Austrian Pilot Study
National Report

Draft report, August 2004

Energy Performance Assessment Method for Existing Dwellings

Report Number: EPA-ED OOI 04-01
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1. Introduction

This report on the Austrian Pilot Study is transacted in the frame of Task 3.c – Pilots of the EPA-ED project (general description see www.epa-ed.org). As the most of the readers might be know, in Austria are existing very different kinds of construction cultures and/or construction standards. Law and policy in construction is given by nine federal states, the Austrian government has no direct competence in legislation. One the most important outcomes according to this fact is very simple: A typical “Austrian House” is not existing. However, 76 percent of all houses are single houses, only 24 percent are apartment buildings. 53 percent of all Austrian dwellings are situated in apartment buildings, 47 percent in single houses.

Table 1: Building Stock Austria 2001

Austrian Buildings and Dwellings 2001	Overall	Single Houses	Apartment Buildings
Buildings, abs.	2046712	1557420	489292
Dwellings, abs	3863262	1809380	2053882
Buildings, %	100	76,09	23,91
Dwellings, %	100	46,84	53,16

Source: Statistics Austria 2003, own calculation

According to these national circumstances of the Austrian building stock we decide to use a typical residential building from the postwar period in Vienna as pilot project in EPA-ED: Nearby 25 percent of all dwellings are built in Vienna, most of them in apartment buildings.

The pilot study has been performed by using an residential apartment building in Vienna, with five floors and a total of 13 apartments and two shops (in the ground floor). This kind of building is widespread in Vienna, and also in some other larger cities of Austria (e.g. Graz, Salzburg, Innsbruck). With

The issues addressed during this evaluation have been:

- Testing the general quality of the EPA-ED tool
- User friendliness of the tool
- Time requirements to complete study
- Acceptance of results by “client”
- Efficiency of the EPA-results in practice (impact on taking measures).

The report includes an implementation of all the EPA-ED tool features and results. Based on this work, the final report presented to the building’s owners was based on illustrations prepared and presented in this report.

2. General description of the apartment building

Location: Vienna, Austria (48°15' N,16°2' E). high-density area, heavy traffic	**Year of Construction:** 1958
Short Description: Built-in, two exposed facades: E/W axis. 5 floors including attic, ground level with entrance and doorway (parking space in the backyard). Total of 13 apartments and two salesrooms.	**Construction:** Brick walls, not insulated. Tiled roof 45°, not insulated. Roof partly in used as residential area (no insulation). Box type windows and single-glazing balcony doors to west, sound insulation windows to east (street). **Previous refurbishment:** gradual installation of sound insulation windows to east axis (street) from 1990-2003
Heating/Cooling/Ventilation Systems: individual natural gas boilers for heating and DHW, no cooling system, no mechanical ventilation	**Total floor Area:** **Total gross heated area:** 1462 m² **Commercial Area:** **Number of Apartments:** 13 **Occupants per Apartment:** 2,5
Annual energy consumption: **Fuel:** 35870 m³ natural gas **Heating Period:** 5 months **Thermal:** 358.000 kWh/year (including domestic hot water & heating) **Electrical:** 3.270 kWh/year (average for apts) 365 kWh/year (common areas)	Annual Heating Energy Consumption (kWh/m² gross heated surface) 283 kWh / m²year (!!!) 180 kWh / m²year – average of buildings of the postwar per. 100-150 kWh / m²year – average of existing apartment buildings <50 kWh / m²year – low energy standard
Annual Electrical Energy Consumption 24,3 (kWh/m² heated apartment area) 30 kWh/m²year (average: 3 persons, 100 m²)	Annual Electrical Energy Consumption 3,8 kWh/m² common use area (only lighting)

2.1 AUDIT / DIAGNOSIS RESULTS

This section gives general information on the building and identifies problems and possible measures to improve the energy performance of the building.

The information in this section was collected during the audit from

- Plans
- Inspection of the building
- Interviews with the building owner and with tenants of selected apartments
- Energy bills
- Calculations on measures of the scenarios (exchange of windows, insulation of walls)

Location

The building is situated in the centre of a northern suburban district of Vienna, at one of the main arterial roads.

Construction

The building was reconstructed on foundations of a building destroyed in the second world war, with the cellar (including ceiling) still in original condition from early twentieth century.
The overall quality of the construction is over-average in relation to other buildings constructed during the post-war period.
As a consequence of the increasing noise level, noise-protection windows have been installed gradually by the tenants in the past 15 years.

Owner/Tenants

The building is privately owned by two owners, each keeping a 50% share. One of the owners lives in the building.
Over 50% of the apartments have been rented out to the same tenant (or tenant family) for 30 years or longer. As rents cannot be raised in those conditions, the income through renting out reserves for investments are relatively low.

Space heating

Problem 1: Windows - heat losses through low standard windows

Causes: The u-value of the windows is not on the approved technical standard. Some of them are 50 years old and have never been renovated since the time of construction (u-value between 2,5 and 5,6 !!!). Also high infiltration is given by this bad technical standards.

Actions

Replacement of the windows on the western (garden) side of the building. Most of the windows on the eastern side (street) have been replaced with low noise windows (with a u-value 1,6 to 2,5!!!) 5 to 10 years ago. According to financial reinvestment it is not feasible, to replace the low noise windows at the moment, even if they have poor u-values.

Windows / doors with poor standards

Problem 2: Heat losses trough the walls

Causes: The insulation level is insufficient due to lower building standards at the time of construction. Walls to the ambient are not insulated.

Actions

Add insulation on the western side of the building and the fire wall in the north. Regarding to the local terms of construction law it is not allowed to add insulation on the street side (only 3 cm are allowed; the building is situated directly on the site border line).

The "Street Side"

View to the garden – walls are not insulated

Problem 3: Heat losses trough the roof

Causes: The roof is not insulated, the insulation level is insufficient due to lower building standards at the time of construction.

Actions

Remove the old roof and construct a new one. This measure seems to be possible if the now unused attic can be developed as new space for residential use. In fact, there will result something about 180 m² on new floor area for rent or sell by the owners.

The roof and the unused attic.

Problem 4: Heat losses trough missing insulation by the hot water distribution pipes

Causes: The distribution pipes are not insulated.

Actions

Insulation of the distribution pipes of the heating system.

Domestic hot water

Problem 1: Heat losses trough missing insulation by the domestic hot water distribution pipes

The distribution pipes are not insulated.

Actions

Insulation of the distribution pipes.

Space cooling

No problems; whether the tool says "high risk"

Ventilation

No problems

Lighting

No problems

2.2 SCENARIOS

At next step a number of different measures regarding to the audit and diagnosis results have been simulated with the EPA-ED tool. This measures have been evaluated, the results are presented on the following pages.

The scenarios include short descriptions and interpretations. All measures are concentrated on the improvement of the insulation standards of the building. Referring to the chosen pilot project, no cooling and/or ventilation systems are necessary, The common lighting system is on a low standard. The replacement of the lamps with low energy lamps has not been simulated, because the economic benefits of this measure would only result in some Euro per year. Other common electricity systems are not installed.

Scenario 0: Baseline – actual stock

The baseline – scenario is given by the existing building without any measures of improvement. See detail information below.

Dwelling		Floor Area, m²	Mean storey height, m
House Brünnerstraße		1482	3,4
Internal Heat Gains		50 W/person	1500 W
Infiltration		0,38 /h	0,531873 m³/s
Mechanical Ventilation		0 /h	0 m³/s

Volume, m³		Persons		Heat Capacity, kJ/Km²
5038,8		30		576
Domistic Hot Water		18,25 l/person		547,5 l
Natural Ventilation		0,7 /h		0,979767 m³/s
Heat Recovery eff 0		Design Temp. Heating 20 °C		Design Temp. Cooling 26 °C

Opaque Constructions	Orientation, deg	Tilt, deg	Area, m²	U, W/m²K	b	Alpha	Fs	Ht, W/K
floor4: floating floor 20 mm, solid bricks 380 mm, finish 10 mm, no insulation	0	0	273,66	1,156	0,5	0,65	1	158,175
roof2: tilted roof, without insulation (wooden panel on wooden timber roof construction, air, roof tiles)	270	45	74,29	1,146	1	0,65	1	85,1363
wall7: ext. plaster / solid bricks / int. plaster 2/38/1cm	90	90	253,53	1,355	1	0,65	1	343,533
wall7: ext. plaster / solid bricks / int. plaster 2/38/1cm	270	90	265,82	1,355	1	0,65	1	360,186
roof2: tilted roof, without insulation (wooden panel on wooden timber roof construction, air, roof tiles)	90	45	74,29	1,146	1	0,65	1	85,1363
wall8: ext. plaster / solid bricks / int. plaster 2/25/1cm	0	90	76,28	1,81	1	0,65	0,6	138,067
floor1: floating floor / solid bricks / finish – 2/38/1 cm, no insulation	0	90	151,42	1,16	0,69	0,65	0,6	121,713
wall4: cavity wall with building board 15/2	0	90	35,7	1,52	0,69	0,65	0,6	37,6016
Sum			1204,99					1329,55

Transparent Constructions	Orientation, deg	Tilt, deg	Area, m²	U, W/m²K	b	Ht, W/K
window 24: wooden frame window, single glazing,	270	90	28,8	2,1	1	60,48
window 27: double glazing, coated, gap 12 mm, gas filling, plastic frame	270	90	10,2	1,65	1	16,83
window3: noise-insulation, double glazing, no coated, 16 mm gap filled with air, plastic frame, two leaves	90	90	21,6	2,72	1	58,752
window4: noise-insulation, double glazing, no coated, 16 mm gap filled with air, plastic frame, three leaves	90	90	43,2	2,73	1	117,936
window5: noise-insulation, double glazing, no coated, 16 mm gap filled with air, plastic frame, one leave	90	90	7,2	2,69	1	19,368
window5 noise-insulation, double glazing, no coated, 16 mm gap filled with air, plastic frame, one leave	270	90	5,4	2,69	1	14,526
window1: box-type, single glazing, Wooden frame, two leaves	90	90	3,6	2,22	1	7,992
window1: box-type, single glazing, Wooden frame, two leaves	270	90	3,6	2,22	1	7,992
window6: heat protection window, frameless	90	90	21,9	1,61	1	35,259
window7: single glazing, metal frame, poorly insulated	90	90	9,9	5,92	1	58,608
window2: box-type, single glazing, Wooden frame, two leaves	270	90	13,6	2,23	1	30,328
door2: balcony door, single glazing, wooden frame, poorly insulated	270	90	51,65	5,46	1	282,009
door1: single glazing, wooden frame, poorly insulated	270	90	6,58	5,24	1	34,4792
door3 single glazing, metal frame, fraction of frame 80 %	90	90	6,58	6,04	1	39,7432
Sum			**233,81**			**784,302**

Glazing factor, frame factors, Solar Savings

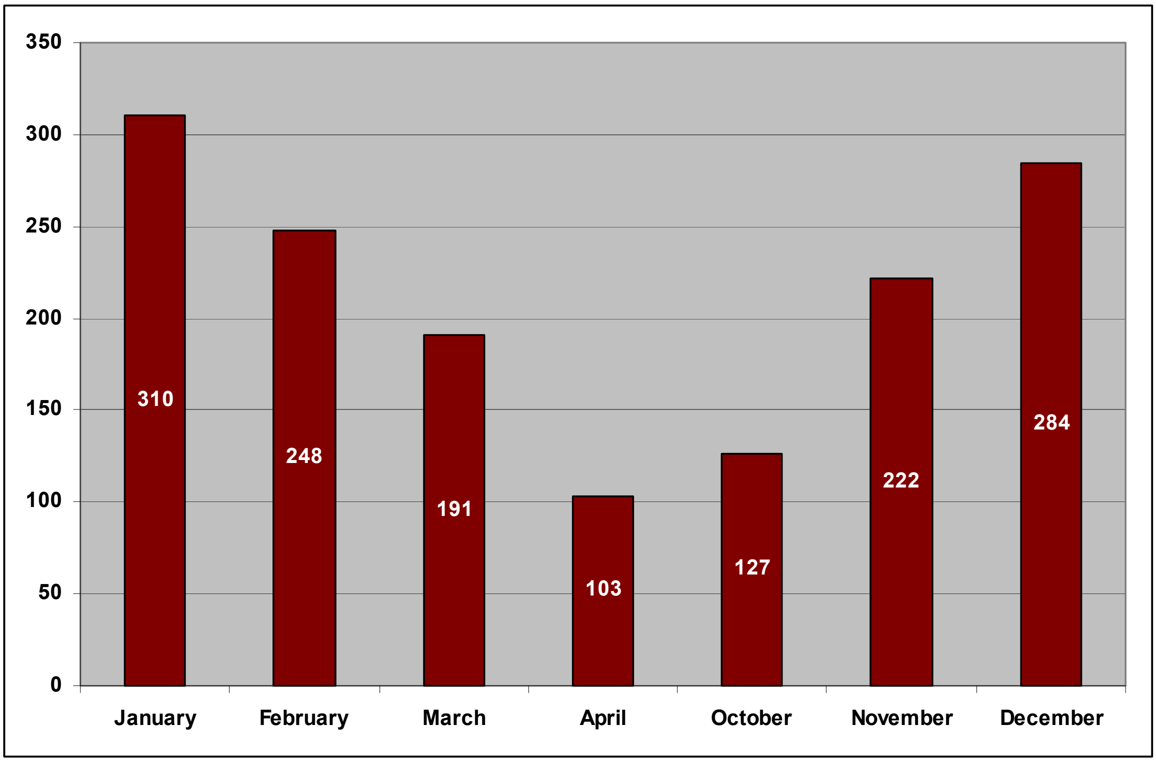
Transparent Constructions	g	Ff	Fs	Fm	Qs, GJ
window 24	0,6	0,7	1	1	29,0939
window 27	0,6	0,7	1	1	10,3041
window3:	0,72	0,7	1	1	26,4648
window4:	0,72	0,7	1	1	52,9297
window5	0,72	0,7	1	1	8,82161
window5	0,72	0,7	1	1	6,54613
window1	0,83	0,7	1	1	5,08468
window1	0,83	0,7	1	1	5,03082
window6	0,6	0,7	1	1	22,3603
window7	0,87	0,7	1	1	14,6567
window2	0,83	0,7	1	1	19,0053
door2	0,87	0,7	1	1	75,6568
door1	0,87	0,7	1	1	9,63837
door3	0,87	0,2	1	1	2,7833
Sum					**288,377**

Heating system, DHW system (no cooling system)

Heating	Fuel	Gen Eff	Dist Eff	CHP Elect Eff, kWh/MJ	Aux Energy, kWh	Fraction
central heating, gas, > 15 year	Natural gas	0,8	0,9	0	370	1
Domistic Hot Water	**Fuel**	**Gen Eff**	**Dist Eff**	**Aux Energy, kWh**	**Fraction**	
HR-107 combi (H)	Natural gas	0,8	0,9	270	1	

GJ	Total	January	February	March	April	October	November	December
Qhd - Base	1485,209	310,028	247,679	191,214	103,348	126,536	222,221	284,183

Transmission losses Baseline Scenario in GJ



Scenario 1: New Windows - Replacement of windows and doors

The windows and balcony doors westward to the garden have poor u-values between 2,5 and 5,6 W/m²K, and are often untight, too. In scenario 1 all windows and balcony doors on the garden side have been replaced with wooden-framed windows (double glazing) with an u-value by 1,3 W/m²K. The windows on the street side (eastwards) also have poor u-values, but they are only 10 years old. It is not realistic, to replace them at the moment. Besides the replacement of windows the drilling pipes have to insulated in this scenario.
On the figures below you will find statistical information on this scenario in detail (only categories in which measures have been set are shown (highlighted))

Dwelling		Floor Area, m²	Mean storey height, m
House Brünnerstraße		1482	3,4
Internal Heat Gains		50 W/person	1500 W
Infiltration		0,22 /h	0,307927 m³/s
Mechanical Ventilation		0 /h	0 m³/s

Note: The infiltration rate has to turn down on a lover level, because the windows have been the most important reason for the weakness of the building.

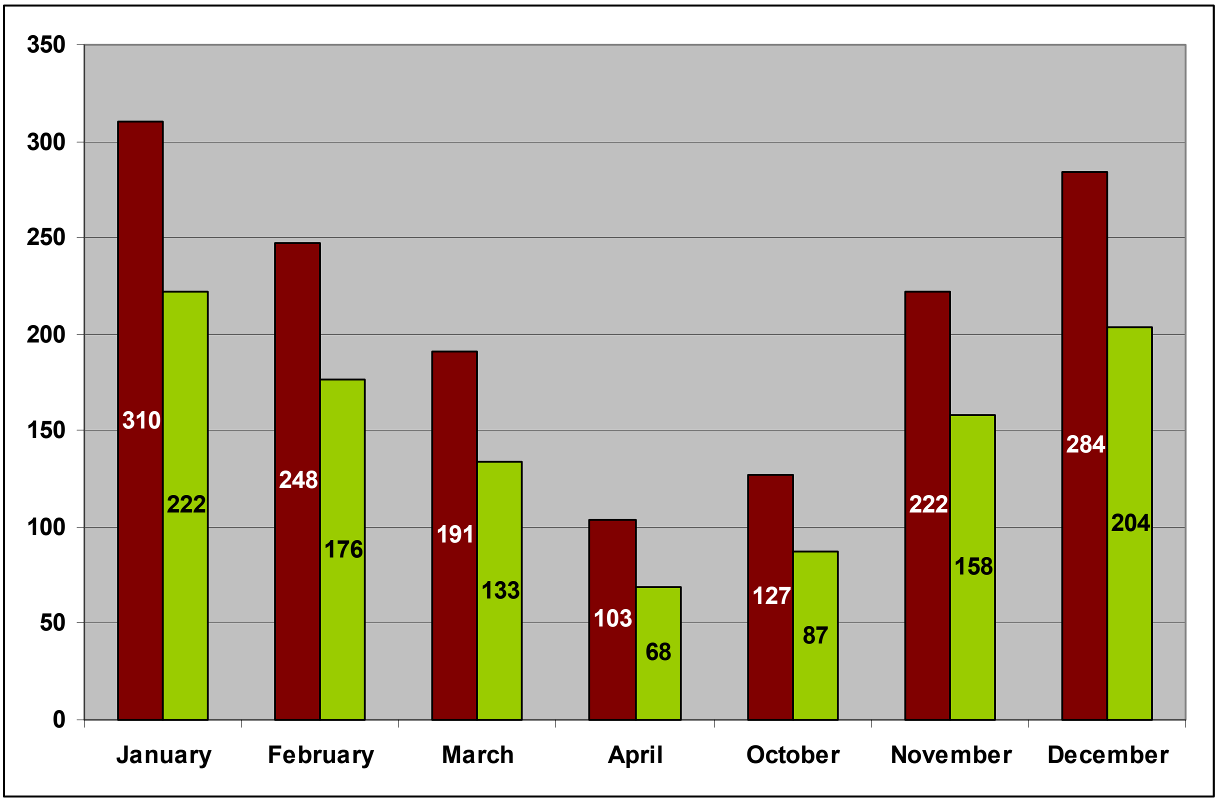
Volume, m³		Persons		Heat Capacity, kJ/Km²
5038,8		30		576
Domistic Hot Water		18,25 l/person		547,5 l
Natural Ventilation		0,7 /h		0,979767 m³/s
Heat Recovery eff 0		Design Temp. Heating 20 °C		Design Temp. Cooling 26 °C

Transparent Constructions	Orientation, deg	Tilt, deg	Area, m²	U, W/m²K	b	Ht, W/K	Cost/m²
window 32: double glazing, woodenframe 5/16/5 - U1,3	270	90	28,8	1,3	1	37,44	250
window 32: double glazing, wooden frame 5/16/5 - U1,3	270	90	10,2	1,3	1	13,26	250
window3: noise-insulation, double glazing, no coated, 16 mm gap filled with air, plastic frame, two leaves	90	90	21,6	2,72	1	58,752	0
window4: noise-insulation, double glazing, no coated, 16 mm gap filled with air, plastic frame, three leaves	90	90	43,2	2,73	1	117,936	0
window5: noise-insulation, double glazing, no coated, 16 mm gap filled with air, plastic frame, one leave	90	90	7,2	2,69	1	19,368	0
window 32: double glazing, wooden frame 5/16/5 - U1,3	270	90	5,4	1,3	1	7,02	**250**
window1: box-type, single glazing, Wooden frame, two leaves	90	90	3,6	2,22	1	7,992	0
window 32: double glazing, wooden frame 5/16/5 - U1,3	270	90	3,6	1,3	1	4,68	**250**
window6: heat protection window, frameless	90	90	21,9	1,61	1	35,259	0
window7: single glazing, metal frame, poorly insulated	90	90	9,9	5,92	1	58,608	0
window 32: double glazing, wooden frame 5/16/5 - U1,3	270	90	13,6	1,3	1	17,68	**250**
door2: balcony door, double glazing, wooden frame 5/16/5 - U1,3	270	90	51,65	1,3	1	67,145	**250**
door1: double glazing, wooden frame 5/16/5 - U1,3	270	90	6,58	1,3	1	8,554	**250**
door3 single glazing, metal frame, fraction of frame 80 %	90	90	6,58	6,04	1	39,7432	0
Sum			**233,81**			493,437	

Heating system, DHW system (no cooling system)

Heating	Fuel	Gen Eff	Dist Eff	CHP Elect Eff, kWh/MJ	Aux Energy, kWh	Fraction	Costs
central heating, gas, > 15 year	Natural gas	0,8	0,95	0	370	1	2000
Domistic Hot Water	**Fuel**	**Gen Eff**	**Dist Eff**	**Aux Energy, kWh**	**Fraction**		
HR-107 combi (H)	Natural gas	0,8	0,98	270	1		2000

Comparison of transmission losses in GJ: Baseline vs New Windows



GJ	Total	January	February	March	April	October	November	December
Qhd – Baseline	1485,209	310,028	247,679	191,214	103,348	126,536	222,221	284,183
Qhd – New Windows	1049,698	222,305	176,400	133,410	68,354	87,385	158,272	203,570

Expected Costs: EURO 33.958,-

Grants / Subsidies: up to 30 % (paid by annuity grants with 10 years term of loan)
Energy Savings per annum: 10.016 m³ natural gas = 120.975 kWh
Reduction of energy costs per annum: Euro 2.169,-
Annuity grant per years: Euro 1.019,- (10times)

Amortisation:
Simple pay back time: 10,65 years
After this period the investment will leave a margin of Euro 2.169,- per annum. The lifetime of windows can be calculated from 20 to 30 years.

The assumed reduction of energy costs includes no increase of energy prices!

Scenario 2: Insulation W/N

Additional to the measures of scenario “New Windows” in scenario “Insulation W/N” the walls on the west and the north side of the building became insulated with 12cm EPS. Therefore the U-value of this walls fall down to 0,25 (or nearby). Also the floor to the cellar has to be insulated with 12cm EPS (taken down construction).

As arguments show in the diagnosis, it is not possible to take insulations on the facade to the east side (street): the existing building code allows only a pass over of 3cm to the front construction line. Therefore it doesn’t make sense to take insulation on this side of the building.

Scenario “Insulation W/N” includes:

- Insulation of all walls to the garden side of the building
- Insulation of the firewall in the north
- Insulation of floor to unheated cellar
- Replacement of the windows on the garden side
- Insulation of the drilling pipes for heating and domestic hot water

On the figures below you will find statistical information on this scenario in detail (only categories in which measures have been set are shown (highlighted))

Dwelling		Floor Area, m²	Mean storey height, m
House Brünnerstraße		1482	3,4
Internal Heat Gains		50 W/person	1500 W
Infiltration		0,15 /h	0,20995 m³/s
Mechanical Ventilation		0 /h	0 m³/s

Note: The infiltration rate has to turn down on a lover level. In addition to the windows, the insulated wall reduce infiltration.

Volume, m³		Persons		Heat Capacity, kJ/Km²
5038,8		30		576
Domistic Hot Water		18,25 l/person		547,5 l
Natural Ventilation		0,7 /h		0,979767 m³/s
Heat Recovery eff 0		Design Temp. Heating 20 °C		Design Temp. Cooling 26 °C

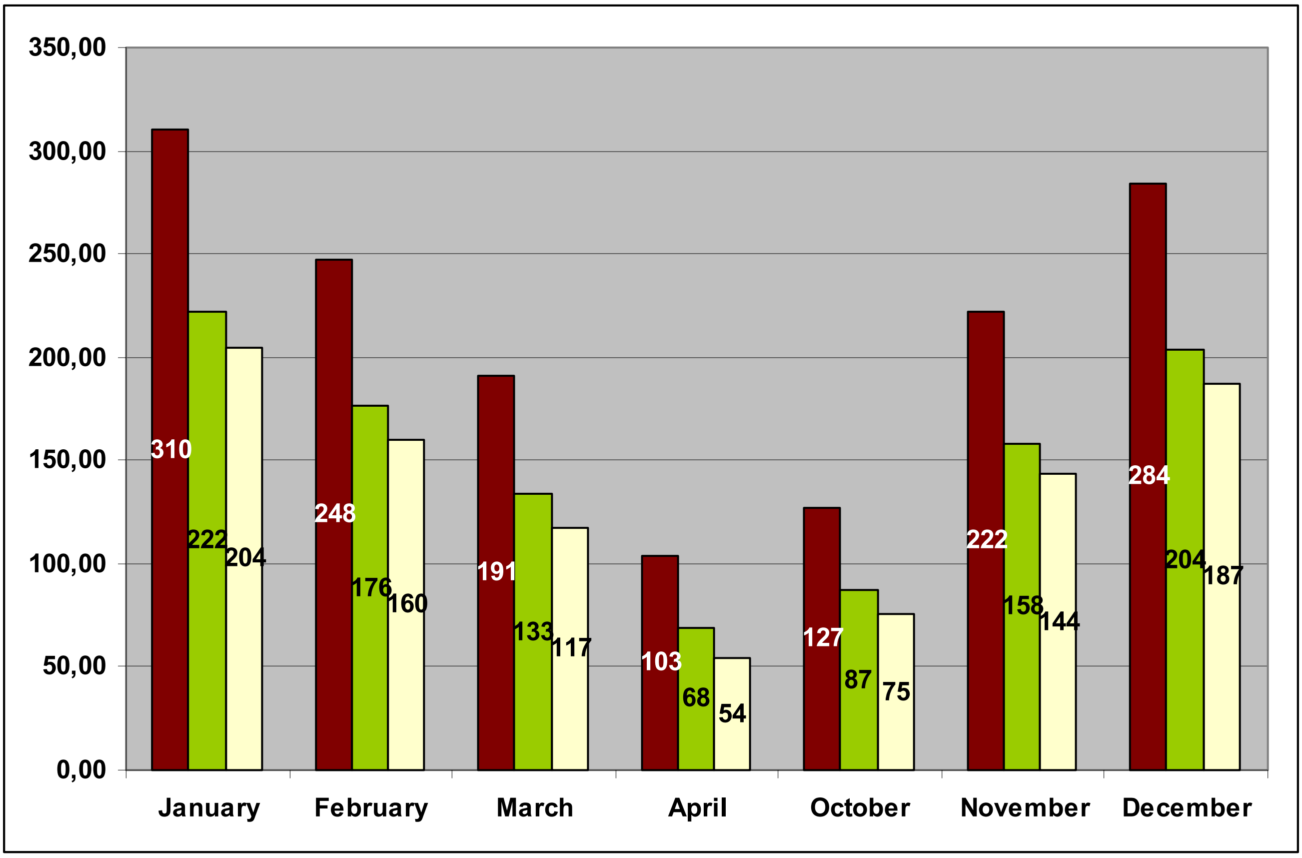
Opaque Constructions	Orientation, deg	Tilt, deg	Area, m²	U, W/m²K	B	Alpha	Fs	Ht, W/K	
floor4: floating floor 20 mm, solid bricks 380 mm, finish 10 mm, no insulation	0	0	273,66	1,156	0,5	0,65	1	158,175	0
roof2: tilted roof, without insulation (wooden panel on wooden timber roof construction, air, roof tiles)	270	45	74,29	1,146	1	0,65	1	85,1363	0
wall7: ext. plaster / solid bricks / int. plaster 2/38/1cm	90	90	253,53	1,355	1	0,65	1	343,533	0
wall7: silicate plaster / EPS / ext. plaster / solid bricks / int. plaster 0,2/12/2/38/1cm	270	90	265,82	0,26	1	0,65	1	69,1132	45
roof2: tilted roof, without insulation (wooden panel on wooden timber roof construction, air, roof tiles)	90	45	74,29	1,146	1	0,65	1	85,1363	0
wall8: silicate plaster / EPS / ext. plaster / solid bricks / int. plaster 0,2/ 12 / 2/25/1cm	0	90	76,28	0,28	1	0,65	0,6	21,3584	45
Floor 4: finish / solid bricks, 380 mm, +120 mm insulation (polystyrol)	0	90	151,42	0,22	0,693	0,65	0,6	23,0834	30
wall4: cavity wall with building board 15/2	0	90	35,7	1,52	0,693	0,65	0,6	37,6016	0
Sum			1204,99					823,138	

Transparent Constructions	Orientation, deg	Tilt, deg	Area, m²	U, W/m²K	b	Ht, W/K	Cost/m²
window 32: double glazing, woodenframe 5/16/5 - U1,3	270	90	28,8	1,3	1	37,44	250
window 32: double glazing, wooden frame 5/16/5 - U1,3	270	90	10,2	1,3	1	13,26	250
window3: noise-insulation, double glazing, no coated, 16 mm gap filled with air, plastic frame, two leaves	90	90	21,6	2,72	1	58,752	0
window4: noise-insulation, double glazing, no coated, 16 mm gap filled with air, plastic frame, three leaves	90	90	43,2	2,73	1	117,936	0
window5: noise-insulation, double glazing, no coated, 16 mm gap filled with air, plastic frame, one leave	90	90	7,2	2,69	1	19,368	0
window 32: double glazing, wooden frame 5/16/5 - U1,3	270	90	5,4	1,3	1	7,02	**250**
window1: box-type, single glazing, Wooden frame, two leaves	90	90	3,6	2,22	1	7,992	0
window 32: double glazing, wooden frame 5/16/5 - U1,3	270	90	3,6	1,3	1	4,68	**250**
window6: heat protection window, frameless	90	90	21,9	1,61	1	35,259	0
window7: single glazing, metal frame, poorly insulated	90	90	9,9	5,92	1	58,608	0
window 32: double glazing, wooden frame 5/16/5 - U1,3	270	90	13,6	1,3	1	17,68	**250**
door2: balcony door, double glazing, wooden frame 5/16/5 - U1,3	270	90	51,65	1,3	1	67,145	**250**
door1: double glazing, wooden frame 5/16/5 - U1,3	270	90	6,58	1,3	1	8,554	**250**
door3 single glazing, metal frame, fraction of frame 80 %	90	90	6,58	6,04	1	39,7432	0
Sum			**233,81**			493,437	

Heating system, DHW system (no cooling system)

Heating	Fuel	Gen Eff	Dist Eff	CHP Elect Eff, kWh/MJ	Aux Energy, kWh	Fraction	Costs
central heating, gas, > 15 year	Natural gas	0,8	0,95	0	370	1	2000
Domistic Hot Water	**Fuel**	**Gen Eff**	**Dist Eff**	**Aux Energy, kWh**	**Fraction**		
HR-107 combi (H)	Natural gas	0,8	0,98	270	1		2000

Comparison of transmission losses in GJ: Baseline vs New Windows PLUS Insulation



GJ	Total	January	February	March	April	October	November	December
Qhd – Baseline	1485,21	310,03	247,68	191,21	103,35	126,54	222,22	284,18
Qhd – New Windows	1049,70	222,31	176,40	133,41	68,35	87,39	158,27	203,57
Qhd - Insulation	941,10	204,15	160,20	116,97	54,19	75,23	143,74	186,64

Expected Costs: EURO 53.895,-

Grants / Subsidies: up to 40 % (paid by annuity grants with 10 years term of loan)
Energy Savings per annum: 11.942 m³ natural gas = 144.238 kWh
Reduction of energy costs per annum: Euro 2.570,-
Annuity grant per years: Euro 1.509,- (10times)

Amortisation:
Simple pay back time: 13,21 years
After this period the investment will leave a margin of Euro 2.570,- per annum. The lifetime of windows can be calculated from 20 to 30 years, and the insulated walls / floors from 30 to 40 years.

The assumed reduction of energy costs includes no increase of energy prices!

Scenario 3: Penthouse - Replacement of roof, enlargement of ground floor

The 3rd scenario includes additive to scenario 1 & 2 measures on renovation and new building. The existing attic is not used at the moment, and contains potential on enlarging the useable ground floor of the building something about 200 m^2. This kind of “renovation” aims at (sometimes extremely high) additional benefits. It is not suitable to simulate these kind of (economic) benefits with EPA-ED; EPA-ED is designed on the aspects of the energy performance of buildings.

However, scenario 3 “Penthouse” includes the replacement of the un-insulated roof; a new modern roof with an U-value 0,17 (existing: 1,15) has to be realised. In the calculation of this scenario only the specific costs for this are included (no costs for the penthouse!). The (economic) results describe the amount of benefit, which has to be acquired for activating additional savings on energy consumption.

Scenario “Insulation W/N” includes:

- Replacement of the roof
- Insulation of all walls to the garden side of the building
- Insulation of the firewall in the north
- Insulation of floor to unheated cellar
- Replacement of the windows on the garden side
- Insulation of the drilling pipes for heating and domestic hot water

On the figures below you will find statistical information on this scenario in detail (only categories in which measures have been set are shown (highlighted))

Dwelling	Floor Area, m^2	Mean storey height, m
House Brünnerstraße	1482 (+200?)	3,4
Internal Heat Gains	50 W/person	1500 W
Infiltration	0,15 /h	0,20995 m^3/s
Mechanical Ventilation	0 /h	0 m^3/s

Note: The infiltration rate has to turn down on a lover level. In addition to the windows, the insulated wall reduce infiltration.

Volume, m^3	Persons	Heat Capacity, kJ/Km^2
5038,8	30 (+4?)	576
Domistic Hot Water	18,25 l/person	547,5 l
Natural Ventilation	0,7 /h	0,979767 m^3/s
Heat Recovery eff 0	Design Temp. Heating 20 °C	Design Temp. Cooling 26 °C

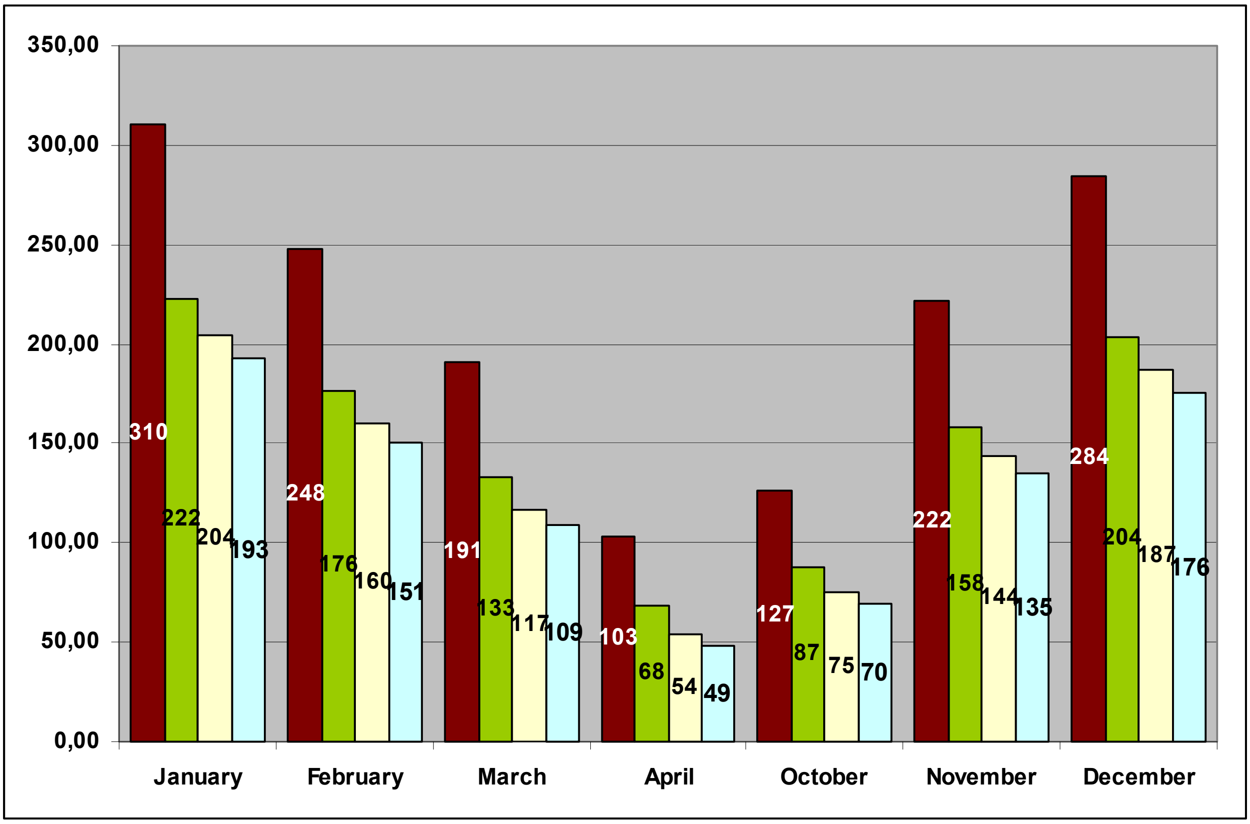
Opaque Constructions	Orientation, deg	Tilt, deg	Area, m²	U, W/m²K	B	Alpha	Fs	Ht, W/K	
floor4: floating floor 20 mm, solid bricks 380 mm, finish 10 mm, no insulation	0	0	273,66	1,156	0,5	0,65	1	158,175	0
roof2: tilted roof, 45°, +200 mm insulation (mineral wool between timber construction)	270	45	74,29	0,17	1	0,65	1	85,1363	110
wall7: ext. plaster / solid bricks / int. plaster 2/38/1cm	90	90	253,53	1,355	1	0,65	1	343,533	0
wall7: silicate plaster / EPS / ext. plaster / solid bricks / int. plaster 0,2/12/2/38/1cm	270	90	265,82	0,26	1	0,65	1	69,1132	45
roof2: tilted roof, 45°, +200 mm insulation (mineral wool between timber construction)	90	45	74,29	0,17	1	0,65	1	85,1363	110
wall8: silicate plaster / EPS / ext. plaster / solid bricks / int. plaster 0,2/ 12 / 2/25/1cm	0	90	76,28	0,28	1	0,65	0,6	21,3584	45
Floor 4: finish / solid bricks, 380 mm, +120 mm insulation (polystyrol)	0	90	151,42	0,22	0,693	0,65	0,6	23,0834	30
wall4: cavity wall with building board 15/2	0	90	35,7	1,52	0,693	0,65	0,6	37,6016	0
Sum			1204,99					823,138	

Transparent Constructions	Orientation, deg	Tilt, deg	Area, m²	U, W/m²K	b	Ht, W/K	Cost/m²
window 32: double glazing, woodenframe 5/16/5 - U1,3	270	90	28,8	1,3	1	37,44	250
window 32: double glazing, wooden frame 5/16/5 - U1,3	270	90	10,2	1,3	1	13,26	250
window3: noise-insulation, double glazing, no coated, 16 mm gap filled with air, plastic frame, two leaves	90	90	21,6	2,72	1	58,752	0
window4: noise-insulation, double glazing, no coated, 16 mm gap filled with air, plastic frame, three leaves	90	90	43,2	2,73	1	117,936	0
window5: noise-insulation, double glazing, no coated, 16 mm gap filled with air, plastic frame, one leave	90	90	7,2	2,69	1	19,368	0
window 32: double glazing, wooden frame 5/16/5 - U1,3	270	90	5,4	1,3	1	7,02	**250**
window1: box-type, single glazing, Wooden frame, two leaves	90	90	3,6	2,22	1	7,992	0
window 32: double glazing, wooden frame 5/16/5 - U1,3	270	90	3,6	1,3	1	4,68	**250**
window6: heat protection window, frameless	90	90	21,9	1,61	1	35,259	0
window7: single glazing, metal frame, poorly insulated	90	90	9,9	5,92	1	58,608	0
window 32: double glazing, wooden frame 5/16/5 - U1,3	270	90	13,6	1,3	1	17,68	**250**
door2: balcony door, double glazing, wooden frame 5/16/5 - U1,3	270	90	51,65	1,3	1	67,145	**250**
door1: double glazing, wooden frame 5/16/5 - U1,3	270	90	6,58	1,3	1	8,554	**250**
door3 single glazing, metal frame, fraction of frame 80 %	90	90	6,58	6,04	1	39,7432	0
Sum			**233,81**			493,437	

Heating system, DHW system (no cooling system)

Heating	Fuel	Gen Eff	Dist Eff	CHP Elect Eff, kWh/MJ	Aux Energy, kWh	Fraction	Costs
central heating, gas, > 15 year	Natural gas	0,8	0,95	0	370	1	2000
Domistic Hot Water	**Fuel**	**Gen Eff**	**Dist Eff**	**Aux Energy, kWh**	**Fraction**		
HR-107 combi (H)	Natural gas	0,8	0,98	270	1		2000

Comparison of transmission losses in GJ:
Baseline vs New Windows PLUS Insulation PLUS Penthouse



GJ	Total	January	February	March	April	October	November	December
Qhd – Baseline	1485,21	310,03	247,68	191,21	103,35	126,54	222,22	284,18
Qhd – New Windows	1049,70	222,31	176,40	133,41	68,35	87,39	158,27	203,57
Qhd - Insulation	941,10	204,15	160,20	116,97	54,19	75,23	143,74	186,64
Qhd - Penthouse	881,03	192,54	150,57	108,72	48,64	69,51	135,10	175,94

Expected Costs: EURO 70.238,-

Grants / Subsidies: up to 40 % (paid by annuity grants with 10 years term of loan)
Energy Savings per annum: 13.292 m³ natural gas = 160.543 kWh
Reduction of energy costs per annum: Euro 2.851,-
Annuity grant per years: Euro 2.810,- (10times)

Amortisation:
Simple pay back time: 12,41 years
After this period the investment will leave a margin of Euro 2.810,- per annum. The lifetime of windows can be calculated from 20 to 30 years, the insulated walls / floors from 30 to 40 years, and the roof from 50 to 60 years.

The assumed reduction of energy costs includes no increase of energy prices!
The assumed “simple” pay back time includes no benefits from a possible enlargement of the useable ground floor.

2.3 PROPOSALS

Based on the results of the simulation of different scenarios, it is necessary to make a cross-over comparison of advantages and disadvantages of the different possibilities for renovation and improvement of the building's quality.

The client (owner of the building) wants to

- Save energy (and thereby to save costs), and
- To have a midterm pay back time (10 years)

As we have been shown by the simulation on costs and the savings on energy, the greatest problem of the object are old windows (transmission losses, losses from infiltration) and low technical standards by the insulation of walls, the roof, and some floors. Natural gas is the main resource for energy supply. Electricity, and other kind of energy is not used for heating, cooling or ventilation in the object. The consumption on electricity for on common is less enough to be outside the focus of improving the energy performance of the building. Solar cells or PV elements are not recommendable, because the object is oriented to west & east. Regarding to this framework on energy supply (and improvement of the energy performance) we propose the following options:

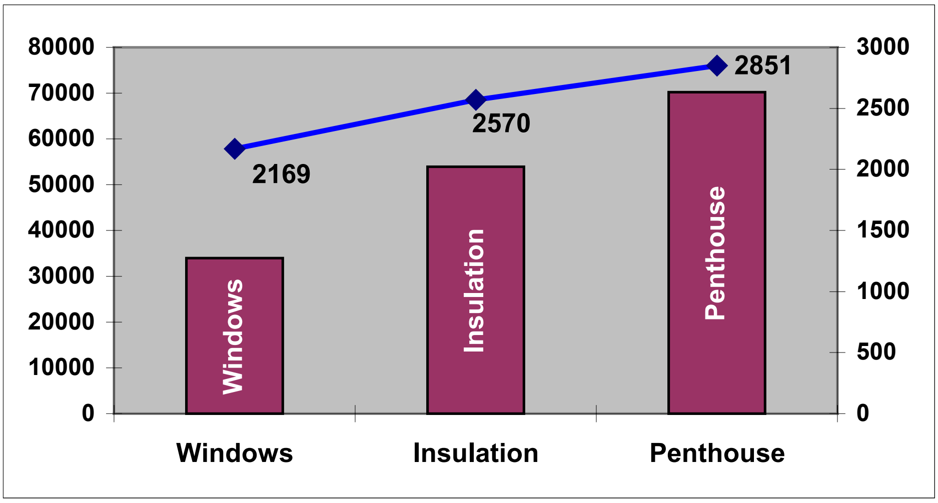
1. 1st Option: If we want to reduce the infiltration losses, we have to replace the windows. The best option would be to remove all windows. This is not reasonable, because half of them are only 5 to 10 years old. The costs on investment are less in comparison to other possibilities.
2. 2nd Option: If there are (financial) possibilities to develop a total renovation including the attic and the roof, this should be done. From the owner's view of point, this might be the best scenario: Choosing this, the owner can stimulate economic benefits (for instance, in order to finance the improvement of the energy performance !?!), which have to be calculated seriously.

One central recommendation can be done: Without grants and subsidies from the Public, the analysed measures wouldn't have an economic base. The recent costs on energy are not high enough for stimulating the improvement of the energy performance of the building. This is one of the core messages of the client (owner of the building): Projects with pay back times longer then 7 to 10 years are not a good base for investment.

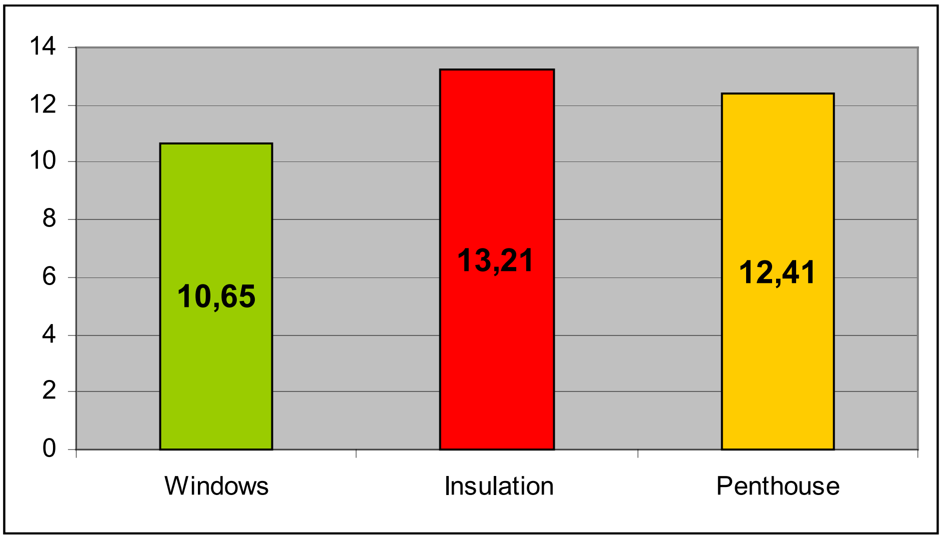
Collecting the advantages and disadvantages of the different scenarios, we prepared the figures below:

Arguments	Baseline	New Windows	Insulation	Penthouse
Energy Performance	Worst	good	Better	best
Economic Risks	???	low		High; largest amount of risk capital
Pay Back Time	No, but risk of debasement	10,65	13,21	12,41
Total Quality of Building	Bad	good	Better	Best
Economic Benefits	Neutral; but risk of debasement			Highest potential
Problems with existing residents	???; problems with high costs on energy	Is given; replacement of the windows	Not really higher	Not really higher

Costs on investment & pay back rates after pay back time



Pay back Time



	Actual	Windows	Insulation	Penthouse
Natural gas in m³	37046	10016	11942	13292
Savings in % of Actual	100	27%	32%	36%

3. RECOMMENDATIONS

Based on the experience gained from the use of the EPA-ED method and tool during the audit and the follow-up analysis, this section presents the specific problems encountered and some relevant recommendations.

At first: We have been testing the EPA-ED with two versions: the now (at the end of the project) available "final version" from August, 28th 2004, and some former editions. However, the now existing version works solid and includes an improved online-manual.

3.1 AUDIT PROCEDURE

The **inspection protocol** is now concise and easy to follow.

Sometimes we felt a little bit confused on the used terminology: checklist, intake procedure, inspection protocol, audit, …

… but this may be also concerning to our recent practise in using some other tools in Austria for comparable activities in renovation of buildings. Everybody inside the construction community is working with a lot of tools, checklists, protocol sheets, and something else.

May be the process on implementation of the EPBD includes a serious opportunity on standardisation of terminology in building and construction consultancy, in particular in building performance assessment.

3.2 CALCULATION TOOL - General

The calculation tool appear to provide reasonable results.

The Austrian method(s) on energy performance assessment (i.e. "Energieausweis") doesn't including detailed simulation on cooling demands, lighting, ventilation, and/or domestic hot water heating. The energy labels are concentrated on the calculation of the estimated heating demand (normally in kWh/m²,a). Ventilation, cooling or DHWH is sometimes included with standardized indicators (e.g. ventilation; the normative standard value is 0,4, including infiltration AND natural ventilation, both in renovation and new building!).

That is why we have been wondering first on big differences in results between the Vienna calculation model and the EPA-ED software tool (we simulated the pilot project in both tools).

How ever: Using the same indicators in natural ventilation and infiltration, we received nearby the same results.

3.3 CALCULATION TOOL – In detail

(a) **Interface**. The screen interface is now functional and provides “microsoftability” in the most user actions. Sometimes the user is tempted to try some copy – paste activities on the whole screen, but they don’t succeed. The “right click beside” alternative works perfect, we think it must be cultivated … However: The EPA-ED tool provides a well-known interface for most of users, each software needs some special efforts.

(b) **Logical Structure**. There is one thing, which needs really getting used to: All (system) constants and libraries are shown at the head of the first screen. We think, this is a quite prominent place for this kind of important files. It might be better, to choose/change them from the navigation bar, using a pull down menu (something like “system-files”, extra, …). The “file manager” or navigation tree is functional as long as you don’t have a lot of scenarios running on EPA-ED. Hereby we have to decide: Full usability in copy-paste function on the screen (tree-system) OR more facility of inspection on the screen by using pull-down menus or buttons/links. I think this is a question of user’s choice and can be discussed in the EPA-ED 2.0 version …
Last, but not least in this section: If you have not add before a sunspace or an unheated space, the program gives a beep by clicking on one of this categories. The Author of this recommendation has been a little bit shocked by doing this the first times (*First Idea: O god, what have I done, will it work again ?!?*). A “Beep” says “Don’t do this” to the user, in some programs you have a last chance to save your work after a beep … Maybe it could be possible to give some on-screen help (e.g. pop-up help text, if something have been done wrong by the user).

(c) **User’ guide**. It is quite good, it is a great help. Congratulation. I think, some sequences are incomprehensible, but this is normal for a good user guide. Example: “*Entries from libraries can be selected in three ways: 1. … 2….?”* or *“**Note**: The default fuel **must be electricity** and **must** exist! Only fuels found in the FUEL_LIB sections are shown in the entry screen of the EPA-tool.*” Why? We don’t know it, and we have been reading, and reading, and ….

(d) **Functionality:** May be the “Note” quoted above is an answer on one of the EPA-ED mysteries we have found. The summary tables includes a lot of information, but no values for the consumed electricity. We have been trying a lot of scenarios, we have reading the user guide, we have been controlling the XML-libraries (Note!), but: Our pilot needs no electricity. And therefore we have no explanation.

Energy, Cost etc.

	Savings	Unit	Actual	S0 - Baseline	S1 - Windows	S2 - Insulation	S3 - Penthouse
	-		Consumption	Consumption	Savings	Savings	Savings
+1	Electricity	kWh	36000,0				
2	Natural gas	m3	35870,0		-27030,6	-25104,4	-23753,8
3	CO2 Emission	kg/year			-63792	-59246	-56059
4	Energy Indicator	GJ/m²			0,811	0,753	0,713
5	Frac. renewable energy (n	-			0,000	0,000	0,000
6	Frac. renewable energy (p	-			0,108	0,131	0,138
7	Risc of overheating	-			High	High	High

	Cost	Unit	/unit	S0 - Baseline	S1 - Windows	S2 - Insulation	S3 - Penthouse
	Total				0	0	0
+1	Electricity	kWh	0,15				
2	Natural gas	m3	0,00		0	0	0
3	Investment Cost				33973	53895	70238
4	Pay Back Time, simple	Years			0,00	0,00	0,00
5	Pay Back Time, net preser	Years			0,00	0,00	0,00

(e) **Scrollbars:** We would like to get some horizontal scroll bars. Sometimes the screen is to small to view all columns of a table.

(f) **Navigation**: … might be easier with all of the arrow keys, including the right and the left arrow key.

(g) **Libraries**: The field for additional descriptions is small. May be a "2nd Key structure" would be useful for organizing and navigating through the libraries (e.g. opaque constructions could be divided into walls, floors, roofs, …). From a XML-structure in this vein, the EPA-ED tool would get a lot of benefit in all regarding fields of usability. (Don't panic: We know about the problems to find the right terminology on an international thesaurus …).

(h) **Manipulation of library data**: Also in the new version it is possible to change some values of the XML-data by on-screen handling. Everybody can "overwrite" program constants from the XML-libraries, specially U-values, g-factors, efficiencies, … We think this is not correct. Each entry represents a own identity, defined by name, values, and some other data. If the user has the possibility to overwrite some parts of this identity, confusion might be the result. By the way, this recommendation is part of a critical self-evaluation: It is very easy (and very fast), to "adjust" the U-value of wall nr. 7 from 2,1 to 0,4. But on behalf of a serious documentation of different scenarios this way of "on-screen-efficiency" includes a lot of problems. Everybody of us knows about this problem: Only two day later, we can not remember on the details of manipulation. Is "wall nr. 7" a wooden-frame system for low energy houses or do they normally use it for the construction of show booth on the funfair? However: The original XML-file can not be overwritten. But there can exist several "wall nr. 7" in different EPA-ED projects. The output of this projects will be published, and not the original entry in the XML-File. Maybe it is possible to design an on-screen XML-interface? The user would be able to develop own XML-libraries.

(i) Library Import: We have a lot of construction services and databases including libraries on climate, construction parts, energy resources and something else regarding to EPA-ED. An import interface would be very useful to enlarge the content of the existing libraries.

(j) OUTPUT- EXPORT: We think it is not a big problem to provide different output – formats (*.txt, *.pdf, *.xml, *.xls, …). Also it would be useful do enable the print – command for the whole project.

FINAL RECOMMONDATION TO THE SOFTWARE TEAM: You have done a very good job!

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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DBUR (Denmark)
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NOA (Greece)
National Observatory of Athens

Funding Partners

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