum Großteil noch von einem Vorgängerbau aus dem 18. Jahrhundert.

Damit aus Gründen des Denkmalschutzes möglichst viele Bauteile erhalten werden konnten, musste der Dachstuhl des Wohnhauses grundsätzlich ertüchtigt werden.

Mit den Dacharbeiten sowie der Sanierung des Dachtragwerks wurde die Zimmerei Amon aus Hallstadt beauftragt. Nach dem Abräumen der alten Dachdeckung sowie dem Entfernen der Traglatten wurde festgestellt, dass zahlreiche Sparren erneuert oder durch Aufblatten verstärkt werden mussten. Der gesamte Stuhl wurde von den Zimmerern nach Statik mit Stahlträgern verstärkt. In großen Bereichen wurden die Fußpunkte des Kehlbalkendaches sowie die Zerrbalkenköpfe ersetzt oder ergänzt. Auch die Kehlbalken mussten erneuert und verstärkt werden. Zudem mussten weitere statische Maßnahmen ergriffen werden, die mit Überzügen aus kräftigen Konstruktionsvollholz-Trägern die Struktur ergänzen.

Die Fachwerkwände wurden mit Lehmwickeln wieder ergänzt und

## UMWELTPRODUKTERKLÄRUNG (EPD)

Neben den gesetzlich vorgeschriebenen Kennzeichnungen für Produkte wie dem CE-Kennzeichen existieren verschiedene freiwillige Umweltkennzeichen. Dabei werden drei Kategorien beschrieben. Die EPD wird als Typ-III-Umweltkennzeichen bezeichnet.

Die wissenschaftlich ermittelten Werte aus der Ökobilanz des Produktes werden nach einem einheitlichen Schema zusammengefasst und dokumentiert. EPDs basieren auf den Normen ISO 14025 und EN 15804. Vor Veröffentlichung der EPD durch das Institut Bauen und Umwelt e.V. (IBU) wird sie von unabhängigen Dritten auf Vollständigkeit, Plausibilität und Normenkonformität geprüft und verifiziert. EPDs richten sich an Planer, Architekten, Bauunternehmen, Investoren, Facility Manager und natürlich an Unternehmen, die mit Herstellung und Dienstleistung an der Wertschöpfungskette von den Rohstoffen bis zum Gebäude beteiligt sind.

### EPD ALS WICHTIGE DATENGRUNDLAGE FÜR NACHHALTIGES BAUEN

Geht es um nachhaltiges Bauen, werden Gebäude im Hinblick auf ihre ökologischen, ökonomischen und sozialen Aspekte betrachtet und bewertet. Dank EPDs für Baustoffe, Bauprodukte und Baukomponenten kann der ökologische Aspekt in die Nachhaltigkeitsbewertung von Bauwerken einfließen.

Somit bilden die international anerkannten EPDs einen wichtigen Eckpfeiler in den Gebäudezertifizierungssystemen von DGNB, BNB, BREEAM und LEED.

### BNK-NACHHALTIGKEITS-BEWERTUNGSSYSTEM

Auch das BNK-System ist ein nationales Nachhaltigkeitsbewertungssystem, das mit Unterstützung des Bundesbauministeriums für Ein- bis Fünffamilienhäuser entwickelt wurde. Das Bau-Institut für Ressourceneffizientes und Nachhaltiges Bauen (BiRN) ist mit der Organisation, Durchführung und Weiterentwicklung des BNK-Gütesiegels betraut. Das BiRN wurde 2015 von Prof. Dr. Natalie Eßig, Paul Mittermeier und Ralph Dietlein gegründet.

BiRN ist eine Ausgründung des Fachgebiets Baukonstruktion und Bauklimatik der Architekturfakultät der Hochschule München im Zuge der Entwicklung des Bewertungssystems Nachhaltiger Kleinwohnhausbau (BNK). *www.bau-irn.de*

◂ Der First wurde als Mörtelfirst ausgeführt

◂ Die Bauherrin legt von Hand ausgeschnittene Muster aus Stanniol an der Fassadenbeschieferung auf

verputzt. Die alten Sparren wurden teilweise aufgedoppelt und egalisiert, damit die darauf angeordnete Lage Holzweichfaserplatte ordentlich und maßgerecht verlegt werden konnte.

Als Dachdeckung sah die Bauherrenschaft eine Biberschwanzdeckung vor. Die Bauherren entschieden sich für den Braas Biber Opal Standard, Matt engobiert in der Farbe Anthrazit. Dieser Biberschwanzziegel ist in der Region Unterfranken weit verbreitet. Mit seinem charakteristischen Rundschnitt und der glatten Oberfläche vereint er historische als auch zeitgemäße Linienführung.

Der traditionelle Dachziegel wird sowohl in Doppeldeckung wie auch als Kronendeckung verlegt. Mit einer Länge von 380 mm und einer Breite von 180 mm ergibt sich bei der gewählten Doppeldeckung in Abhängigkeit vom Lattenabstand ein Bedarf von durchschnittlich 33,7 bis 38,3 Stück/m². Für den Dachziegel liegt eine EPD (Umweltprodukterklärung) vom IBU (Institut Bauen und Umwelt e.V.) vor.

Auf der Holzweichfaserplatte verlegten die Zimmerer eine diffusionsfähige Unterdeckbahn und ordneten eine Konterlattung an. Darauf wurde die Traglattung 40/50 mm in Abhängigkeit von der Konstruktionslänge des Daches für die Biberschwanzdeckung befestigt. Danach wurde das Dach eingeteilt und abgeschnürt.

An der Traufe verlegten die Zimmerer eine Reihe Traufziegel als Unterlage für die erste sichtbare Reihe Biberschwanzziegel. Die vorgesteckten Dachziegel konnten anschließend schnell verlegt werden.

Die Ortgänge an der Wetterseite links und rechts wurden von den Zimmerern mit einem Ortgangziegel fachgerecht ausgeführt. Die Abdeckhöhe der Ortgangkonstruktion beträgt dabei 50 mm. Der Bedarf beträgt nur drei Stück pro Meter Ortgang. Durch die geformte Aufkantung wird das Wasser sicher auf die Dachfläche geführt. Die Ortgänge an der Straßenseite wurden mit Zahnleiste entsprechend den Vorgaben der Denkmalpflege eingedeckt. Die Einbindung in die Schieferfassade erfolgte mit einem Schieferstreifen sowie unterlegtem Vogelgitter. Der First wurde nach Vorgabe der Denkmalpflege als Mörtelfirst ausgeführt.

Im Dachsystem setzten die Zimmerer auch einen materialgerechten Sanilüfter aus Ton ein. Hierzu sparte der Juniorchef Martin Amon die Dachlattung im Bereich der Dachdurchführung aus. Mit einer mitgelieferten Zentrierscheibe und einer Schablone kann die Position der Durchführung im Deckbild auf der Unterdachkonstruktion angezeichnet und der Rohrdurchmesser auf der Zusatzmaßnahme ausgeschnitten werden. Ein Anschlussring wird in die Unterdeckbahn eingedreht und bietet so eine regensichere und winddichte Durchführung des Lüfterrohres durch die Dachkonstruktion.

Die oberen Fachwerkgeschosse wurden an der Fassade unter weitgehender Verwendung alter rautenförmiger Steine wieder neu verschiefert. Zusätzlich brachte die Bauherrin in Eigenleistung noch eine Verzierung an. Diese wurde nach historischer Vorlage auf den Schiefersteinen aufgetragen. Hierzu hatte die Bauherrin aus Stanniol-Folie entsprechende Muster ausgeschnitten und mit Leinöl als Mixtion auf den Schiefersteinen aufgelegt. Stanniol wurde in früheren Zeiten als eine Bleisilberlegierung gefertigt. Heute ist es eine dünne, gewalzte Zinnfolie.

**Horst Pavel, Oberursel** ■

**STECK BRIEF**

**PROJEKT:**
Sanierung Hofanlage H14
D-96274 Itzgrund

**BAUHERR:**
Prof. Dr. Natalie Eßig,
Ralph Dietlein

**DACHARBEITEN:**
Amon Holzbau GmbH
D-96103 Hallstadt
www.amon-holzbau.de

**FASSADENARBEITEN:**
Wunder Bedachungen GmbH
D-96450 Coburg
www.dachdeckerei-wunder.de

**BEDACHUNGSMATERIAL:**
Braas Biber Opal Standard,
Matt engobiert, Anthrazit