Inspection protocol – Austrian version

Final Report, August 2004

Energy Performance Assessment Method for Existing Dwellings

Report Number: EPA-ED NOA 04-03
EC Contract: 4.1030/Z/01-142/2001
www.epa-ed.org

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Date:
August 26, 2004

Report Number:
EPA-ED ÖÖI 04-02

EC Contract
4.1030/Z/01-142/2001

www.epa-ed.org

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1 Introduction

The aim of an inspection protocol is to:

- guide the EPA-consultant in performing a good quality audit.
- achieve more uniformity in collecting the data for the assessment of the energy performance of a building, thus serving as a quality control.
- make the comparison between different dwellings more accurate, due to a uniform approach.

These objectives should be realised in an efficient and effective way. The data required by the EPA software interface is well attuned to practice. The software libraries are well structured and the various items included in the libraries (i.e. construction elements, heating system typologies etc.) are adapted to the Austrian market, in line with common building practice for old and new constructions. Additional information may easily be incorporated and the libraries will be further enhanced during the development of the national version of the software, upon completion of the project.

In order to derive at an efficient building audit there is a direct link between the input data to the software interface and the inspection protocol.

This document describes the necessary building data that is collected during the building audit. It is therefore necessary for the auditor to have access to the building and its installations.

2 Surface area

Surface areas are to be determined for the thermal envelope of the building and for building elements from attached non-airconditioned spaces.
The **thermal envelope** is defined as the building structure acting as a boundary between the indoor environment (air is conditioned by heating or cooling systems) and the outdoor environment or adjacent non-airconditioned spaces. Walls and floors between dwellings separating conditioned spaces are assumed to have no heat exchange on an annual basis, and are therefore not taken into account.
The **surface area** is defined at as the **outside area** of the building elements (i.e. walls, floor). However, this does not necessarily mean that the area should be measured from the outside (i.e. external dimensions of elements). Internal dimensions can also be used by adding the thickness of walls and floors to derive to the external surface area.
The main categories of surface areas to be distinguished are windows, doors, facades, floors and roofs.
Elements may include sections with different constructions and U-values. For example, a facade can be partly an uninsulated cavity wall and partly a brick wall construction, or in other cases, a façade can be partly an insulated wall and an uninsulated load bearing (concrete) structure. In these cases, the surface areas should be determined separately.
It is also necessary to make a subdivision in surface areas in case that different energy saving measures are foreseen for the same building element. Generally, the definition of surfaces also needs to anticipate that the addition of thermal insulation will be applicable to certain sections of the same building element.

For every main category of elements, the following discussion addresses the points of particular interest.

Figure 1 illustrates a simplified cross section and floor plan of building, to clarify the definition of thermal envelope. The intermediate wall between the dwellings is heated on both sides and thus has no heat losses. Therefore, the intermediate (seperation) wall between the dwellings does not effect the energy performance of the dwelling (building), and is not taken into account.

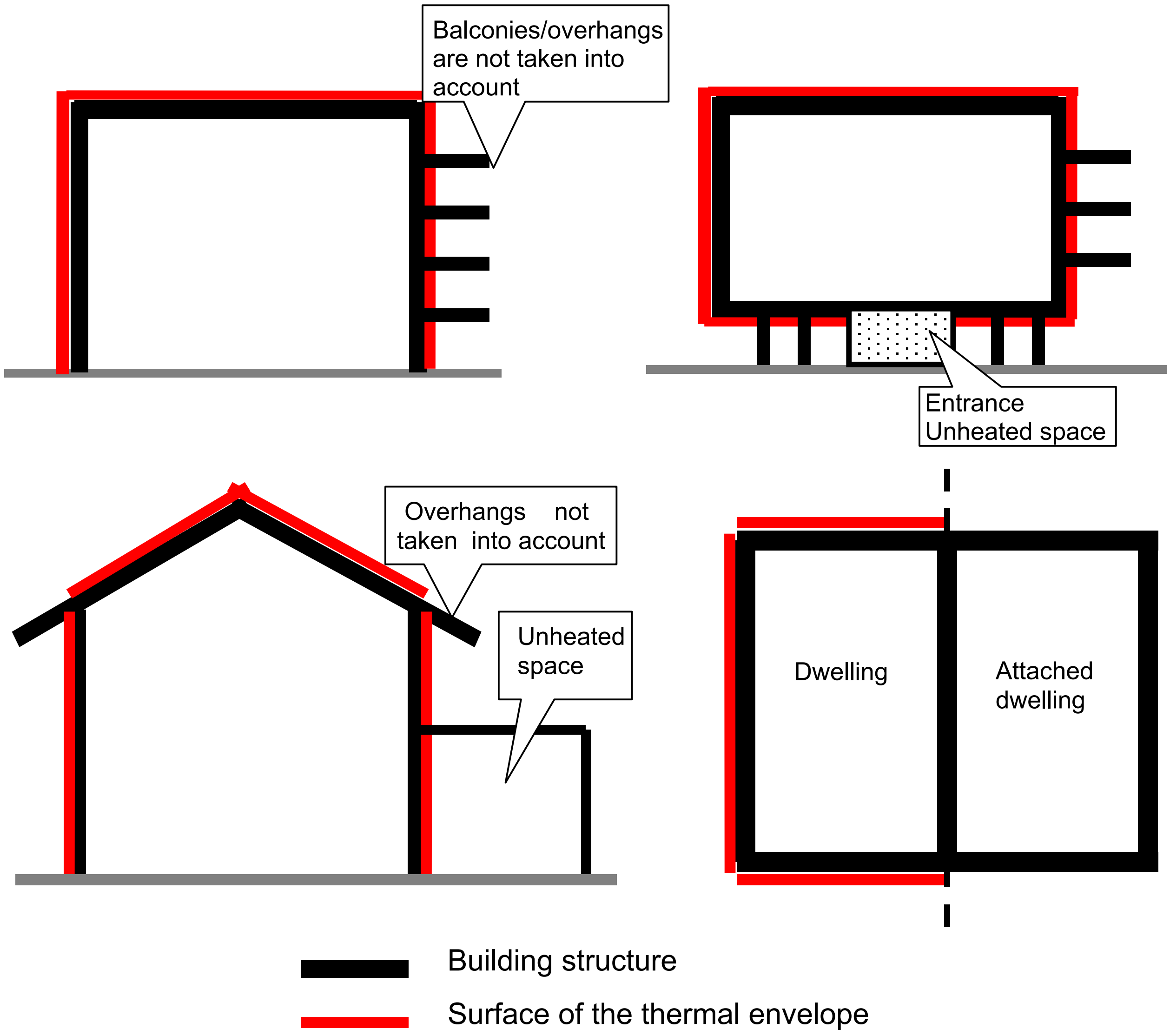


Figure 1: Definition of Thermal envelope

2.1 Windows and doors

The U-value of windows is defined as the combined U-value of glazing and framing. Subsequently, the surface area for windows and doors is defined as the area of the facade opening (including the frame). The same approach is used for doors.
Standard construction libraries are available in the software that correspond to the most common combinations of glazing/doors and framing.
For the solar contribution through the glazing this gross surface area is not appropriate. Only the glazed surface has to be taken into account. In order to reduce the building audit effort, a correction factor deals with this effect, called the **frame factor**. This factor is given as a default value. The auditor can adjust this value, in case the framing percentage differs significantly from the average value.
The window and door areas can easily be measured from both the inside and the outside.

2.2 Opaque walls

The surface area of opaque walls is defined as the total surface using the outside dimensions of the building element minus the surface area of windows and doors. In case of separation elements (walls, floors) between dwellings, the width of the surface is defined upto the centre of the separation construction. In practice this value can be determined by taking the internal dimension adding the thickness of one separation wall/floor. If interior walls or floors are present their thickness also has to be added when measuring the internal dimensions. Parts of building elements connected to adjacent non-conditioned spaces should be determined as separate constructions. This principal is illustrated in Figure 2.

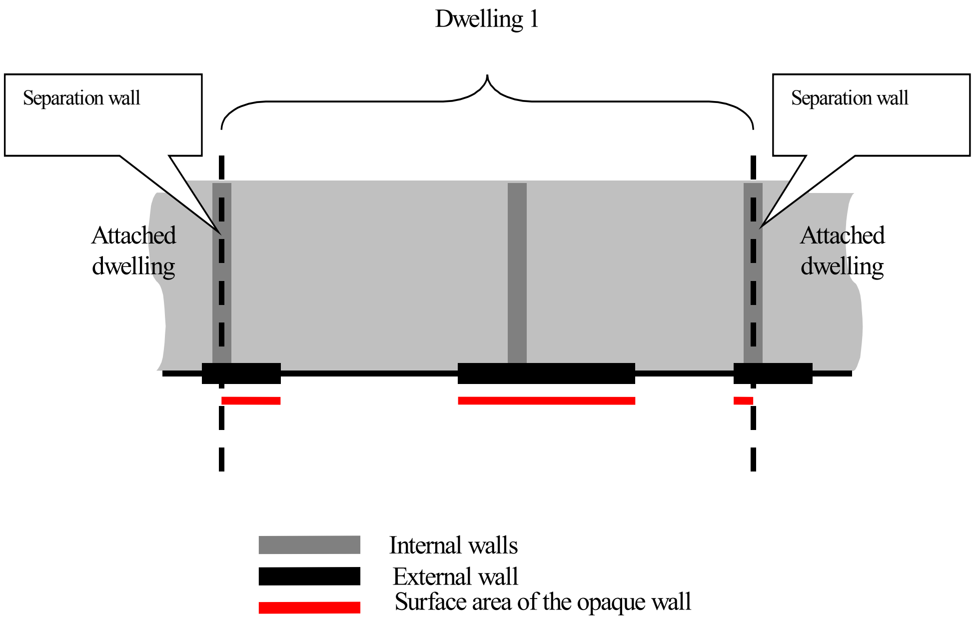


Figure 2: Floor plan of the surface area for an opaque wall.

2.3 Roof

As already stated, the overhang of a roof surface does not contribute to any significant heat losses (other than thermal bridging) and therefore is not taken into account when measuring the total roof surface (Figure 1). Skylights, separation walls and interior walls are dealt with in the same way as explained is section 2.2 (Opaque walls).

In many cases the surface of a flat roof equals the surface of the ground floor including the area of the external walls.

For tilted roofs (i.e. for houses), although the surface area is hard to measure, it can easily be determined by multiplying the surface of the floor beneath it with a correction factor. This factor depends on the pitch angle of the roof (Figure 3). Auditors may use a transparent sheet with tilt lines as a simple instrument to visually determine the roof angle.

roof angle	factor
0°	1,00
15°	1,04
30°	1,15
40°	1,31
45°	1,41
50°	1,56
55°	1,74
60°	2,00
65°	2,37
70°	2,92
75°	3,86

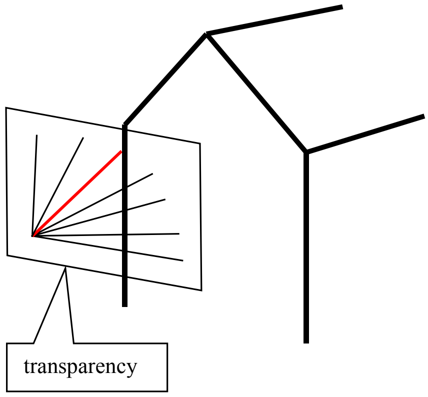


Figure 3: Correction factor for the estimation of a tilted roof area.

2.4 Floors

For calculating the energy losses through transmission, only the floor that is ground coupled or exposed to the outdoor environment or above a non-heated space (i.e. basement) has to be taken into account. Floor sections above spaces with different boundary conditions (previously described) have to be measured separately. The floor area is calculated using the interior dimensions; the joints with the facade are considered as a part of the façade area.

The gross floor area of the thermal envelope is used to calculate an energy indicator and also in sizing the heat capacity of the building thermal mass.
A simple definition of the gross floor area is the surface area of all the floors inside the thermal envelope, including the floor area covered by interior walls.

3 Thermal characteristics of the building components (U-value, solar transmittance and thermal mass)

The construction of the various envelope components is sometimes hard to establish by visual inspection, while damaging the structure in order to investigate its composition is no option. However, it is necessary to determine the U-value of the construction. The auditor should therefore focus on the construction layers with the highest thermal resistance (the ones that insulate the best, like insulation material, air gaps, lightweight concrete, etc.) These layers have the highest impact on the U-value. It is sometimes difficult to visually determine whether a building element has thermal insulation and to determine its thickness. Taking into account various parameters, it is possible to come up with a proper estimate of the U-value.
The following observations may be used to determine the U-value of a building element:

- The year of construction and the common construction details and insulation requirements at that time.
- Drawings and building description - if available.
- Visual inspection of the construction by a skilled auditor.
- Measuring the thickness of the construction.
- Visual inspection of internal layers through air gaps (e.g. sliding openings through cavity walls) or lifting a roof tile.
- Information about the addition of thermal insulation provided from the owner/user.

The auditor should give special attention to the roof construction, since the addition of thermal insulation is a common refurbishment of older buildings.
The software libraries provide information on common building constructions and U-values.

3.1 Windows and doors

The software libraries provide information on common window and door constructions.
For glazings, the auditor has to select the type based on the number of window panes, the presence of coatings and gas filled cavities. The number of panes can simply be counted. Coatings can be detected by holding a small flame from a cigarette lighter in front of the glazing. Different colours of the reflections of the flame indicate a coating.
In general, double pane windows without a coating will most probably have no gas filled cavity. In many cases there is product identification visible in the spacer of the window. Sometimes this can be an indication of the typology of the glazing. Based on these characteristics the window properties are provided by the software library.
In Austria, installation of new windows has been a popular and well promoted measure since the 1980ies. In most of these cases, the intention for the change has been improvement of noise insulation. It is important to check these newly installed windows carefully, as u-values of noise-insulation windows can differ a lot from other energy efficient windows, in spite of similar appearance.

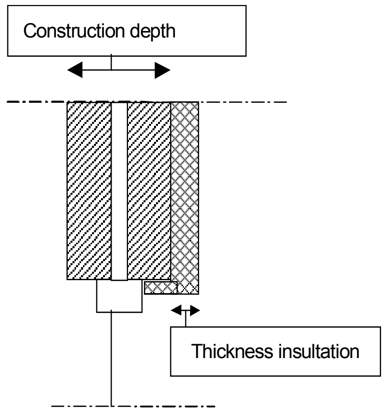
Shading (solar protection) plays a dominant role on the buildings thermal performance during summer and the indoor visual comfort conditions. External shading may be provided by the neighbouring buildings (common in dense urban environments), trees (common in suburban environments), building elements (i.e. balconies that act as overhangs) and other movable external shading devices (i.e. awnings). The shading coefficient also depends on the window orientation. Values are available in a software library, for different shading devices and orientations.

3.2 Opaque walls

Most walls are masonry structures; **massive walls** or **cavity walls** (to be determined by the brick pattern). Facades include a reinforced concrete load bearing structure and brick walls.
In Austria, the period of construction can be a relevant source of information. Whereas up to the second world war, brick walls have been a dominating construction element, post war- construction shows mixed building structures. Original structures such as foundations and cellars kept their function, and some newly constructed building parts were made from original materials. This has to be taken into account during the audit. Building construction during the period from early 1960ies to mid 1980ies was based on concrete structures with poor thermal insulation. Only from the mid 1980ies, renovation of dwellings and improved thermal insulation of new dwellings became a relevant topic. The software library provides various construction typologies.

The auditor should consult with the building/dwelling owner to determine whether there has been **additional of thermal insulation** at a later stage, during a major building refurbishment, especially in case of uninsulated walls. This may probably be encountered when a houses has undergone major refurbishment, for example, building extension with new horizontal or vertical construction.

Three types of additional thermal insulation is commonly used:



Internal insulation can be detected by an internal cladding on an outer wall. This is not a very common technique. The thickness of the insulation layer can be determined by measuring the total thickness of the wall (at facade openings) and subtracting the width of the original construction, also taking into account the thickness of the interior finish and a small cavity (cladding and cavity take about 2 cm).

External insulation is easy to identify. The thickness can be determined the same way as described for internal insulation.

Cavity insulation in masonry walls, using foam insulation to fill-up the cavity. This can be detected by a regular pattern of filling holes and in many cases the vents for crawlspace ventilation are remodelled using plastic tubes fitting in a drill hole and covered by a grid at the outside. If there are small openings in the outer leaf of the wall it is possible to check with a needle if the cavity is filled.

3.3 Roof

Similar to the other building elements, the year of construction can be used to determine the construction details and the corresponding U-value. The software library provides various construction typologies.
In the case of **flat roofs** or low pitch sloped roofs, additional insulation is applied in very often in conjunction with the replacement of roof covering. Internal insulation is usually not applied and is not advisable since it may result to moisture problems. Additional insulation is usually applied externally, under the roof cover. The sound of tapping on the roof cover will indicate if insulation is underneath. Establishing the thickness may be troublesome. Indications on the thickness can be derived from the joints and detailing at the edges of the roof, or at penetrations through the roof like pipes, chimneys, etc. The auditor should consult with the owner or check the drawings or contracts with contractors, in order to determine whether the roof is thermally insulated.

Sloped roofs with a cover of tiles are sometimes insulated just underneath the tiles. Lifting a tile may provide information about the presence of thermal insulation.

In many cases, thermal insulation may be added at a later stage on the interior side of the roof, covering it with a nice finish. It is hard to check whether there is insulation inside the construction and if so to determine its thickness. Examining the edges of the interior finish (joints with crawl space floor and wall) may result in finding holes or cracks that give the opportunity to investigate the construction. The auditor should consult with the owner or check the drawings or contracts with contractors, in order to determine whether the roof is thermally insulated.

3.4 Floors

Interior building floors are not insulated. Floors are insulated according to the building code in the year of realisation. Additional insulation is possible underneath the floor (in case of an unheated cellar), or as a layer on top of the floor under the floor covering. Inspection or information from the client should provide the information. The software library provides various construction typologies.

3.5 Thermal mass

The thermal mass of a building (typically contained in walls, floors, partitions, constructed of material with high heat capacity) absorbs heat and regulates the magnitude of indoor temperature swings. In summer, it reduces peak cooling load and transfers a part of the absorbed heat into the night hours. The cooling load can then be covered by passive cooling techniques, since the outdoor conditions are more favourable. The role of thermal mass in winter is primarily associated with regulating the indoor air temperature, and if properly placed may also be used to absorb and store solar heat gains, thus reducing the heating load.
Thermal mass of Austrian buildings depend on the time and type of construction, with high thermal mass dominating because of typical construction materials such as concrete and brick walls.

4 Installations

Examining the different system components in order to derive data on their efficiency is quite complex and time consuming compared to the scope of the audit process. That is why inspection of appliances for heating (both for space heating and hot water), space cooling and ventilation is based on visual inspection and recognition of the typology of components. The infiltration related to the air tightness of indoor spaces is included in the ventilation system approach.

4.1 Ventilation system

Ventilation has a strong impact on the overall energy performance of a building, so specific attention has to be paid on this part of the audit.

Austrian buildings are mostly **naturally ventilated** by opening the windows. It is very difficult to determine the total amount of outdoor air entering the indoor spaces, during an audit and by visual inspection on an arbitrary day of the year.
Infiltration depends on the quality of the openings' (windows, doors) construction. To determine the infiltration rate, consult with the owner/resident. High infiltration rates result to cold drafts in winter that cause discomfort. High infiltration through windows and balcony doors can be easily identifiable by the movement of curtains. Sliding windows and balcony doors usually have high infiltration rates. The auditor should also look around the door frame and sill, for dirty surfaces, indicating air inlets; check brushes and air stops around the opening frames; use a sheet of paper to check whether it is possible to slide it through the opening when it is closed; observe whether there is light passing through the sides or under the door.
Shaft openings for natural ventilation in bathrooms are quite common in Austrian buildings. These opening cause additional infiltration which has to be considered in the infiltration.
Mechanically ventilated spaces include kitchens that use exhaust fans, and some times bathrooms and toilets.
The software library provides relevant information, taking into account the construction typologies of the building envelope and the windows.

4.2 Heating installation

For the heating installation the following systems are applied.

Space heating:

1. Local heating system for one room by means of a oil or wood fired furnace
2. Central heating system with radiators per dwelling
3. Collective heating systems with radiators (mostly used for apartment buildings)
4. External heat sources providing heat to the building (e.g. district heating)
5. Systems using an active solar system
6. Systems using a heat pump to provide heating.

If space heating is provided by a boiler (as in most of Austrian buildings), efficiency can be easily determined using a maintenance sheet . However, since some owners do not regularly maintain the heating system or in case that the maintenance sheet is not readily available, the efficiency can be determined based on the age of the boiler and its overall condition. The software library provides relevant information.

Hot water

1. Instantaneous water heater
2. Storage water heater (electricity)
3. Storage water heater (gas)
4. Combined space and hot water heater
5. Heat pump for hot water
6. Active solar system

Similar to space heating the inspector has to classify the systems based on their appearance and the information on the attached shield.

The **heat distribution** system includes all the pipes that transfer the hot water to the heat delivery units (radiators) and back to the heat production units. The pipes must be properly insulated in order to reduce heat losses. The auditor can visually inspect the pipes that run through the common use areas and determine whether they are properly insulated or not.

The **hot water consumption** is determined based on the daily attendance and the number of occupants living in the dwelling. The software library provides relevant information.

4.3 Cooling installation

Cooling installations are not commonly used in Austrian dwellings. If there is a cooling system, efficiency can be determined by the type of the installation. The software library provides information on typical efficiency.

4.4 Lighting of common/public areas in the building

Electrical energy consumption for lighting in common/public areas of apartment buildings covers the entrance area, stairway, parking and outdoor lighting. It is a minor portion of the building's total electrical energy consumption. Therefore, the software library provides relevant information based on a rough estimate, by distinguishing three categories:

- No common lighting
- Conventional common lighting (no energy saving measures taken, using incandescent lamps)
- Energy efficient common lighting (energy saving measures taken, like low energy lamps and on/off controls).

For houses or one dwelling audits, this issue is not addressed.

4.5 Photovoltaics

Photovoltaics (PV) are used to directly convert solar energy to electricity. The contribution of PV panels is determined based on the size (PV area) and orientation. Efficiency of the system is determined by the type of cells. The software library provides information.

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6 Project Description

The EPA-ED research project seeks to conceptualise and develop the strategic, organisational and technological framework to deliver a model for assessing the energy performance of existing dwellings at European level. This framework intends to stimulate RUE and RES. The efficiency and success of the energy performance assessment-approach (EPA-approach) depends on the way it fits into practice. Thus, a range of relevant issues have been taken into account - from the economic impact of RUE and RES for inhabitants of existing dwellings to integration of measures into maintenance schedules and - from the effects of RUE and RES on the interior climate in dwellings to the strategic impulse of this approach on a national level.

The energy performance assessment method is being developed making use of existing methods available in the European Countries.

The attention for the energy performance of existing dwellings is just starting in most countries. Energy performance can be greatly improved by rational use of energy (RUE) and the use of renewable energy sources (RES). This RTD research project directly addresses both the SAVE and the ALTENER programme, focussing on RUE in (existing) dwellings, while incorporating RES.

The workplan has been structured in 5 research tasks:
Task 1: Benchmark of European conditions related to existing dwellings

- Benchmark of European conditions related to existing dwellings
- Benchmark of existing policies with respect to RUE and RES in existing dwellings
- Benchmark of building regulations with respect to existing dwellings (both legislative and incentive)
- Benchmark of existing housing market and actors
- Benchmark of the energy market
- Benchmark of building and installations technology in existing dwellings
- Benchmark of energy balance of existing dwellings on a national level
- Benchmark of climate data

Task 2: Strategy for stimulating RUE and RES through a uniform Energy Performance Assessment Method

Task 3: Energy Performance Assessment tool

- Description
- Prototype
- Pilot studies in at least one project in each participating country
- Adaptations of the prototype tool
- Supporting tools: check lists, inspection protocols, guidelines etc

Task 4: Translation into new policies

- Set of tools for tuning, accentuating Member State policies, using the EPA-ED method and tool for existing dwellings.
- Recommendations for the development of RUE, RES policies in countries without such policies.

Task 5: Dissemination

- Website, brochures, manual

Project Partners

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