3encult

EFFICIENT ENERGY FOR EU CULTURAL HERITAGE

D 2.2 = D3.2 Position Paper on criteria regarding the assessment of energy efficiency measures regarding their compatibility with conservation issues

EUROPEAN COMMISSION

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0 Abstract

There are several energy efficiency measures possible to be used for the retrofit of a building. The decision which of those measures are to be applied to any building is based on the estimation of their suitability. In the case of monument buildings also their compatibility is an important, probably the most important criteria. Actually the experiences on conservation compatible building retrofitting increase. Also the number of documents from different European Countries on that important task rises. These commonly available basis can be used to participate on the existing experience. In the deliverable D2.2=D3.2 Position Paper on criteria for the assessment of conservation compatibility of energy efficiency measures several experiences and strategies as well as recommendations are collected, checked, discussed and evaluated to generate a wide basis how to approach resilient and wide accepted criteria for the assessment of conservation compatibility of the energy efficiency measures within and beyond 3ENCULT. It should be brought to mind that this accounts for all built heritage independent from its listed or non-listed status. However, legally the final assessment and decision is up the responsible monument conservation administration.

Within this the basic hypothesis is always to respect multiple aspects in parallel. Thus for the decision on the single case possibly always the work of a multidisciplinary team is needed. For all different aspects of energy efficiency and demands of the monument qualitative and quantitative assessment criteria would be helpful to enhance a comprehensible evaluation.

To prepare a suitable approach towards the assessment of conservation compatibility of several energy efficiency measures for the 3Encult project and finally for a European Guideline some successful procedures came into evaluation. It is shown that several ways of decision are possible to come to best practice solutions, but the work to do so has to be managed. To introduce and integrate all experience of the total team a workshop was proceeded in the frame of a project meeting.

Energetic retrofit on European monuments is a challenging and actual task. But neither such alteration on heritage is impossible nor this is easy. No energy saving measure on a building is conservation compatible or incompatible per se. Working on the building heritage stock it is indispensable always to refer specific solutions to specific real objects and their problems. As a result of 3ENCULT the approach starting on one hand with a single heritage building and on the other without prejustice with the collection of all actual and effective energy solutions is the only possible way to come to a sustainable answer. For all retrofitting measures at all possible places of installation the impact on the monument, on the heritage value, the loss of original material and the change of the appearance has to be balanced. Also has the effectively to be weight as the sustainability in terms of damage risks and the reversibility of the new addition. This does yield to specific developed and object adapted results, which most often are a perfect combination of existing standard solutions. This additional work in planning does lead to an improved and forward looking result for energy efficiency in the important European Cultural Heritage.

1 Introduction and Objective

Within the European policy to reduce energy use and carbon dioxide emissions specifically targeted energy requirements of buildings whether new or existing, residential or non-residential the heritage stock takes a special position. As most of the energy performance standards do not reflect enough towards "grey energy" inhabited in the long standing buildings. However, upgrading the thermal efficiency of the existing building stock presents a challenge, particularly where the building was built using traditional materials and construction methods and is of architectural or historical interest.

Here we have to discuss the criteria regarding the assessment of energy efficiency measures regarding their compatibility with conservation relevance. To achieve that it is necessary to approach both individually and interlink the results. The objective is to set up an instrument within the project applied on the different case studies, and based on those experiences to develop solutions which are instrumented within new guidelines.

Evaluating the inquiry on available material it was most auspicious to combine the outcome of several different approaches.

Irish guideline (Ireland 2010) – refers to embodied energy and whole-life costing. When describing the case studies, three kinds of assessment are distinguished: energy assessment, conservation assessment and lifecycle assessment.

http://www.ahg.gov.ie/en/Publications/HeritagePublications/BuiltHeritagePolicyPublications/Energy%20Efficiency%20in%20Traditional%20Buildings%20%282010%29.pdf

Austrian guideline (Austria 2011) “Energieeffizienz am Baudenkmal”. offers 10 basic rules (p.8) from conservation point of view. At any point it stresses the need for proof of damage free of the single energy efficiency measure. Moreover the importance to simulations is stressed.
In the follwing the original text is given and an own, not yet verified translation offered.

1. ORIGINAL Oberste Zielsetzung von Denkmalschutz und Denkmalpflege ist die möglichst unveränderte Erhaltung der historisch überlieferten Substanz und Erscheinung. Im Falle notwendiger Veränderungen sind der Vorzustand, die Ma□nahmen und der Zustand nach den Eingriffen gemäß denkmalpflegerischen Standards zu dokumentieren.
1. THE ORIGINAL Superior Objective of monument conservation is the unchanged preservation of the historic stock and its appearance as far as possible. In the case of necessary changes the preexisting state, the measures and the state after the measures are to be documented under preservation standards.

2. ANALYSE Viele Baudenkmale weisen eine über die Zeit gewachsene, äußerst heterogene Substanz auf. Im Vorfeld einer Planung ist daher die möglichst vollständige Kenntnis des Bestands sowohl in bautechnischer als auch in bauphysikalischer Hinsicht notwendig.
2. ANALYSIS Most of the monuments exhibit a quite heterogeneous constitution grown in time. In the course of the planning a complete knowledge on the stock as well with respect to structurally as with respect to building physics is essential.

3. GESAMTPROJEKT Projekte sollen sich durch eine ganzheitliche Planung auszeichnen und sich nicht auf Einzelmaßnahmen fokussieren. Das Erreichen einzelner flächenbezogener U-Werte oder theoretischer Heizwärmebedarf-Angaben ist nicht zielführend, sondern es muss eine sinnvolle Optimierung des Gesamtenergiehaushalts eines Objekts angestrebt werden.
3. OVERALL PROJECT Measures shall be based on a holistic planning and not focus on single actions. The achievement of single U-values or theoretical demands on thermal heat is not adequate. The aim is to reach the sensible improvement of the total energy budget of the building.

4. NUTZERVERHALTEN Die Zielsetzung einer energetischen Sanierung kann nicht auf vorgegebenen Ansätzen wie beim normierten Energieausweis basieren, sondern muss konkret auf die Nutzung und das Nutzerverhalten im Objekt eingehen.
4. USER BEHAVIOR The aim of the energetic retrofit shall not be based of specified guidelines like the standardized Energy Performance Certificate, but has to refer to the practical use and the behavior of the user in the specified object.

5. INDIVIDUELL Baudenkmale erfordern Einzellösungen anstelle von Standardrezepten. Dies verlangt von den Beteiligten die Bereitschaft zu einem unter Umständen erhöhten Planungsaufwand, einer verbesserten Qualitätssicherung und verstärkter Kommunikation mit oder zwischen Baufachleuten, Bauherrschaft und Denkmalpflege bis zum Abschluss der Ma□nahmen.
5. INDIVIDUAL Monuments need individual solutions instead of standard formulations. This asks all parties involved the readiness of probably increased planning efforts, an improved quality assurance and intensified communication with and between expert, owner, investor and monument preservation until the termination of the measures.

6. INSTANDSETZUNG Als erster Schritt sind Fehlerquellen am Baudenkmal zu erheben, Reparaturen auszuführen und ursprüngliche Funktionskonzepte zu reaktivieren, um das Potential der historischen Substanz wieder zur Geltung zu bringen. Erst wenn die Möglichkeiten einer Instandsetzung ausgeschöpft sind, wird über eventuelle Ergänzungen oder Auswechslungen entschieden.
6. REPAIRS The first step is to look for sources of errors on the monument, do repairs and reactivate original functions to promote the historic ideas. No until the chances of restoration exploited one may decide on amendments or exchanges.

7. MATERIALKONFORM Notwendige Ergänzungen im Zuge energetischer Verbesserungen sind in der Materialität möglichst konform mit dem überlieferten Bestand auszuführen.
7. MATERIAL ACCORDANT Necessary amendments in the course of energetic improvements have to be accordant to the existing materials.

8. FEHLERTOLERANT Da man sowohl in der Herstellung als auch in der Benutzung erfahrungsgemäß keine idealen Zustände vorfindet, sind fehlertolerante, reparaturfähige bzw. reversible Konstruktionen vorzuziehen.
8 FAULT TOLERANT Given the fact that as well in production as in use there is never ideal conditions fault tolerant, repairable and reversible constructions are preferred.

9. RISIKOFREI Eine langjährige Schadensfreiheit ist zu gewährleisten. Die Beteiligung von BauphysikerInnen mit einschlägiger Erfahrung im Umgang mit der Sanierung von Baudenkmalen ist hierzu oft notwendig. Neuerungen beziehungsweise Versuche sind am Baudenkmal ausschließlich dann vertretbar, wenn sie im Rahmen eines wissenschaftlichen Projekts begleitet werden. Ansonsten gilt für alle Ma□nahmen: lieber weniger und sicher – als viel und riskant.
9. RISK FREE A long standing damage freeness is to guaranteed. For this often the participation of experts in building physics with major experience in monument conservation is necessary. Innovations and experiments on monuments are solely justifiable if this is included in serious scientific projects. In other respects it is imperative: better less and save - than much and risky.

10. WEITBLICK Ma□nahmen am Denkmal reihen sich in eine schrittweise Optimierung im Laufe der vergangenen Jahrhunderte ein. Eine Erhaltung erfordert von allen Beteiligten einen über die allgemeine Haftung oder Amortisationszeit hinaus gehenden Weitblick.
10. FAR-SIGHTEDNESS/VISION Measures on a monument queue in a stepwise development of the former centuries. Preservation forces all participants a vision beyond liability or time of depreciation.

German text taken from: http://www.bda.at/documents/944221227.pdf

English Guideline "English Heritage 2011": ENERGY EFFICIENCY AND HISTORIC BUILDINGS - APPLICATION OF PART L OF THE BUILDING REGULATIONS TO HISTORIC AND TRADITIONALLY CONSTRUCTED BUILDINGS. This fully illustrated guidance has been produced to help prevent conflicts between the requirements of Part L of the Building Regulations and the conservation of historic and traditionally constructed buildings. The advice acts as 'second tier' supporting guidance in the interpretation of Approved Documents L1B and L2B that should be taken into account when determining

appropriate energy performance standards fro works to historic and traditionally constructed buildings. The following areas are covered in the guidance:
- The background to the legislation and the need to reduce greenhouse gas emissions
- An interpretation of the regulations themselves as applied to historic and traditionally constructed buildings
- Understanding the buildings before carrying out upgrading works
- Meeting the requirements of part L
- Advice on the thermal upgrading of various building elements
The guidance supersedes English Heritage's previous publication Building Regulations and Historic Buildings an interim guidance note on the application of Part L (2004).

http://www.english-heritage.org.uk/publications/energy-efficiency-historic-buildings-ptl/

"**Saxonian pilot study**" Saxony 2011: http://tu-dresden.de/die_tu_dresden/fakultaeten/fakultaet_architektur/ibk/forschung/forschung_projekte_2010/smi-pilotstudie_denkmal-energie/SMI-Pilotstudie_Denkmal-Energie with link to file: http://tu-dresden.de/die_tu_dresden/fakultaeten/fakultaet_architektur/ibk/forschung/forschung_projekte_2010/smi-pilotstudie_denkmal-energie/SMI-Pilotstudie_Denkmal-Energie.pdf

"**Copenhagen approach**": With a multidisciplinary team in an iterative approach towards the solution was developed.

The two latter were chosen for closer inspection and use within the 3Encult project. In a later stage of the project development the approaches of SAVE and DoMo were evaluated.

2 An iterative approach: Copenhagen example

With the energy retrofit of the listed "Old Material Court" in Copenhagen the owner aimed not only at giving its contribution to CO_2 emission reduction, but also at showing on the basis of a study case, how this can be achieved for listed buildings in Denmark in general. Realea A/S, a foundation owning a large number of historic buildings, to this aimed worked closely together with the Danish Heritage Authority and experts from the different fields. The final solution was developed in an iterative process, starting from a high number of potential solutions from which in several rounds of increasingly detailed analysis suboptimal solutions were refused (deleted from the list) and promising brought forward – the typical approach of what is known as Integrated Design Process IDP.

2.1 Overall approach

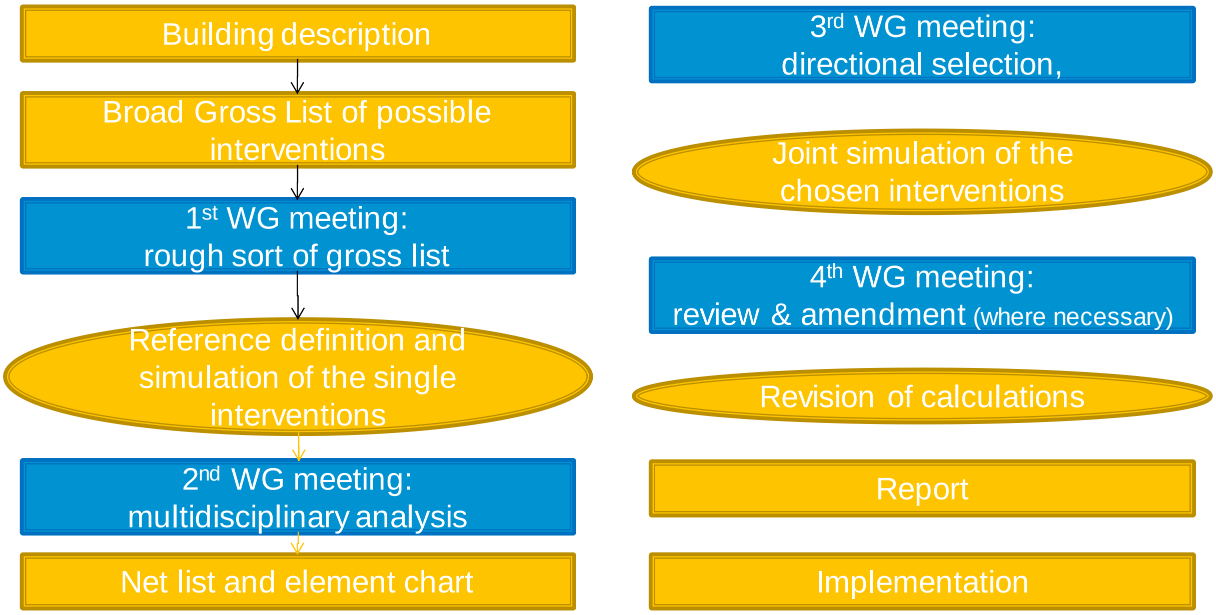
Starting position	Old Material Court to be renovated and used for office purposes.
Objective	1. Reduce **CO_2 emissions** and guarantee high **indoor comfort** with office use, in compliance with conservation and architecture 2. Provide **guideline** for the more than 1000 protected buildings in Denmark used for office purposes
Approach – within multidisciplinary working group	1. Building analysis and description 2. Broad gross list of possible interventions 3. Dynamic simulation of single interventions and evaluation of CO2 emissions and indoor climate 4. Stepwise reduction of options and selection of the solution to be implemented

2.2 Multidisciplinary working group

With the multidisciplinary working group, professionals with great experience in building renovation contributed to the single tasks with their specific viewpoint each

Building owner	impact on rental opportunities, operating and maintenance conditions
Heritage authority	conservation viewpoint (also general evaluation of building typology)
Architects	shape, appearance, functionality, interior design conditions
Structural engineer	impact on existing construction, risk assessment (moisture)
Services engineer	assessment of energy and indoor climate

2.3 Workflow



2.3.1 Building description

For each of the 4 buildings of the Old Material Court, which despite forming a harmonious ensemble, date from different periods of construction, the following information was provided as starting point:

- building and construction history
- existing conditions
- historic and architectural value

5.3 **Bygning 4 - Kontorbygningen mod Byghusgade**

Bygningens historie
Bygningen er opført i 1768, tilbygget i 1819 og 1889, og derudover ombygget markant af flere omgange, første gang allerede i 1771.

Bygningen er atten fag lang og to etager høj. Taget har halvalmet gavl mod syd, stående gavl mod nord og en høj rejsning, hvorpå fire skorstenspiber og en brandkam markerer sig. På tagfladen er der tretten kviste mod gården, elleve kviste mod gaden, og derudover en række tagvinduer, som giver lys til en udnyttet tagetage. Bygningens sokkel er meget beskeden, og man træder således næsten direkte ind i bygningen.

De bærende fredningsværdier er:
- Længdeskillevæggen
- Forskelle mellem bygningens nordlige og sydlige del
- Rumstrukturelle helheder
- Snedkerdetaljer

Figure 1 Example for a building description

2.3.2 Energy analysis of the status quo

As a first step (i) consumption from energy bills, (ii) thermographs, (iii) blower door test and (iv) calculation of demand according Danish certification scheme were performed.

In a second step dynamic simulation calibrated on consumption values gave the basic model for the analysis of the refurbishment options in the coming rounds.

The dynamic simulation with the in Denmark widely used software BSim, focussed on the calculation of the combined effects of any measure on (i) Heating demand, (ii) Electricity demand, (iii) Cooling demand and (iv) Indoor comfort.

4.3 **Builddesk Energimærkningen - anvendelsen**
I projektet er beregningsmodellen udelukkede brugt til at klassificere bygningerne i forhold til myndighedskrav og som sammenligningsgrundlag for den eksisterende danske bygningsmasse.

	Myndighedskrav BR08, for nybyggeri	Eksist. forhold.	Nye forhold.
Forvalterboligen	99 kWh/m2	213kWh/m2 Energiklasse E	173kWh/m2 Energiklasse D
Kontorbygn. v/Bryghusg.	97 kWh/m2	229 kWh/m2 Energiklasse F	182 kWh/m2 Energiklasse E
Halvtagshusene	98 kWh/m2	221 kWh/m2 Energiklasse F	184kWh/m2 Energiklasse E
Bindingsværksbygningen	98 kWh/m2	222 kWh/m2 Energiklasse F	170kWh/m2 Energiklasse D

2.3.3 Broad gross list of possible interventions

Starting from broad gross list of possible solutions, not adequate ones were removed step by step, promising further analysed. Decisions in each step were taken within the multidisciplinary working group and were well documented.

Bygning 4

Nr.	Energitiltag	V1	V2	V3	V4	Beskrivelse af fravalg
Vinduer og solafskærmning						
01a	Udskiftning af vinduer til nye superlavenergi vinduer					Fredning og arkitektur respekteres ikke
01b	Nye superlavenergi vinduer i nye vindueshuller					Fredning og arkitektur respekteres ikke
02	Nye energiforsatsglas + solafskærmende udvendigt glas					Udvendige glas kan ikke udskiftes pga. arkitektur og fredning
02a	Nye energiforsatsglas i eksist. forsatsrammer					
02b	Nye solafskærmende forsatsglas					Farven på glassene er for markant
03	Nye vinduer med indvendig solafskærmning					Fredning og arkitektur respekteres ikke
04	Udvendig solafskærmning					Fredning og arkitektur respekteres ikke
Isolering og bygningstæthed						
05	Indvendig efterisolering af ydervægge					Fredning og arkitektur respekteres ikke
06	Udvendig efterisolering af ydervægge					Fredning og arkitektur respekteres ikke
07	Efterisolering af skrålofter					Tiltaget har ikke stor nok effekt
08	Efterisolering af terrændæk					Ikke CO2 rentabel
09	Brug af isoleringstypen "supertynd"					Kvaliteten af isoleringstypen er usikker og effekten ikke stor nok
10	Etablering af bygningstæthed					
Ventilation						
11	Naturlig ventilering - via åbning af vinduer					
12	Natkøling, ventilation - indtag i klimaskærm og udtag i tag					Friskluftindtag gennem klimaskærm ikke mulig.
13	Hybrid ventilation, indtag i klimaskærm og udsugning via varmepumpe					Friskluftindtag gennem klimaskærm ikke mulig.
14	Traditionel mekanisk ventilation via ventilationssystem					Tiltaget udgår pga. økonomi
15	Friskluftindtag via solvægge, aktive glaspartier					Fredning og arkitektur respekteres ikke
Varme, vand og køl						
16	Køling via mekanisk recirkulering af luft i rum					
17	Passiv køling af rum via nedkølet loft eller væg					Fredning og arkitektur respekteres ikke
18	Køling hvor overskudsvarmen afsættes til luften ude					
19	Køling via jordslanger					Kølebehov er ikke tilstrækkelig
20	Køling via varmepumpe til grund/havvand					Kølebehov er ikke tilstrækkelig
21	Radiatoropvarmning					Radiatorer placeres kun i rum hvor der ikke er et kølebehov.
22	Gulvvarme					Ny gulv opbygning kun mulig i stueetagen
23	Central brugsvandsproduktion					Ikke CO2 rentabel
24	Decentral brugsvandsproduktion					
28	Opsamling af regnvand					Begrænset vandforbrug
El						
25	Energibesparende lyskilder					
26	Dagslysstyring					
27	Centralstyring af el forbrugskomponenter					
Solfanger og solceller						
29	Solfanger til varmtvandsproduktion					Fredning og arkitektur respekteres ikke
30	Solfanger tilopvarmning					Fredning og arkitektur respekteres ikke
31	Solceller					Fredning og arkitektur respekteres ikke
Adfærd og indretning						
32	Flytning af varmeafgivende udstyr fra kontor til fælles serverrum					Kræver at krav til lejers udstyr/rutiner bliver defineret præcist.
33	Fælleskantine					
34	Fælles møde- og konferencefaciliteter					
35	Vindfang ved hovedadgangsvej					Fredning og arkitektur respekteres ikke

Figure 2 List of possible solutions

In the element chart for each potential solution, a description, comments and summarised simulation results were reported in so called "element charts" (see Figure 3), furthermore in a later stage for a number of possible combinations of measures the total resulting CO_2 emission reduction and effect of indoor climate were determined (see Figure 4).

Nr.:	Element	Beskrivelse	Specifikation	Bygning 1.	Bygning 7, 8, og 9.	Byg
02	Nye energi forsatsglas. Plus solafskærmende udvendig glas.	På glaspartier med forsatsglas udskiftes glasset med energiglas og udvendige glas udskiftes til et sol afskærmene glas.	Eksist. Soltrans. 0,77 Visuel lys. 0,74 Vinduer samlet u-værdi 2,2 - 2,8 Nye glas. Soltrans. 0,34 Visuel lys. 0,74 Vinduer samlet u-værdi 1,7 – 1,5.	*Glas i forsatsrammer udskiftes til et energiglas.* *Glas i vinduesrammer udskiftes til et sol afskæmende glas.* Forbrug / MWh/Ton / KWh/Kg pr. m2 CO2 19,49 36,76 4,24% Trans. tab -33,88 -63,9 27,58% Varme 23,33 44,0 22,05% El udstyr 24,78 46,8 0,00% El lys 3,16 6,0 -27,04% Køling -3,89 -7,3 27,47% Indeklima konsekv. / Ny (timer) / Eksist. Stue møde 24.5< 2511,0 2568 Stue møde 27< 1475 1658 Stue kontor 2 24.5< 2769,0 2892 Stue kontor 2 3 27< 1740 1913 1sal kontor 1 24.5< 2747 2787 1sal kontor 1 27< 1708 1845 1sal kontor2 24.5< 2839 2889 1sal kontor2 27< 1766 1868	*Glas i forsatsrammer udskiftes til et energiglas.* *Glas i vinduesrammer udskiftes til et sol afskæmende glas.* Forbrug / MWh/Ton / KWh/Kg pr. m2 CO2 20,39 36,54 7,25% Trans. tab -63,19 -113,3 24,85% Varme 52,89 94,8 14,92% El udstyr 15,14 27,1 0,00% El lys 6,84 12,3 -19,24% Køling -3,16 -5,7 59,38% Indeklima konsekv. / Ny (timer) / Eksist. Stue kontor1 24.5< 717,0 1895 Stue kontor1 27< 120 769 1sal kontor1 24.5< 1520 2056 1sal kontor1 27< 629 1134	*Gla.* *Gla.* *me.* *Gla.* *skæ*
02a	Nye energi forsatsglas.	På glaspartier med forsatsglas udskiftes glasset med	Eksist. Soltrans. 0,77 Visuel lys. 0,74	Glas i forsatsrammer udskiftes til et energiglas. Forbrug / MWh/Ton / KWh/Kg pr. m2 CO2 19.48 36.75 4.29%	Glas i forsatsrammer udskiftes til et energiglas. Forbrug / MWh/Ton / KWh/Kg pr. m2	Glas

Figure 3 Element chart for potential solution n°02

2a. Energiglas. 3mm glas monteret i eksisterende rammer

10. tæthed 0,5 h-1 kælder.
0,2 h-1 stueetagen.
0,2 h-1 1sal. Se blower-door rapport

11. Ventilering via vinduer.
18. Køling.
Speciel design unit (Hudevad). Dette ikke er mulig radiatorskjuler.
25. energibesparende lyskilder.
27. Centralstyring af strøm.

Forbrug	MWh/Ton	KWh/Kg pr. m2	
CO2	16,27	30,69	20,06%
Trans. tab	-33,90	-64,0	27,54%
Varme	18,67	35,2	37,60%
El udstyr	19,97	37,7	19,40%
El lys	2,72	5,1	-9,39%
Køling	-5,78	-10,9	-7,90%
Ventilation	0,00	0,0	
Indeklima konsekv.		Ny (timer)	Eksist.
Stue møde 24.5<		426,0	2568
Stue møde 27<		2	1658
Stue kontor 2 24.5<		632,0	2892
Stue kontor 2 3 27<		36	1913
1sal kontor 1 24.5<		388	2787
1sal kontor 1 27<		5	1845
1sal kontor2 24.5<		201	2889
1sal kontor2 27<		0	1868

1b. Solafskærmende energiglas bygning 9 stue.
2a. Energiglas (minus bygn 8).
04. Udvendig solafskærmning styret reduktionsfaktor stue 0,5 (minus stue bygn 9.)
05. indvendig efterisolering isolering af bagvægge, samt gavl væg på 1 sal.
07. Ny tagisolering / dampspærre
08. Efterisolering terrændæk
10. Bygningstæthed 1sal 0,17 bygningstæthed stueetagen 0,35.
14. Balanceret ventilation.
18. Køling
25. Energibesparende lyskilder
27. Centralstyring af strøm

Forbrug	MWh/Ton	KWh/Kg pr. m2	
CO2	18,33	32,85	16,61%
Trans. tab	-50,97	-91,3	39,39%
Varme	30,71	55,0	50,61%
El udstyr	15,74	28,2	-3,97%
El lys	4,87	8,7	15,19%
El ventilation	2,34	4,2	
Køling	-6,69	-12,0	13,91%
Indeklima konsekv.		Ny (timer)	Eksist.
Stue kontor1 24.5<		142,0	1895
Stue kontor1 27<		0	769
1sal kontor1 24.5<		373	2056
1sal kontor1 27<		6	1134

2a. energiglas
05. Ydervægge isoleret i køkken afsnit og bi rum.
08. terrændæk
10. tæthed 0,5 l/h stueetagen.
0,16 l/h 1sal.
14. Ventilation grundluftskifte 12 l/s person.
18. Køling
25. energibesparende lyskilder.
27. Centralstyring af strøm.

Forbrug	MWh/Ton	KWh/Kg pr. m2	
CO2	44,03	53,17	13,93%
Trans. tab	-82,73	-99,9	31,47%
Varme	39,58	47,8	54,78%
El udstyr	54,63	66,0	8,75%
El lys	5,63	6,8	17,24%
Køling	-14,78	-17,9	-59,13%
Ventilation	4,35	5,3	
Indeklima konsekv.		Ny (timer)	Eksist.
Stue kantine 24.5<		192,0	392
Stue kantine 27<		0	49
Stue møde 3 24.5<		44,0	484
Stue møde 3 27<		0	32
1sal møde 24.5<		275	1886
1sal møde 27<		0	801
1sal kontor 2, 24.5<		638	4047
1sal kontor 2, 27<		73	2916

2a. energiglas
08. terrændæk kun hvis det løser føringsveje problemer. (Udgået).
10. tæthed 0,29 l/h stueetagen.
0,20 l/h 1sal.
0,20 l/h 2sal.
11. Ventilering via vinduer.
14. Ventilation grundluftskifte 12 l/s person. Kun vis det er økonomisk regn tabel (udgået)
18. Køling som bygning 1
25. energibesparende lyskilder.
27. Centralstyring af strøm.

Forbrug	MWh/Ton	KWh/Kg pr. m2	
CO2	52,86	63,85	23,70%
Trans. tab	-157,79	-190,6	19,62%
Varme	99,48	120,1	9,67%
El udstyr	56,06	67,7	30,01%
El lys	8,18	9,9	18,29%
Køling	-16,38	-19,8	17,39%
Ventilation	0,00	0,0	
Indeklima konsekv.		Ny (timer)	Eksist.
Stue kontor 1 24.5<		46,0	2000
Stue kontor 1 27<		0	555
1sal kontor 1 24.5<		385,0	2837
1sal kontor 1 27<		1	1721
2sal kontor 1 24.5<		936	4161
2sal kontor 1 27<		49	2898
2sal kontor 2 24,5<		302	3239
2sal kontor 2 27 <		0	2117

Figure 4 Combined effects of different packages of measures

3 Definition of assessment criteria, their quantification and visualisation in a pilot study in Saxony

The ministry for inner affairs in Saxony (Sächsisches Staatsministerium des Innern), Germany, together with its monument conservation office started in 2009 an initiative to face the future challenges of energy efficiency measures in protected residential buildings, as those have a significant contingent in all of the residential stock in Saxony. The board round table of various representations of interests supported the idea to approach the problem by evaluating executed results of the last decade. This was the basis for the Pilot Study in Saxony Energetische Sanierung von Baudenkmalen, Pilotstudie zum Modellprojekt des Sächsischen Staatsministeriums des Innern.

3.1 Overall approach

Starting position	Share of protected buildings in residential sector in Saxony ~10% (3-5% in Germany, 2% in Austria) Pilot study commissioned by “Sächsisches Staatsministerium des Innern”
Objective	Assessment of energy efficiency measures in **protected residential buildings** ▪ Energy ▪ Conservation compatibility ▪ Building climate (Bauklimatik) ▪ Construction
Approach – within multidisciplinary working group	1. Analysis based on case studies 2. Definition of buildings typologies, selection of buildings for each of them 3. Definition of interventions to be analysed 4. Dynamic simulation of single interventions 5. Assessment

3.2 Multidisciplinary working group

Heritage authorities	general evaluation of building typology & conservation viewpoint
Architects	building typology, conservation aspects shape, appearance, functionality
Building Physics	energy efficiency evaluation computer simulations impact on existing construction, risk assessment (moisture)
Building owner (Wohnungsbaugesellschaft)	impact on rental opportunities, operating and maintenance conditions

3.3 Assessment criteria

Based on the Sustainability Triangle Ecology – Economy – Society a number of assessment criteria were defined and associated with different compatibility aspects, ranging from ecological, over economic, constructional and functional to conservation compatibility (see Figure 5 but also Figure 7). Although the authors of the study underline, that all these aspects determine the sustainability of a solution, not all of them could be assessed in the pilot study.

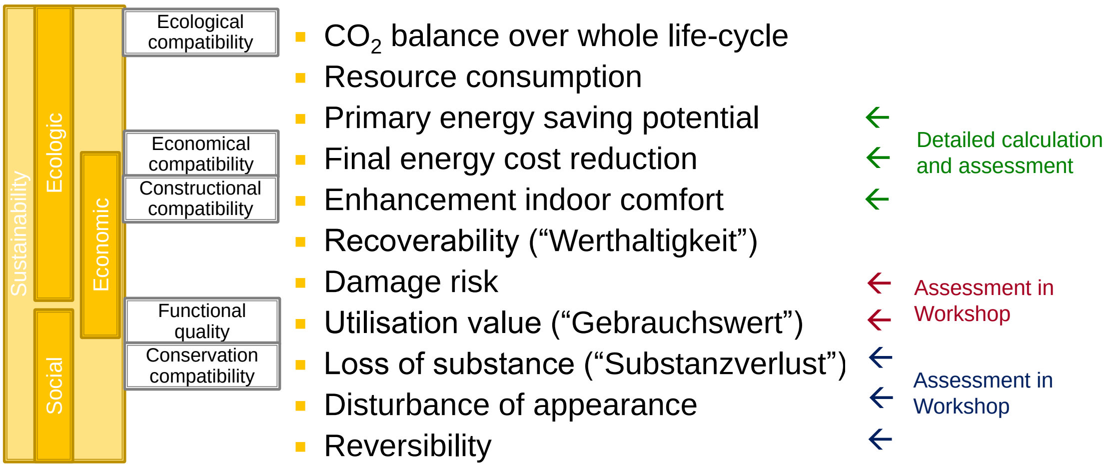


Figure 5 List of assessment criteria

3.4 Approach and analysis tools

Also in this case the single objects and their heritage value were described by experts from the Heritage Authorities (see Figure 6). And again dynamic simulations with EnergyPlus/Design Builder allowed to (i) define the reference scenario (for better comparability of single measures prescinding from existing structural damages), (ii) simulate and assess the single measures and (iii) simulate and assess a bundle of measures.

Landesamt für Denkmalpflege Sachsen
Michael Müller

22.03.2010

SMI, Modellprojekt Denkmal und Energie
Dresden, OT Trachau, Leipziger Straße 286–290, Denkmalbegründung

Die Leipziger Straße 286 – 290 ist vor allem wegen ihrer baugeschichtlichen Bedeutung ein Kulturdenkmal.

Aufnahmejahr unbekannt

Das hier zu beurteilende Objekt befindet sich im nordöstlichen Teil Dresdens, an einer der wichtigsten Ausfallstraßen der Stadt und kurz vor der Ortsgrenze nach Radebeul.

Das dreigeschossige Gebäude mit einem Mansard- und zwei Walmdächern wurde um 1928 durch die Baugesellschaft Schümichen und Gladewitz errichtet. Möglicherweise geht die Gründung der Firma auf den etwa im ersten Viertel des 20. Jahrhunderts in Dresden tätigen Architekten und Professor Carl Schümichen zurück.

Die baugeschichtliche Bedeutung der Leipziger Straße 286–290 in Dresden-Trachau ergibt

- 2 -

schmucklose Baukörper mit Lochfassaden und Sattel- oder Walmdächern, gelegentlich auch Mansarddächern. Für die Fenster- und Türöffnungen wurden stehende Formate verwendet. Gestalterische Betonungen erfolgten auf einfachste Weise mittels Klappläden, Sprossenfenster, Weinspalier, wenige Gliederungen und minimalen Dekor. Das können Friese, Ecklisenen, Profilierungen, Putzspiegel, Scheitelsteine oder stilisierte Ornamente sein. Der Traditionalismus der 1920er Jahre war eng verbunden mit der nach 1900 aufkommenden Reformarchitektur, die sich durch ausgewogen proportionierte Formen und wenigen, lediglich akzentuierenden Bauschmuck auszeichnete.
Die Fassaden der Leipziger Straße 286 – 290 werden von streng axialen Fensterachsen und einem umlaufenden Traufgesims über dem dritten Stockwerk gegliedert. Die bereits erwähnte Staffelung erfolgt durch zwei seitliche angeordnete pavillonartige Trakte, die ein viertes Vollgeschoss zeigen und mit Walmdächern abschließen. Sie werden von Ecklisenen hervorgehoben. Den dreigeschossigen, niedrigeren Flügel dazwischen bedeckt ein ausgebautes Mansarddach. Neben den Ecklisenen akzentuieren Klappläden und Putzspiegel auf sparsame und zugleich wirkungsvolle Weise einzelne Bereiche. Für eine weitere Belebung sorgen seitlich und rückwärtig angebrachte Balkone. Die schlichte Raffinesse des Entwurfs von Schümichen und Gladewitz wird an solchen Details wie der geschickten Betonung und Einordnung der rückwärtigen Treppenhausachsen deutlich.
Am Beispiel der Leipziger Straße 286 – 290 in Dresden-Trachau werden die Stilmerkmale traditionalistischer Architektur anschaulich nachvollziehbar, somit ist die markante Anlage zum Aufzeigen der Architekturentwicklung in den 1920er bzw. der Weimarer Republik besonders geeignet.

Bisher wurde nur die Nr. 286 saniert. Die anderen Häuser sollen jedoch folgen. Maßnahmen zur energetischen Ertüchtigung des Hauses erfolgten im Jahre 2008.
Dabei wurden die Decken zwischen den Vollgeschossen sowie dem zweiten Obergeschoss und der ausgebauten Mansarde mit einer Mineralfaserdeckung versehen. Des Weiteren erhielt die Kellerdecke eine Dämmung. Außerdem ließ man die Decke zwischen der Mansarde und dem Oberdach sowie die Flächen der Mansarde dämmen. Im Zusammenhang damit erhielt das Gebäude Isolierglasfenster.
Die Fassaden blieben von energetischen Maßnahmen unberührt, erhielten weder ein Wärmedämmverbundsystem noch einen Wärmedämmputz (Ausnahme von der Energieeinsparungsverordnung).

Nach erfolgter Einschätzung vor Ort wirken sich die Maßnahmen wenig auf den Denkmalwert aus, da sich das hierfür ausschlaggebende architektonische Erscheinungsbild der straßenseitigen Fassade weitestgehend erhalten hat.

Figure 6 Description of the heritage of value ("Denkmalbegründung") of a study case within the pilot study in Saxony

INTEGRIERTE UND VERGLEICHENDE GESAMTBEWERTUNG

A.1 GEBÄUDE IN OFFENER BAUWEISE - Freistehende Wohnstallhäuser auf dem Land 18./19. Jh.

Charakteristik siehe Anhang 3, Gebäudekenndaten und Typisierung!

Nachhaltigkeitsfelder				Ökologisches Kapital			Ökologisches Kapital / Ökonomisches Kapital	Ökonomisches Kapital			Soziales / Kulturelles Kapital			
Kriterienklassen				Ökologische Verträglichkeit			Wirtschaftliche Verträglichkeit	Bautechnische Verträglichkeit			Funktionale Qualität	Denkmalverträglichkeit		
Bewertungskriterien				CO2-Bilanz	Ressourcen	Primärenergie	Endenergie	Behaglichkeit	Werthaltigkeit	Schadensrisiko	Gebrauchswert	Substanz	Erscheinungsbild	Reversibilität
Kurzbeschreibung der Bewertungskriterien				CO2-Bilanz über den gesamten Lebenszyklus	Ressourcen-verbrauch, Stoffkreislauf, Toxizität verwendeter Materialien	Einsparpotential Primärenergie (Qp), Ermittlung gemäß geltenden Primärenergie-faktoren	Betriebskosteneinsparung End-energie Heizung (Gas: 0,6Ct/kWh, FW: 0,9Ct/kWh) u. Strom (20Ct/kWh)	Verbesserung der therm. Behaglichkeit, Reduktion der Anzahl von Unbehaglichkeits-stunden	Verbesserung der Nachhaltigkeit, Zukunfts-/Anpassungs-fähigkeit, Werthaltigkeit	Steigerung des Schadensrisikos, Prognostizier-barkeit der Maßnahme	Verbesserung der Funktionalität und Nutzer-freundlichkeit	Substanzverlust bei Umsetzung der Maßnahme	Beeinträchtigung von Erscheinungs-bild, Lesbarkeit	Wiederherstell-barkeit des Vorzustandes
MASSNAHMEN Effekte:			Einheit Positiv : Negativ	Bewertung ↑ ++ ↗ + → 0 ↘ - ↓ --	Bewertung ↑ ++ ↗ + → 0 ↘ - ↓ --	prozentuale Einsparung 100% groß : : 0% klein	prozentuale Einsparung 100% groß : : 0% klein	prozentuale Verbesserung 100% besser : : 0% gleich	Bewertung ↑ ++ ↗ + → 0 ↘ - ↓ --	Bewertung ↑ ++ ↗ + → 0 ↘ - ↓ --	Bewertung ↑ ++ ↗ + → 0 ↘ - ↓ --	Bewertung ↑ ++ ↗ + → 0 ↘ - ↓ --	Bewertung ↑ ++ ↗ + → 0 ↘ - ↓ --	Bewertung ↑ ++ ↗ + → 0 ↘ - ↓ --
Optimierung Gebäudehülle und Anlagentechnik			Variante	A	B	C	D	E	F	G	H	I	J	K
Keller	1	Perimeterdämmung, KG-Außenwand		-	-	-	-	-	-	-	-	-	-	-
	2	Unterer Abschluß: KG-Decke/EG-Fb.	1	k.A.	k.A.	2%	2%	2%	k.A.	→	↗	→	→	↘
Dach	3	Oberste Geschoßdecke	2	k.A.	k.A.	2%	2%	1%	k.A.	↑	→	↑	↑	↑
	4	Zwischensparrendämmung	3a	k.A.	k.A.	4%	4%	0%	k.A.	→	↘	↗	↗	↗
	5	Aufsparrendämmung	3b	k.A.	k.A.	4%	4%	0%	k.A.	↑	→	→	↘	↘
Fassade	6	WDVS (verputzt) Straßenseite	4a	k.A.	↓	33%	31%	10%	↓	↘	→	↗	↓	↘
	7	WDVS (verputzt) Hofseite	4b	k.A.	↓	33%	31%	10%	↓	↘	→	↗	↓	↘
	8	hinterlüftete Verschalungen Straße	4c	k.A.	k.A.	33%	31%	10%	k.A.	↑	→	↗	↘	↘
	9	hinterlüftete Verschalungen Hof	4d	k.A.	k.A.	33%	31%	10%	k.A.	↑	→	↗	↗	↘
	10	Wärmedämmputz Straßenseite	4e	k.A.	k.A.	22%	20%	6%	k.A.	↗	→	↗	→	↘
	11	Wärmedämmputz Hofseite	4f	k.A.	k.A.	22%	20%	6%	k.A.	↗	→	↗	→	↘
	12	Innendämmung	4g	k.A.	k.A.	27%	24%	6%	k.A.	k.A.	↘	→	→	↘
	13	Mehrschalige Fass. /Kerndämmung	4h	-	-	-	-	-	-	-	-	-	-	-
	14	VIP, TWD	4i	-	-	-	-	-	-	-	-	-	-	-
Luftdichtheit	15	Abdichten (Aufarb.)Fenster+Konstr.	5a	k.A.	k.A.	6%	5%	2%	k.A.	↗	→	↗	↑	↑
Fenster	16	Neue Fenster (WSV) Straßenseite	5b	k.A.	k.A.	10%	9%	2%	k.A.	↓ !	↘	↓	↗	↓
	17	Neue Fenster (WSV) Hofseite	5c	k.A.	k.A.	10%	9%	2%	k.A.	↓ !	↘	↓	↗	↓
	18	Zusatzfenster	5d	k.A.	k.A.	10%	9%	2%	k.A.	↓ !	→	↑	↑	↗
Lüftungsanlage	19	Abdichtung+mech. Lüftung mit WRG	5e	k.A.	k.A.	7%	6%	2%	k.A.	→	↑	→	↗	↗
Haustechnik	20	Effizienz der Heizungsanlage	6	k.A.	k.A.	17%	16%	0%	k.A.	→	→	↑	↑	↑
Kombination	21	Maßnahmen 1, 2, 3a, 4a-f, 5a-e, 6	90	k.A.	k.A.	56%	51%	15%	k.A.	k.A.	k.A.	k.A.	k.A.	k.A.
Nutzung von Energie-Erzeugungspotentialen														
Solarthermie	22	Dach Straßenseite	7a	k.A.	k.A.	6%	6%	0%	k.A.	→	→	↑	↓	↑
	23	Dach Hofseite	7b	k.A.	k.A.	6%	6%	0%	k.A.	→	→	↑	↓	↑
	24	Fassade Straßenseite	7c	-	-	-	-		-	-	-	-	-	-
	25	Fassade Hofseite	7d	-	-	-	-		-	-	-	-	-	-
Photovoltaik	26	Dach Straßenseite	8a	k.A.	k.A.	4%	6%	0%	k.A.	→	→	↑	↓	↑
	27	Dach Hofseite	8b	k.A.	k.A.	4%	6%	0%	k.A.	→	→	↑	↓	↑
	28	Fassade Straßenseite	8c	-	-	-	-		-	-	-	-	-	-
	29	Fassade Hofseite	8d	-	-	-	-		-	-	-	-	-	-
Kraft-Wärme-K.	30	Mini BHKW	9a	-	-	-	-		-	-	-	-	-	-
(KWK)	31	Nah-/Fernwärme aus Groß-KWK	9b	k.A.	k.A.	29%	0%	0%	k.A.	→	→	↑	↑	↑
Umweltwärme	32	z.B. Geothermie mit Wärmepumpe	10	k.A.	k.A.	26%	3%	0%	k.A.	→	→	↑	↑	↑
				-	-	-	-	-	-	-	-	-	-	-
Quartiersbezogene Faktoren														
Externe Faktoren														

Legende: - nicht behandelt k.A.: keine Angabe Maßnahme ist : ↑ i.d.R.unbedenklich ↗ : zu prüfen (tendenziell positiv) → : zu prüfen bzw. keine Veränderung ↘ : zu prüfen (tendenziell negativ) ↓ : i.d.R.bedenklich ! : starke Schwankung im Ergebnis

Figure 7 Summary of results for one case study – assessment with qualitative and quantitative criteria

3.5 Visualisation

Also in visualisation of the outcome stroked new path. Each single possible energy efficiency measure was evaluated towards is efficiency and towards its compatibility with respect to each building type group.

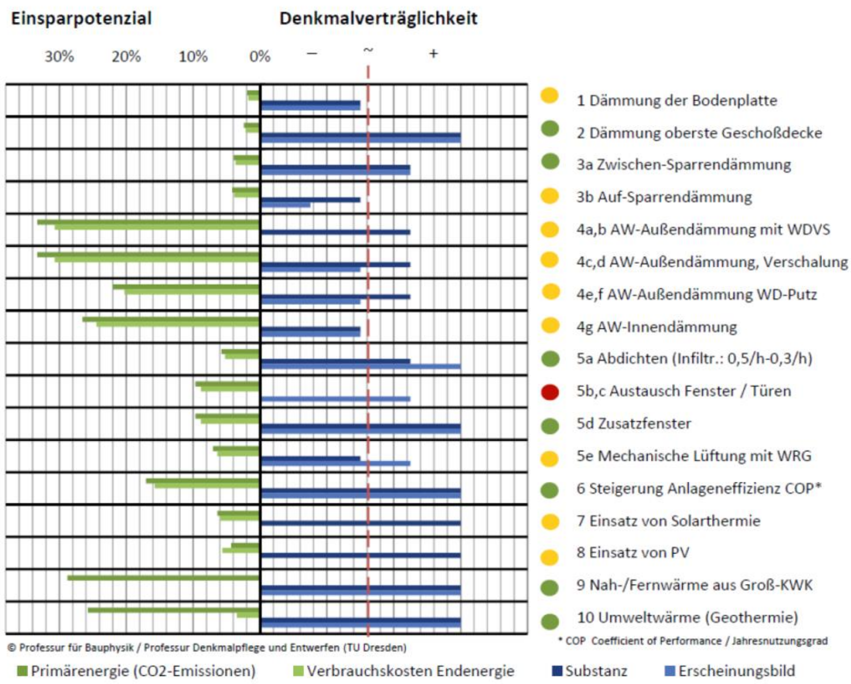


Figure 8 Visualisation of energy reduction potential and conservation compatibility criteria

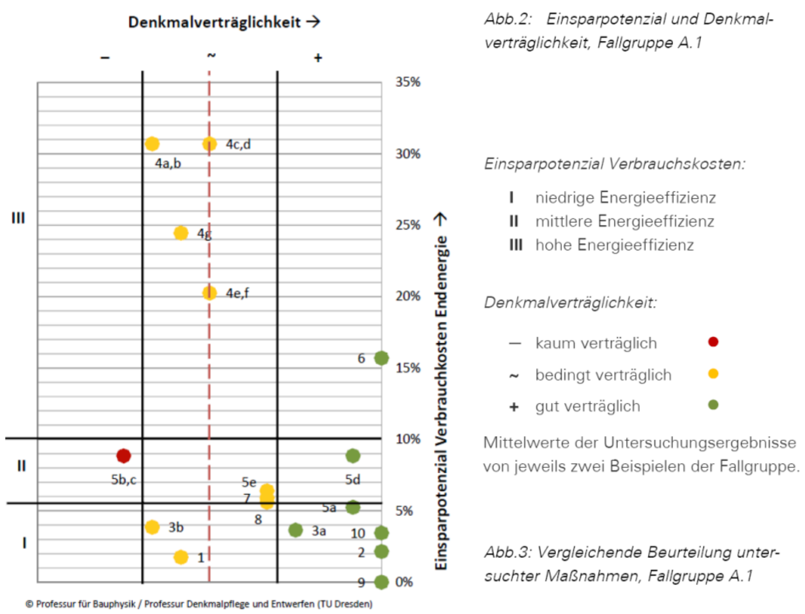


Figure 9 Visualisation of energy performance and conservation compatibility criteria

4 Multidisciplinary workshop

Main strategic aim of the workshop of the 3ENCULT partners on 2nd of March 2011 was the multidisciplinary dialog, the possibility to see things from another perspectives, to learn new aspects and to start developing new solutions based on this exchange.

It brought together the background from different disciplines, summarised in two early deliverables of the project (D2.1 and D3.1), and invited partners to share their opinions and specific experiences.

Furthermore within the workshop the formation of the specific working groups and start of discussion of specific questions to be tackled within work package 3 of the research project took place.

4.1 1st session - setting the frame

Olav Helbig (TUD) presented Deliverable 2.1 - Demand analysis and historic building classification.

After the demand analysis covering comfortable building climate and preservation of construction (Venice Charter: "… shown by scientific data and proved by experience …") as well as economic aspects, principles about historic building classification, preservation motives, authenticity and the consequences for energy refurbishment were introduced and completed by the description of approaches for a task-oriented classification systems for sustainable conservation. Finally, five theses were presented.

Rainer Pfluger (UIBK) presented Deliverable 3.1 - State of the art of energy efficiency solutions.

Underlining that individual solutions have to be found for each Historic Building, for the single research themes in WP3 the internal reviews of the status of the art were introduced and the core issues for discussion as basis for the small groups in the afternoon were presented. Some examples for technical solutions were given round the table to be "touched".

Alexandra Troi (EURAC) and Christoph Franzen (IDK) presented as basis for the discussion of the approach to be applied within 3ENCULT two examples: (i) the case of Copenhagen with the presentation of an IDP for historic buildings (see section 2) and (ii) the case of Saxony (Dresden) with focus on the methodology of presenting results in term of energy performance and conservation issues (see section 3).

After the presentations an interested discussion started, key ideas and comments brought in by partners covered: (a) as solution is for buildings are needed, we should start with the building, not the other way around; (b) principles – products: we should not go too fast from one to the other; (c) how are thresholds selected, calculation vs. human decision; (d) it is necessary to distinguish between monumental and private buildings; (e) how can cultural compatibility be quantified? (f) it is not our task to make a decision, but to help to make decision.

Finally Ms. Federica Legnani (COBO) with her presentation of the situation in Bologna pointed out a number of practical experiences and issues encountered by a municipality: Considering not only the city centre but the whole city area and having introduced different categories for historic buildings, the "monumental" and "documental" ones - the former including buildings protected on national level, the latter buildings built before 1949 (and criteria for protection are defined on municipality level) - the Municipality has a tool in its building regulation to consider in a comprehensive and differentiated way the protection of its Cultural Heritage. As regards the Energy Efficiency Plan, however, while for the energy refurbishment of not protected building several incentive systems have proven to be successful (e.g. increase of allowable built volume), no answers are yet available on how to reach the historic buildings and how to - at the same time - encourage intervention and guarantee quality and compatibility with preservation issues.

4.2 2nd session - statements and feedback from single partners

Simone Reeb (TUDA) states that the approach from Dresden takes into account the points of view of the different stakeholders and could be very helpful for developing a decision base in individual case studies in 3ENCULT.

Magdi Khalil (TUD-IBK) recommends to take the Dresden approach as a reference and adjust it for our purpose.

Franziska Haas (TUD-IBAD) recognizes the need for visualization, she underlines however that the aggregation process applied in the Dresden study is “a chellenge” for conservators. She proposes to improve the system for the needs in our case – applying it for visualization at the end of the case study, but trying also to improve our approach.

Jens Engel (REMMERS) claims for more discussion about technical solutions, reminding that there exists already a variety of solutions and underlining his ambition to develop improved products within the project.

Enrico Esposito (ARTEMIS) emphasizes the need for guidelines as a fixed basis. Although recognizing the necessity to adapt them to single cases, he underlines the importance of norms and thresholds since human judgment is difficult and will always be different (quot capita tot sententiae).

Giacomo Paci (UNIBO-DEIS) highlights the big amount of historic buildings and that 3ENCULT should find the way to work in collaboration with conservators and building owners, also here in Bologna.

Matteo Orlandi (ARUP) describes three steps we should follow: (i) get correct requirements (Copenhagen); (ii) communicate results to potential clients and owners (Dresden); (iii) define limits and threshold - for the technical point of view but also for the conservator point of view. Thinking to the future, we should add sustainability and adaptability of the solutions and of the methodologies.

Torben Dahl (KA) identifies a tension between the principal qualitative approach and the need to develop a practical tool, which has to be dealt with in 3ENCULT and states that we might have to lose a bit at each side when balancing the issues.

Wilfried Pohl (BLL) emphasizes his eagerness to start working on the case studies, to look at the buildings, and find solutions.

Georg Gaigg (CS Innsbruck) brings in the point of view of users and owners, who should get recommendation and advice also for long term after the refurbishment, including economic aspects, comfort etc.

Rainer Pfluger (UIBK) expresses his deep concern in relation to multi-parameter analyses (mentioning as another example LEED). Arithmetic averages between different categories are misleading and decisions about weighting factors are strongly political.

Zeno Bastian (PHI) draws attention to the chance of an energy refurbishment for conservation: in most cases conservation and energy refurbishment go hand in hand, and the issue is more to show, how an intervention helps protecting a building that merely to make sure that it does not harm.

Daniel Garcia Gil (CARTIF) sees a clear need for a tool to define priorities and then easily decide which solution can be applied.

Camilla Colla (UNIBO-DICAM) points out the importance of the principles presented by Olav Helbig and underlines the significance of considering always also the use and destination of a building. She considers the project a good chance to test guidelines and procedure and make practical experience with products at the case studies. While she appreciates guidelines and thresholds, she remarks that they should not be too rigid and each building should be evaluated itself.

Maryke van Staden (ICLEI) agrees that the particular context is important, but however supports the development of guidelines. The template can be a common outcome. She also points out, that for dissemination towards municipalities we should develop a summarized descriptive text (~6-pages) for each CS.

Marleen Spiekman (TNO) remarks, that even if there is a need for some thresholds, black and white approaches do not reflect the reality. Her experience in building legislation implies that people tend to stop thinking themselves when there is guidelines/threshold and she would thus propose to stress the need of experts in individual cases. Furthermore she appreciates the graphical visualization especially for the communication, but points however out, that single factors cannot be “added”.

Ola Wedebrunn (KA) explains that we need a strategic and open vision.

Francesco Tutino (COBO) underlines the sustainability of the overall approach as aim and explains that he expects the project results to support the municipality of Bologna in encouraging compatible energy refurbishment of historic buildings and thus reaching the overall targets of energy performance the city has committed itself to, among others, as member of the Covenant of Mayors.

Thiery van Steenberghe (REHVA) underlines that it is important to find common ground for our work and that experience of previous projects/work in similar field should be looked at.

Roberto Lollini (ERUAC) finally concludes with underlining the importance that the single case studies define implementation plans as soon as possible in order to allow good coordination and use best this big opportunity to test approaches, tools and solutions.

To complete the above statements, just e few ideas coming out from the meeting with 3ENCULT’s External Advisory Group are reported here, too: **Luc Bourdeau (E2BA)** emphasizes the aspect that when talking about historic buildings each case is a special case with different problems to be solved. **Jean-Marc Vallet** underlined that an important issue is the evaluation of the approach. For conservation, it is important to go to the field to see what is available and possible. Reversibility of measures is necessary if modification is needed in the future. Furthermore the use and future development of the use have to be specifically considered. **Michele Vigne (UIPI)** points out the limited financial resources of building owners to do interventions in their buildings. In the following discussion the participants share the opinion, that it is most important to make sure to have sustainable value for invested money.

4.3 3rd session – discussion in working groups

Furthermore within the workshop the partners gathered in four working groups and discussed questions regarding integration of technical and cultural heritage issues. The working group themes covered each several of the subthemes dealt with in the projects WP3 (Energy Efficiency Solution) and referred to “envelope”, “windows and light”, “ventilation” and “heating and cooling”.

These working groups were thus the starting point for the multidisciplinary elaboration of solutions within 3ENCULT.

5 DuMo method

Short explanation of the DuMo methodology and the changeability index

5.1 The idea behind DuMo:

The DuMo methodology is used to quantitatively rate the sustainability of cultural heritage before and after renovation (Du = (Dutch for) sustainable and Mo = monument). The method is used in practice in the Netherlands and therefore is more than a theoretical approach. It links quantitative rating of a sustainable value (Du) with a quantitative rating of a monumental value (Mo) of a historic building. In this annex we'll focus on the Mo-value, which we could also call the changeability index, and the link between Du and Mo. Mo-value: The idea behind the Mo-value is that it is an indication for how far we can go with changing the building or parts of the building without changing the cultural heritage value of the building. So, it is not a measure of the cultural heritage value itself. Therefore we call it the touchableness or changeableness of the building. The Mo-value is defined in such a way that a high value means a low changeableness of the building, so the higher the Mo-value, the less changes to the building are possible without changing the cultural heritage value.

The DuMo value on its turn is determined by multiplying the Du and de Mo value: DuMo = Du x Mo. Note that in our case the Du-value might be an energy performance level. The idea about the simple multiplication is that a building can get a high (= 'good') DuMo level by a high Du or a high Mo value, meaning that a lower Du-level (or a worse energy performance level in our case), can be compensated by a high Mo-level. Or in other words: a historic building with a high Mo-value and a low Du-value can have a comparable DuMo-value as a non-historic building with a low Mo-value and a high Du-value, so the high Mo-value makes up for the fact that only so much can be done in the historic building compared to the non-historic building in terms of energy saving measures. Of course this asks for a good tuning of Du and Mo.

The Mo-value is determined by two building or architectural historians, who independently rate the Mo-value based on a prescribed procedure and together come to a combined consensus on the value. For this, the experts inspect the building on the inside and outside and use existing building historical information about the building. To guarantee a complete inspection, the inspection is done via a working sheet based on the inspection method normally used with monumental buildings in the Netherlands. This method might be replaced by a national or regional know method, or by the Raumbuch method which is suggested in 3ENCULT and which is a globally comparable inspection scheme. However, the scheme used for assessing the Mo-value is a simplified version of the usual inspection protocol, taking into account that the assessment of the DuMo-value will only be an indication of the possibilities related to the energy performance and not a too precise method. The inspection for the DuMo assessment focuses on the envelope, the ground floor, all facades, windows, roofs, roof constructions, of which the touchableness is judged on the inside and outside: The inspection focuses on the building parts and elements were the changes due to energy saving measures can be expected.

The nature of the Mo-value and the DuMo multiplication determines some of the characteristics of the method:

- The Mo-value will never be completely objective. This makes it invalid as basis for setting minimum legal energy performance requirement levels and not suitable for setting financial schemes on a large scale. However, probably no rating of whatever cultural heritage value of a building will be objective and fit for these purposes without a case to case evaluation.

- What will be possible is using the value as a means of communication among experts and professionals of different backgrounds. And as an instrument used to harmonize the evaluation of the possibilities for energy efficient or sustainable renovation of historical buildings among experts.

- Every building can get a Mo-value, not only officially listed buildings. This way also for not listed buildings it is possible to show why it might be valid not to take all energy saving measures that normally would be expected of a building.

The rating of the Mo-value will probably differ among countries or regions. This doesn't need to be a problem, especially since the energy performance evaluation of buildings also differs per county or region and climate and cultural differences (among other things) make complete harmonization in energy performance evaluation not evident even in the future. Tuning of Du on Mo (or energy performance on Mo) is clearly also a national or regional task. But although the DuMo evaluation procedure needs to be worked out on national or regional level, the general methodology can be determined on European level (e.g. on CEN level), as is done with the energy performance methodology already.

5.2 The Mo assessment

The Mo-assessment method as it is developed for the Netherland is as follows (tuned to the Dutch situation, so not necessarily usable without changes in other nations/regions):

To determine the Mo-value, the building stock of historic building and listed monuments is classified in a number of categories. There are three categories for protected monuments (protected by law or regulation) and a category for historic buildings without protected status. For each category the characteristics are defined, and a list of reference building is drawn up which illustrate the characteristics in practice (Note that since this method is developed for the Netherlands, the reference buildings of course are Dutch buildings). The categorization is based on the level of touchability: the higher and more numerous or more extensive the cultural values that are recognized in the building, the lower its touchability is. Furthermore, for each category the value the Mo-coefficient is given. This value is somewhat variable per category, because the monuments are diverse in nature and significance. For the same reason, there is some overlap of the Mo-coefficient values for the successive categories. The diagram below (step 1) shows the classification of the categories with their qualifications, the Mo-coefficient and the reference objects.

Step 1: classification of the categories with their qualifications, the Mo-coefficient and the reference

objects

Touchability category	Mo-value	Definition	Level of possible changes/touchability	Examples/references
A	2-3	Monuments for which the unaltered maintenance of the main structure, including the historic finishing details are paramount. The functionality is completely subservient to the historic structure of the object and its parts. The building itself largely determines what function it has or may have. The characteristic of the object is primarily "museological documental".	Intervention is almost entirely at the service of preserving the cultural values. Functional adaptations are almost completely subordinate to preserving historical values. Public accessibility and conservation are the main reasons for taking action. The operation mode is maximum subservient to cultural preservation	• St. Hubertus Hunting Lodge, Otterlo • Villa Sonneveld, Rotterdam • Czar Peter House, Zaandam • Snouck of Loos House, Enkhuizen • House Trompenburg, 's-Graveland • Cruquius Pumping Station • National-ruins
B	1.5-2	Monuments for which the preservation of the main structure, including the historic finishing details are paramount, but certain functional adjustments are possible based on the nature or purpose of the functions that the building contains. The characteristic is "museological functional".	Intervention is at the service to assist preservation of cultural values. Functional adjustments under strict conditions are possible. The cultural values of the building and its components are generally of a high level, but there are also elements / components with relatively large intervention possibilities.	• Royal Palace, Amsterdam • German Embassy, The Hague • Castle Slangenburg, Doetinchem • Mauritshuis, The Hague • Museum–Palace Het Loo, Apeldoorn • Van Nelle Factory, Rotterdam • National Gallery, Amsterdam
C	1-1.5	Monuments for which conservation is aimed at preservation of the main structure and components with their workmanship and functional vitality. The buildings are naturally used in a flexible way, in their existence structural changes have taken place and extensions might exist that don't contributed to the cultural values of the object. New changes are now possible. The characteristic is "monumental flexible".	The building is characterized by intervention and change in past and present. Adjustments serve the functional performance of the building, within the boundaries of cultural preservation. In a C-building, there will be A or B components present.	• St. Vitus Church, Bussum • Arsenal, Naarden • The average residential monumental house • many houses that have become offices • Many architectural industrial buildings
X	1-3	Not (yet) listed built heritage with reasonably intact preserved original intent. The characteristics of these buildings contain "cultural perspective".	Free, but always focused on conservation values. Also in an X-building there will be A, B, or C components present.	• Water tower, Baarn • Housing of 1900 and later • Many industrial objects • Large part of development within protected conservation areas

5.3 Rating method:

The touchability category is determined on the basis of the inspection by the building historian of the building and on the basis of comparison with the reference objects. Deployment of a qualified architectural historian is hereby required because the method weighs and classifies the monumental values in and around the building.

After determining the touchability category, the historian also determines the numerical value of the Mo-coefficient, based on weighting the values on the Mo-coefficient worksheet (step 2). It is important to note that the calculation of the Mo-value is strongly indicative; hard performance figures cannot be used to generate the value, so no details summing up is done. The method doesn't give a clear-cut result, but a professional (architectural historian) issued indicator values and a set of reference buildings from which the touchability profile and the Mo-coefficient are determined. It is clear that a numerical final judgment on the basis of scores on different cultural heritage aspects (see step 2) is not possible, but determining the touchableness of the building components and a Mo-coefficient for the building as a whole on the basis of those scores is possible.

Remarks:

- P gives a very positive score on the assessed point
- Q indicates a positive to fair score on the assessed point
- R indicates a moderate score on the assessed point
- S indicates a negative or even disturbing score at the rated point
- The total score on the questions gives an idea of the character of the building or monument in cultural values. Overall, the touchability is inversely proportional to the cultural value of the object: high cultural value means low touchability.
- Of course, general culture historical qualifications, such as the significance of the building for local development, or relationship with a historical person, have no direct link with the adaptability or touchability of the building in the context of energy measures. Nevertheless, the general impression from the answers to the questions on monument values at the scale of the building as a whole do give an impression. Indeed, a lower general cultural value justifies a lower 'threshold' for the changeability of the monument. Conversely, a higher score on general cultural values should mean that adjustments to the monument are less or not desirable at all.
- The global distribution of the cultural heritage-levels P, Q, R, and makes it possible for the building historian / architect to determine the Mo-coefficient. Here, the mentioned characteristics and example buildings of the touchability categories A, B, or C function as basic references: to determine whether the building is characterized as 'museum-documentary' (A) 'museum-functional' (B), "monumental flexible '(C) or 'with cultural perspective' (Xa, b, or c).
- How high the number of the Mo-coefficient is within its touchability category, is then dependent on the value as is established in the assessment of the building by the expert. Roughly quite a few 'P'-scores means that the numerical value of the Mo-coefficient is at the high end within the touchability category, on the other hand many ' R ' scores means that the Mo-coefficient will be at the lower end within the touchability category.
- The instrument intentionally doesn't give a numerical route to that categorization: a monument could also be given a high Mo-coefficient if only some aspects, components or characteristics have a high score. It is up to the the expert to judge the touchability category (A, B, C or X) and within this to judge the Mo-coefficient (or 2-3; 1.5 to 2, 1 to 1.5 or 1-3).
- The touchability level of a building in the category X (which is not (yet) a protected monument) is judged in the same way as the listed buildings.

Item	**Score P**	**Score Q**	**Score R**	**Score S**	
Quality of building style and type, if rare					Architectural historical value
Idem, if general					
Architectural quality, if rare					
Idem, if general					
Construction quality, if rare					
Idem, if general					
Meaning within oeuvre of architect					
Interest related to historical themes					Cultural historic value
Interest related to local historical developments					
Interest related to local historical person or event					
Interest of surrounding to the building					Context value
Interest of building to the surrounding					
How much remains of historical material					Completeness
Technical state					
Total score	… x P	… x Q	… x R	… x S	
Touchability category:					
Value of Mo-coefficient:					

- *Step 2: Mo-coefficient worksheet*

6 SAVE/Architecture and Energy Refurbishment concept

SAVE and Energy savings

For more than 20 years the Danish registration and evaluation system called SAVE (Survey of Architectural Values in the Environment) method has been an important tool as a basis for designation of landmark buildings and urban environments in Denmark. From 1990, when the system was developed, to 2007 the SAVE system has proved its usefulness as the methodical foundation of 90 published preservational atlases which cover 75 of the old municipalities and more than 360.000 buildings. InterSAVE is the international version.

SAVE is basically addressing a total registration of the built environment in a municipality for the purpose to produce a preservation atlas for the municipality.

But it could as well be applied for registration and survey of a single building and its surroundings.

The description comes in most parts from the booklet "InterSAVE" by the Danish Ministry of Environment and Energy, The National Forest and Nature Agency, from 1995, or translated from publications from the Danish Ministry of Environment and Energy, The National Forest and Nature Agency, and from the Danish Ministry of Culture, The Cultural Heritage Agency Further information can be found at:

http://www.kulturstyrelsen.dk/fileadmin/user_upload/kulturarv/publikationer/emneopdelt/kommuner/Kulturarvstyrelsen_SAVE_print.pdf
http://www.sns.dk/byer-byg/Netpub/INTRSAVE/TEKST/CONTENTS.HTM

The initial drive for developing a new system was the signing in 1985 of the Granada Convention where the term "architectural heritage" was defined more widely than before, especially "Groups of buildings", and which imposes the signatories to maintain inventories and prepare appropriate documentation for the purpose of precise identification of the monuments, groups of buildings and sites to be protected.

SAVE Process

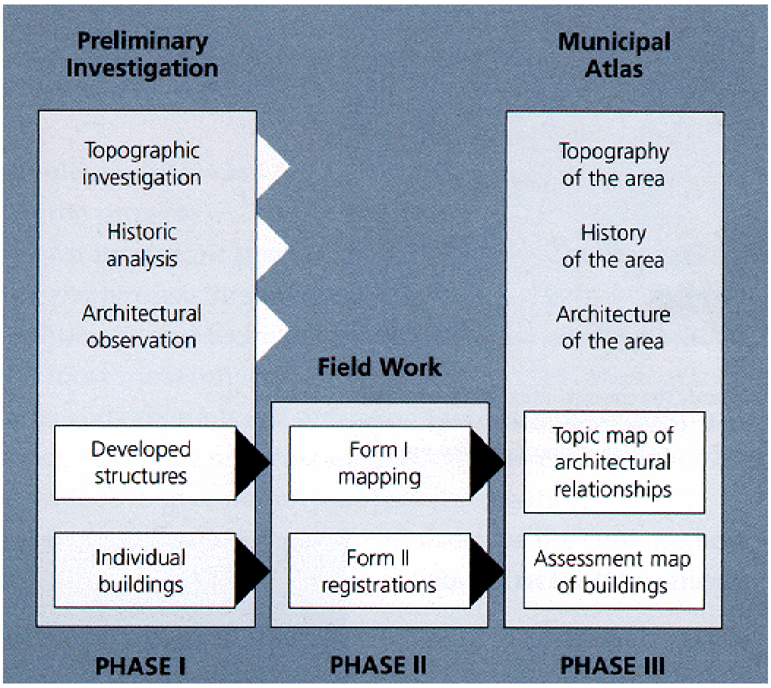


Figure 6.1 Outline of the phases in SAVE

The whole process is divided into 3 phases, and can be carried out in a few weeks for a single building and its surroundings.

An important point is setting up of a local consultative group consisting of representatives of the local authority (politicians and technical employees), the central authority, the local museum, the local archive, preservation associations and other interest groups. The consultative group should be informed and consulted before and during the project in order to evaluate the work as well as to give supplementary information.

6.1 Phase I, The preliminary investigation

In this phase the consultant collects and adapts available information on the topographical, historical and architectural characteristics of the area. He also carries out some preliminary registrations in order to verify the general information collected.

This information is presented in a report under the headings corresponding to the headings in the final report. An important element is a tentative list of the developed structures described in the following phase.

In an appendix are presented maps covering the whole area in the following scales: 1:2000 for the housing scheme and 1:500 for a single building plan. On the first map all existing buildings should be indicated.

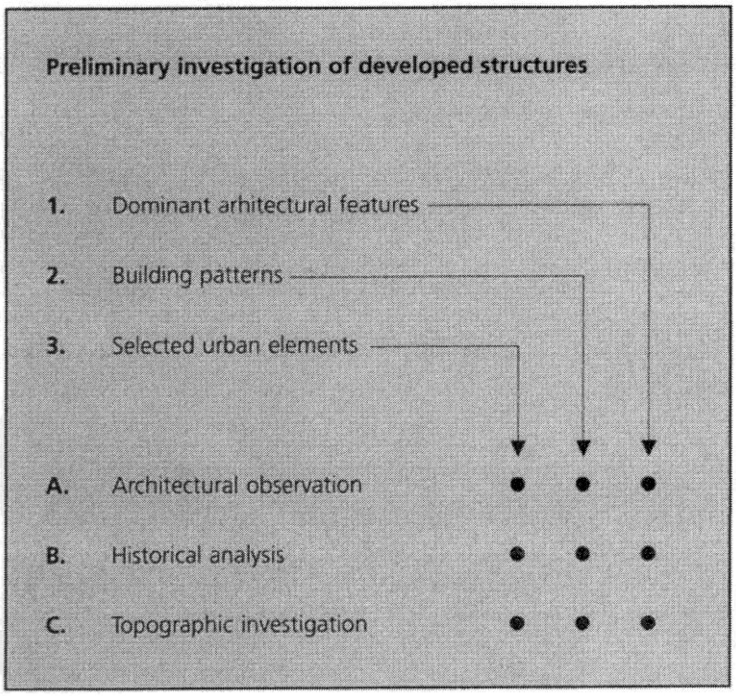


Figure 6.2 Diagram showing the work process in the preliminary investigation. The three levels: Dominant architectural features, Building patterns and Selected urban elements are qualified by Architectural observation, Historical analysis and Topographic investigation.

The report is presented to the local group for final approval as a programme for the following process and as a tool for further work for the consultant.

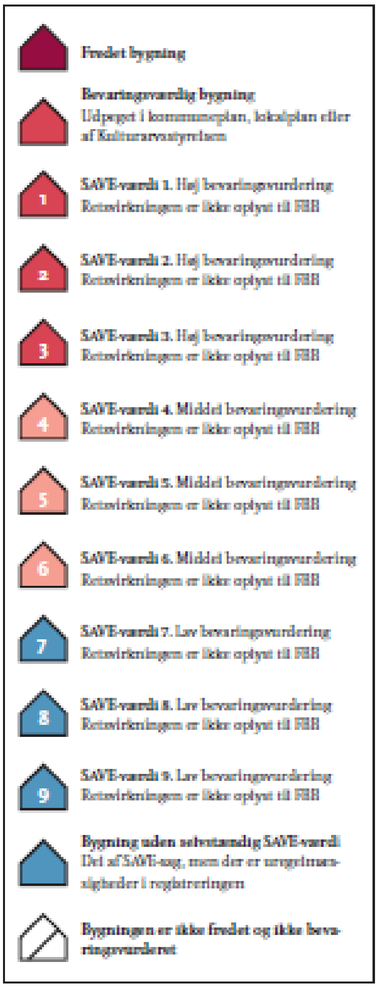
6.2 Phase II. The Field Work

In this Phase the architectural features are described in two different ways: 1) Developed structures and 2) Individual buildings. For both there is a form with blanks to be filled out.

Developed Structures

Developed structures are coherent entities (townscapes) and are evaluated as such. They can comprise anything from a few buildings to entire streets, squares, districts and even whole towns. Developed structures are divided into 3 categories: a) Dominant architectural features, b) Building patterns and c) Selected urban elements.

Fig. 6.3 Individual buildings



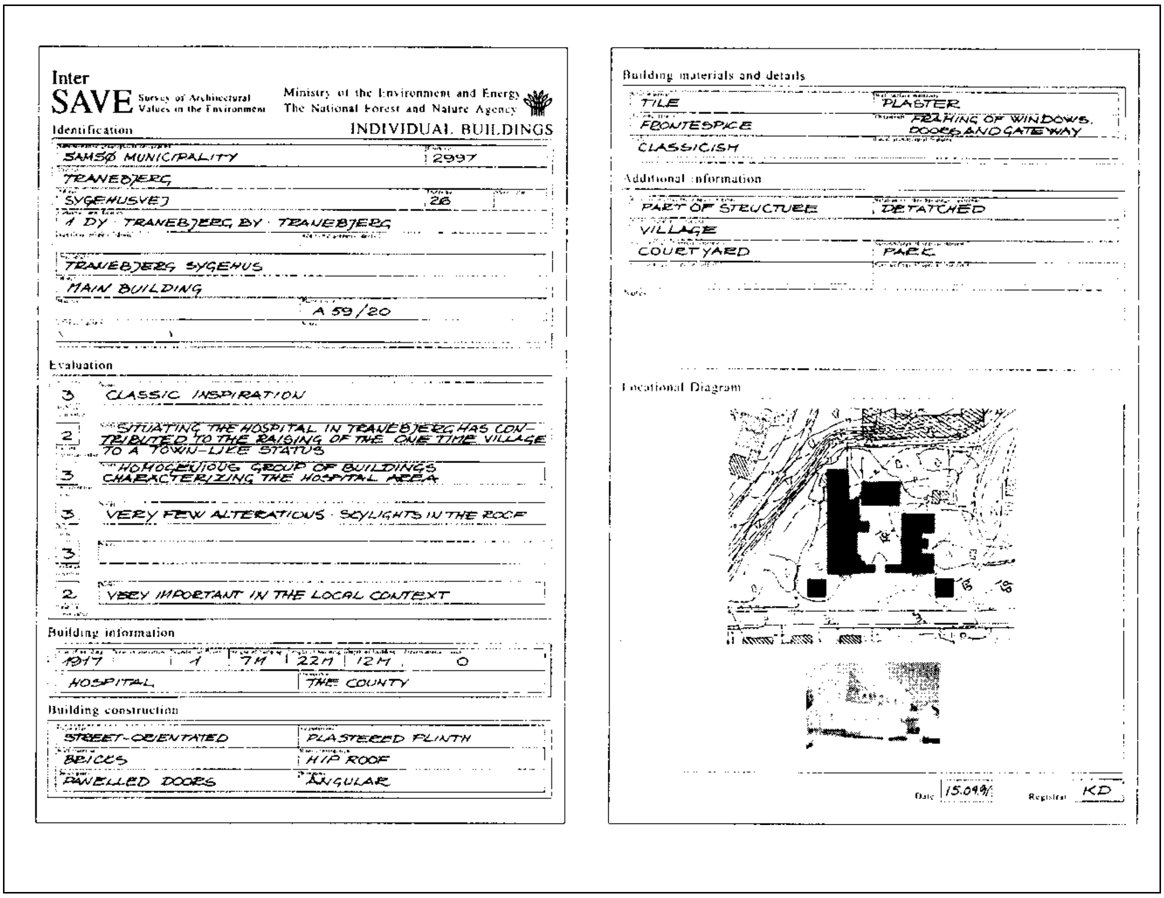
Individual Buildings are identified by existing national identification systems. Basic information such as age, materials, number of storeys and square meters as well as a more detailed description is given in a number of blanks with room for code indication

The most important part of the description form is the evaluation, which is composed of 5 different assessments:

- Architectural value (proportions, harmony of the composition, outstanding work of a certain architect)
- Cultural-historical value (evidence of social functions, evidence of evolution in craftsmanship or technology)
- Environmental value (degree of harmony with the environment)
- Originality (degree of original exterior preserved, possibility of rehabilitation)
- Technical state (whether in good or bad repair)

For the evaluations is used a 9-step scale (1 is the highest step). For properties with a number of buildings a general layout of their position is drawn. Lastly one or two photographs are taken.

The evaluation of the preservation value of an individual building is difficult, since most people have their personal opinion about architecture. So a common standard is needed. That is why the registrars should be given a short training (1 week) in how to evaluate buildings. Registrars should be professionals, architects, art historians or people with some experience in building registration, preferably familiar with the regional or local building tradition.



Inter SAVE Survey of Architectural Values in the Environment
Ministry of the Environment and Energy
The National Forest and Nature Agency

Identification — INDIVIDUAL BUILDINGS

SAMSØ MUNICIPALITY — 2997
TRANEBJERG
SYGEHUSVEJ — 26
1 DY TRANEBJERG BY · TRANEBJERG
TRANEBJERG SYGEHUS
MAIN BUILDING
A 59/20

Evaluation

3 — CLASSIC INSPIRATION
2 — SITUATING THE HOSPITAL IN TRANEBJERG HAS CONTRIBUTED TO THE RAISING OF THE ONE TIME VILLAGE TO A TOWN-LIKE STATUS
3 — HOMOGENEOUS GROUP OF BUILDINGS CHARACTERIZING THE HOSPITAL AREA
3 — VERY FEW ALTERATIONS · SKYLIGHTS IN THE ROOF
3
2 — VERY IMPORTANT IN THE LOCAL CONTEXT

Building information

1917 — 1 — 7M — 22M — 12M — 0
HOSPITAL — THE COUNTY

Building construction

STREET-ORIENTATED — PLASTERED PLINTH
BRICKS — HIP ROOF
PANELLED DOORS — ANGULAR

Building materials and details

TILE — PLASTER
FRONTESPICE — FRAMING OF WINDOWS, DOORS AND GATEWAY
CLASSICISM

Additional information

PART OF STRUCTURE — DETATCHED
VILLAGE
COURTYARD — PARK

Note

Locational Diagram

Date 15.09.91 — Registrar KD

Figure 6.4 Example of a completed building registration form

It would be useful, if a selection of different types of local architecture together with a short commentary is procured.

The results of the field work are directly applicable in the local administration, planning and allocation of building permissions. Also it provides a platform for preventive maintenance.

6.3 Phase III. The Preservational Atlas

The work ends with the publication of a preservational atlas which is an illustrated summary of the preliminary investigation and the mapping and registration field work.

The purpose of an atlas is to make the most important results readily accessible to the local community, creating in this way a common point of reference for the local authorities and the local population.

The Application of SAVE in the project "ARCHITECTURE & ENERGY REFURBISH-MENT - Brickbuilt multistorey housing from 1920 to 1960.

Kuben Management, DAC, Esbensen Engineering and The Royal Danish Academy of Fine Arts, School of Architecture, 2011.

The brick built housing schemes from 1920 to 1960 constitute a large part of the built environment, not only in Denmark, but throughout Europe. Looking closer to the brick built environment from the period it represents not only a large share of the total existing building stock, but also a unique architectural and craftsmanship tradition. However, the brickwork buildings also face an all-inclusive transformation to be future-proof and up-to-date homes - inside and out – and in line with current standards, environmental requirements and needs. To renovate and future-proof the brick buildings is partly about the refurbishment in accordance with the increased energy and building requirements – and partly to secure and protect architectural and cultural quality and people's well-being in and around the brick building.

EXCEPTIONS FROM BUILDING REGULATION

Listed buildings and buildings with a SAVE value from 1 to 3 normally have exception from Building Regulation's energy requirements, when refurbished. Whereas Buildings with a SAVE value from 4 to 9 have to comply with the requirements, which means that a majority of the traditional building stock (mostly built in brick) is threatened by cultural and architectural losses related to energy interventions connected to refurbishment.

Four categories of cultural and architectural value were defined from Listed Buildings through SAVE category 1-3, SAVE category 4-6 to SAVE category 7-9.

All of these categories have cultural value as well as they all have potentials for E-savings but to a variable degree from A to D. This categorisation also leaves the buildings with a "Space for Negotiation" between the building authority and the building owner to indicate that special and local conditions could be taken into consideration, when decisions are taken regarding the degree of interventions of energy savings.

To illustrate the potentials of the "the negotiation space" a reference building was chosen. This building could hypothetically be placed in all categories from A to D with different potentials for energy savings.

In the illustration below the possible savings in the four categories are indicated.

It should be emphasized that these interventions are highly hypothetical, but they can indicate a way to develop a more appropriate method and process for the balancing cultural value with E-savings in the decision process.

POSSIBLE SAVINGS – REFERENCE BUILDING

Energibesparelse i procent ift. reference.	Fredede bygninger og bygninger med høj bevaringsværdi	Bevaringsværdige bygninger	Bygninger med enkeltstående arkitektoniske kvaliteter	Anonyme bygninger
Vinduer og solafskærmning				
Forsatsrammer med energiglas, U = 1,7	-	5 %	-	-
Lavenergi vinduer, U = 1,4	-	-	11 %	-
Superlavenergi vinduer, U = 1	-	-	-	14 %
Isolering og tæthed				
Hulmursisolering, - gavle, 75 mm	4 %	4 %	-	-
Delvis udvendig efterisolering af ydervægge, gavle, 200 mm + hulmursisolering 75 mm	-	-	8 %	-
Nye højisolerede kviste, 200 mm i vægge og 250 mm i tag	-	-	2 %	-
Total udvendig efterisolering af ydervægge + hulmursisolering, 75 mm + 200 mm	-	-	-	26 %
Tagetage efterisoleres u. ombygning: 200 mm på loft, 100 mm i skunke, 75 mm i skråvægge	16 %	16 %	16 %	-
Tagetage efterisoleres inkl. ombygning: 400 mm på loft, 250 mm i skunke, 200 mm i skråvægge - inkl. nye kviste	-	-	-	22 %
Tæthed, 0,4 h-1	-	3 %	-	-
Tæthed, 0,3 h-1	-	-	6 %	-
Tæthed, 0,1 h-1	-	-	-	12 %
Ventilation				
Kontroludsugning	- 2 %	- 2 %	-	-
Central ventilation	-	-	7 %	-
Decentral ventilation	-	-	-	9 %
Varme- og vandinstallationer				
Ny varmecentral, inkl. efterisolering af rør i kælder	13 %	13 %	13 %	13 %
Energibesparelse				
Samlet energibesparelse ift. reference ved udførelse af de markerede tiltag	30 %	35 %	50 %	75 %

Figure 6.6 Evaluation list

7 Comparison and Discussion on DuMo and Save

To make this exercise concrete, we have looked at two existing concepts/methods:

- The changeability index, which is part of the (Dutch) DuMo method [ref1].
- The (Danish) SAVE/Architecture and Energy Refurbishment concept [ref2].

Globally seen, these two concepts/methods are comparable: they have a comparable aim and a comparable concept how to reach this aim: to make the cultural heritage context of a building quantifiable in a relative simple way by rating buildings on a gradual scale or within successive categories. The way how this categorization is done differs between the two methods and obviously numerous alternatives are possible.

Our discussion mainly focused on the pros and cons of the overall idea behind these concepts, not about the differences in detail. This is seen as the most fruitful for input to CEN at this stage, since wishes and demands about the general concepts could be worked out in the details of the method in a later stage.

The aim of the general idea can be summarized clearly by a graph from a Danish report [ref3] about the Danish concept. This graph show that there is a relation between the historic building category (apart from the method behind the categorization) and the amount of energy saving options that are possible in the buildings (see figure 8.1), even if of course what measures are possible exactly differs from case to case.

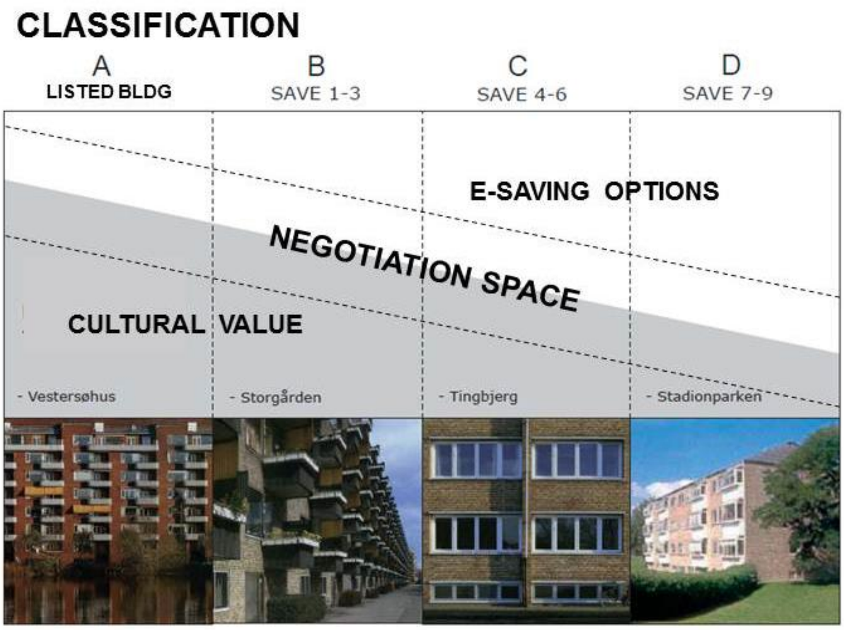


Figure 8.1: Illustration of the relation between the historic building category and the amount of energy saving that is possible in the buildings (Note: this is only an example not a fixed correlation) [Ref3]

Looking more into detail the two concepts differ. Roughly the difference is that the SAVE/Architecture and Energy Refurbishment concept is a qualitative and quantitative assessment of the cultural significance of the building and its surroundings, while the changeability index rates how far we can go with changing the building or parts of the building without changing the cultural heritage value of the building. For more details on both concepts, see annex A and B.

As alternative we'd also like to mention the approach of EnerPHit building certification. This method is briefly explained.

7.1 Pros and cons of these concepts/methods in general

The discussion about the general concept behind the two methods has led to various arguments in favor and against these concepts. The aspects that were mentioned are described and summarized in Table 8.1. A main advantage of a benchmark of the historical building context is that it can start communication among experts of different disciplines and between experts and laypeople.

An important drawback that was mentioned is that such a rating or categorization gives the impression that energy saving contradicts with historic buildings, while improvement of historic buildings and making it livable and comfortable often goes hand in hand with making it energy efficient, while both are necessary for saving the building from vacancy and decay. If a building scores high on historic value or the changeability index, it doesn't mean that in all cases only few energy savings can be realized: this differs from case to case. Sometimes it is even possible to save energy without many changes or negative impact on the building. On the other hand, although individual cases can always differ, the changeability index indicates the amount of changes that are possible and if almost no changes are possible it is plausible that the negotiation space to take energy saving measures is smaller than if the changeability is high and lots of changes to the building are possible. It is important that the meaning of such a rating is clearly understood: it is purely a means of communication that explains to non-experts why there might be more or less possibility for energy saving measures. And simplified rating schemes have proven to be very powerful communication tools.

The concept gives the possibility to buildings that are not protected/listed and legally need to apply to energy saving regulations (due to the recasted EPBD) to show why possibly energy saving measures are not always evident. Or the other way around: in protect buildings there might be more energy saving measures possible than initially thought, and a higher changeability index or other categorization might help to show this. The topic of classification is discussed intensively in whole of Europe. One considers, for example, the debates on the European Heritage Label. An introduction of a classification might have far-reaching consequences beyond the considered tight focus on energy retrofit of cultural heritage buildings. It is not the aim to make this a direct legal prove, but it can be used as starting point of a discussion. Some fear however, that there is a risk anyway that a classification of buildings in this way eventually will become a constituting instrument.

On the other hand, considering the value of the historic buildings, meaning the need for protection, maintenance and ideally also continued use as a building, it is essential to understand its current condition, including energy use and maintenance needs. This implies the necessity to conduct a proper evaluation of threats and weaknesses, as well as opportunities for protection and renovation. This is typically being done by historic building experts who have no training on the topic of energy. Having a standardised approach, outlining minimum requirements may be valuable in this context, since it includes cross-discipline communication and exchange.

Part of the assessment of both concepts is documentation of a qualitative investigation of the possibilities on detail level to make changes and take certain energy saving measures. The fact whether a building is listed or not is not enough information to find solutions. More documentation is needed and the assessment of the concept can be an added value. It is generally agreed that such a qualitative investigation on detail level is of major importance. Putting a figure on every aspect is less seen as evident and quantitatively summarizing this on building level even less, since it is doubted whether a global rating can say anything about decisions that are possible on detail level. It is even doubted that it is possible at all to classify the cultural heritage value of a building or that a value rated in such a method has any value in some countries. In Germany for instance, a building is listed or not and there seems no room for anything in between. Although even in Germany it is assumed that for communication purposes a concept that looks at the changeability on detail level can have an added value, even there might be room to put figures on these aspects as long as the information remains on detail level. And in addition: the concept can also be a starting point for discussion about non-listed buildings.

On the other hand, both concepts have been used in practice: dozens of historic buildings have been rated by the changeability index in the Netherland [ref1], and the usability of the index as proposed seems to work. In addition, one of the 3ENCULT partners has experience with the use of the Danish method and sees it as a good tool for awareness raising: we can fear that a categorization might underestimates the possibilities of energy savings in buildings, but experience shows that not having any such indication often leads to not thinking about possibilities at all. It was noted that this information needs to be present at the start of a discussion, because otherwise a lot of decisions have been taken and there is no way back to getting saving measures on the agenda. It was added that there is especially a need for discussion on an informed basis: how can we secure an informed discussion if there is not such a tool?

A final remark is made that the cost aspect should be taken into account in a method to be of value.

7.2 Conclusions and advice

Conclusions

A discussion was held about the necessity of a possible benchmark of the historic building context in relation to the rating of the energy performance of historic buildings. Opinions about the usability of such a benchmark differ. It should be noted that the opinions about the general idea behind the concepts was not related to the background of the participant: opinions pro and con appear to be divided among all disciplines. Consensus was reached about neither most of the pros nor most of the cons of the concepts. A summary of the advantages and disadvantages is given in table 8.1.

Advantages about the general concept: • Facilitates communication; • It raises awareness about the fact that in many listed buildings energy saving measures are possible, while now they are often simply not even considered; • At the moment there are (in many countries) only two flavors: listed and non-listed building. More categories make it possible to start the discussion more nuanced; • And it facilitates discussion about why in a *protected* building there might be more possible than initially though; • Added value lies in the informed basis of the discussion.
Disadvantages about the general concept: • Implies that energy saving and saving historic buildings contradicts, while we need to do both; • There will always be a need for a case to case evaluation: A high historic building value or changeability value doesn't always mean a low energy saving level; • The general concept judges the whole building, while a global rating doesn't say anything about decisions that are possible on detail level; • Is it even possible to classify cultural heritage?; • A quantitative assess of historic value cannot replace a qualitative description; for the evaluation of measures still all information would be needed.

Table 8.1 summary of advantages and disadvantages of a benchmark of the historic building context

Although no consensus was reached about the usefulness of a quantitative rating, what was generally agreed was that good documentation is needed. The assessment methods of both concepts contain a documentation phase where the details of the building are judged on the possibility to change them or take specific energy saving measures. Such documentation can be a first step in the facilitation of the communication about the context of energy saving in historic buildings and it can help to develop solutions to make historic buildings more energy efficient.

Advice

For the development of a CEN Standard, it might be useful to strive for a standard level of documentation, in a form in which we at least lay down one or several methods/procedures that can be taken up by Member States, but where national additions and modifications are possible, e.g. in national annexes or by taking over only parts. Experience within CEN learns that it's useless to try and come to consensus about a very rigid system; Having a flexible procedure with for instance 2 or 3 routes and room for national annexes, a) helps MS to develop/implement these ways of thinking and working and b) reduces the amount of methods/procedures from 27 to only a few.

For discussion within the CEN working group, we also suggest a careful discussion about whether a classification of heritage value shall be fixed by law, and what consequences would result for conservation in general, or whether it is a method that functions as a guideline of operations; that can be used for the energy efficient refurbishment of a building where the classification of building parts is used only internally and/or as a means of communication within a multidisciplinary team and towards consumers.

It seems worthwhile to investigate the experiences with the two concepts (and possible other alternative concepts if they exist) in practice, to see what benefits the various qualitative and quantitative aspects of the concepts have, and what justifies their use above the current way of working.

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8 Approach of EnerPHit building certification

Short explanation of the Approach of EnerPHit building certification

Within 3encult the existing EnerPHit standard for energy retrofit with Passive House components has been supplemented with procedures and requirements for certification of listed buildings. In contrast to the changeability index and the SAVE method EnerPHit does not judge historic value or energy efficiency on a whole-building level. Instead, all relevant individual building components (e.g. roof, windows, ventilations system etc.) have to meet the requirements for Passive House components. The overall space heating demand of a building is a result of the measures applied to these individual components. It is stated in the certificate, but there is no upper limit for it.

For listed buildings the requirements are not generally lowered. Instead exemptions can apply for each individual building component. Example: In a building with protected historic street facade, but a plain rear facade without historic value, full Passive House level exterior insulation is to be applied to the rear facade, whereas the street facade receives a thinner interior insulation.

This way all energy saving measures, that can be applied without compromising the historic value of the building are actually fully realized. Exemptions to component requirements are possible in all cases, in which conflicts with requirements by cultural heritage authorities would otherwise occur.

9 Conclusions

Energetic retrofit on European monuments is a challenging and actual task. But neither such alteration on heritage is impossible nor this is easy. No energy saving measure on a building is conservation compatible or incompatible per se. Working on the building heritage stock it is indispensible always to refer specific solutions to specific real objects and their problems. As a result of 3ENCULT the approach starting on one hand with a single heritage building and on the other without prejustice with the collection of all actual and effective energy solutions is the only possible way to come to a sustainalble answer. For all retrofitting measures at all possible places of installation the impact on the monument, on the heritage value, the loss of original material and the change of the apperance has to be balanced. Also has the effectivity to be weight as the sustainibility in terms of damage risks and the reversibility of the new addition. This does yield to specific developped and object adapted results, which most often are a perfect combination of existing standard solutions. This additional work in planning does lead to an improved and forward looking result for energy efficiency in the important European Cultural Heritage.

10 Actual literature review

Basic of this part was a thorough investigation of materials, which are grapple with energetic rehabilitation of historic buildings from different perspectives, various starting points, divergent qualities and quantities as well as heterogeneous targets groups. In the course of this the investigation for publications occurs on the one side in Germany and on the other side in countries of European Union. In the countries of European Union the national Organizations for Preservation of Historical Monuments were the main source of information.

Helpful and practically orientated are the youngest publications in England, Scotland and Ireland, which are released on national level. The publication >>Energy Heritage. A Guide to improving energy efficiency in traditional and historic homes<< by ChangeWorks explain: "Building conservation and energy efficiency are both key aspects of sustainability. […] It is possible to reduce energy inefficiency in homes, even in historic buildings, without compromising their historic and architectural character. The key lies in balancing historic buildings` characters, retention of original fabric, energy conservation and the needs of modern householders."1 "This document, which encourages and facilitates energy efficiency improvements in traditional and historic homes across the UK, came about a result of ChangeWorks` Energy Heritage project.[…] Energy Heritage has shown that traditional homes can be made more energy efficient, often through relatively easy and minor interventions, and retain their historic character and appearance. The lessons drawn from the Energy Heritage project are the basis of this guide.2 Also in Scotland the Edinburgh World Heritage Trust published the >>Historic Home Guide. Energy Efficiency. << "The purpose of this guidebook is to advise owners and residents about energy efficiency solutions that can improve the thermal performance of historic buildings, reduce carbon emissions and lower fuel bills." 3 It is a convenient booklet with a practically overview for building owners. Two publications in England could be consulted. On the one side there is >>Energy efficient historic homes. Case studies<< by the Energy Saving Trust. "This guide is primarily aimed at the owners of the hundreds of thousands of historic homes in the UK which are either listed or lie within a conservation area. In England and Wales Part L of the Building Regulations requires that 'sensible and reasonable' energy efficiency measures be incorporated during refurbishment work and it is vital that home owners understand just what this entails. The case studies in this document describe recent refurbishment projects on a range of historic homes dating from the 16th to the 19thcenturies, all of which included energy efficiency improvements. They illustrate just what can be achieved while taking into account a building's historic significance, performance characteristics, design and the materials it is made of (i.e. its 'fabric')."4 On the other side the "English Heritage supports the Government's aims to improve the energy efficiency of existing buildings through Part L of the Building Regulations. […]However, reducing carbon emissions from buildings is not just about heating and insulating the building fabric. Much can be achieved by changing behaviour, avoiding waste, using energy efficient controls and equipment and managing the building to its optimum performance, all of which is as relevant to older buildings as new ones."5 "The guidance has been produced to help prevent conflicts between energy efficiency requirements in Part L of the Building Regulations and the conservation of historic and traditionally constructed buildings. Much of the advice will also be relevant where thermal upgrading is planned without the specific need to comply with these regulations." 6 The guide is for building owners and occupiers, architects, surveyors and similar professionals, building contractors, materials and component suppliers officials, such as conservation and planning officers, building-control surveyors, approved inspectors, environmental health officers and housing officers. Also the government of Ireland issued in 2010 >>Energy Efficiency in traditional buildings<< and postulated: "It is Government policy to reduce energy use and carbon dioxide emissions from the burning of fossil fuels. The European Directive on the Energy Performance of Buildings (2002/91/EC) adopted into Irish law in 2006, specifically targeted energy requirements of buildings whether new or existing, residential

1 ChangeWorks (2008) S. 13.

2 ChangeWorks (2008) S. 3.

3 Edinburgh World Heritage Trust (no year) S. 2.

4 Energy Safing Trust (2005) S. 3.

5 English Heritage (2011) S. 4.

6 English Heritage (2011) S. 5.

or non-residential. […] This booklet sets out to provide introductory guidance for owners and to act as an aide-memoire for building professionals and contractors. While the main objective is to address how the thermal efficiency of traditionally built buildings can be enhanced, it is intended to balance this with the conservation of the architectural heritage. To that end, this booklet explores ways of improving energy efficiency while maintaining architectural character and significance, the intention is to show how to improve the quality of the architectural environment while maintaining the historic fabric of traditional buildings."7 The requirements obtained results in the USA. The publication by Jo Hensley and Antonio Aguilar >>Improving Energy Efficiency in Historic Buildings<< point out that "The concept of energy conservation in buildings is not new. Throughout history building owners have dealt with changing fuel supplies and the need for efficient use of these fuels. […] This guidance is provided in accordance with the Secretary of the Interior's Standards for Rehabilitation to ensure that the architectural integrity of the historic property is preserved. Achieving a successful retrofit project must balance the goals of energy efficiency with the least impact to the historic building." 8 The information brochure outline in short breaks what is possible and necessary to energetic rehabilitation of particular building components.

The Austrian Federal Office for Preservation of Historical Monuments published in 2011 the guideline "Energy-efficiency on historic buildings"9, which could be a pattern. The saving of fossil fuels and carbon dioxide is one of the most urgent tasks in Europe and cause currently numerous ambition projects. The guideline by the Austrian Federal Office for Preservation of Historical Monuments explains the principles of energetic rehabilitation of historic buildings. It is a guide to estimate different measures, which are acceptable or possibly inacceptable. There are only methods treated, which could gave a consequence for substance, structure and appearance by changes in construction. Beside these facts also criteria like durability, location, ecology and sustainability of buildings play an important part. The Swiss Confederation published10 together with the federal State Office of Energy and the Swiss Commission of Historical Monument Preservation already in 2009 an advice for energetic improvement of historic buildings. To reduce energy consumption and to perform residual need by renewable energy: that is the leitmotif of the energy policy in Swiss. The careful treatment of historic buildings is a desire of society since generations. Both matters have their authorizations based on the same stance and pursue the same aim: they support the same sustainable development. This recommendation mainly turns to experts. But also for buildings owners it could gives important clues.

The research in Germany was structured systematically by Federal States on state level and communal level. A further classification concerns to institutional organizations and investigations of scientific publications and research projects as well as their results. It was assessed, that apart from the Federal state Baden-Württemberg, Bayern and Sachsen particular Nordrhein-Westfalen become apparent because of publications to the topic. In Hessen in additional to the publications by the State Office for the Preservation of Historical Monuments also publications on communal level were figure out. Professional publications, articles in professional journals and engineering pamphlets are representing numerously in Germany. They consider with energetic rehabilitation in a building physics way or from the perspective of cultural heritage preservation, which discus the conflict between energy saving and claim on monumental protection in general or based on examples.

The study by the >>Institut für Energie und Umweltforschung Heidelberg (Ifeu)<<11 explore restrictions of insulation in building stock. It analyses the effect on calorific requirements in Germany. Aim was answer to questions, how restrictions of insulation play an important part for buildings medium- and long-acting. The restrictions of insulation were analysed in style, quantity and energetic effect in dependence on conditions of insulation. Focal task of the research project "Wärmeschutz für Sonderfälle"12 was to work up experiences and solution approaches and open it for a taller category of people. With the results it was possible to create instructions and planning aids. The depicted strategies should enable to economic energetic rehabilitation of the sensitive stock situation. Base of the research

7 Government of Ireland (2010) S. 4.

8 Hensley et al. (2011) S. 1.

9 Bundesdenkmalamt Österreich(2011).

10 Schweizerische Eidgenossenschaft, et al. (2009).

11 Beuth Hochschule für Technik Berlin et al. (2012).

12 Bundesministerium für Verkehr, Bau und Stadtentwicklung et al. (2009).

project was the EnEV 2007. The guideline “Energieeinsparung und Denkmalschutz”13 describes the possibilities of the KfW-Förderprogramm (aid program) for historic buildings, which should energetically refurbish, and exceptions permits. The guideline discharges the task to annotate coherences, suggest historic buildings and assist in inspection procedure for exception permits. The guideline by the Bavarian State Office of Cultural Heritage Preservation14 deals with solarthermics, photovoltaics, wind power, geothermics and energy by biomass. It is an obligatory guideline for the employees of the Bavarian State Office. Also it could pass along as recommendation for building owners, planners and public authorities. The handbook “Energieeffiziente historische Stadtkerne”15 is the result of a research projects in the years 2011/ 2012. It was initiated by the workgroup >>Städte mit historischen Stadtkernen<< by the federal state Brandenburg. Reason of the study was the question, if historic centers could sustain the requirements of energy-efficient city development. Aim is to bring climate protection and cultural heritage preservation in line. The results are illustrated in the handbook as a guideline for coming practice of urban regeneration. The advices are practically and give individual solution approaches. The pilot project “Energetische Sanierung von Baudenkmalen”16 is a component of the action plan “Klima und Energie” by the Free State of Saxony. The University of Technology Dresden exemplary examines measures on historic buildings according to energetic, building climate and constructive subjects. They were assessing of the compatibility for historic buildings. Aim was to bring problem-solving approaches, targets of climate protection, economics of measures and sustainability in line. The results slip in a guideline by the Free State of Saxony17. It turns to building owners, architects and engineers. On base of legal and technical defaults it should support. The city Frankfurt am Main attended in a brochure to energetic rehabilitation of building by Gründerzeit[18]. As in numerous cities in Germany the buildings by Gründerzeit influences whole neighborhoods. The facades of those buildings are because of the sophisticated design of facades and roofs a special challenge. The brochure inspire to energetic rehabilitation. It informs about aid programs and economic of measures of energy saving.

The overall result of the research for publication is shown in part 2. The bibliographical references are structured corresponding to the pattern of investigation as explained at the beginning.

All cited and mentioned publications are included in part 3 Examples, except die publications by the city Frankfurt am Main and ChangeWorks, because they don´t exist digital.

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