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

3encult
EFFICIENT ENERGY FOR EU CULTURAL HERITAGE

EUROPEAN COMMISSION
DG ENVIRONMENT

Seventh Framework Programme

Theme [EeB.ENV.2010.3.2.4-1]

[Compatible solutions for improving the energy efficiency of historic buildings in urban areas]

Collaborative Project – GRANT AGREEMENT No. 260162

SEVENTH FRAMEWORK PROGRAMME

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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. To date several documents from different European Countries are available to pre-asses the compatibility of some energy efficiency measures for historic buildings. 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 trays 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.

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 recherché on available material it was most auspicious to combine the outcome of at 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.environ.ie/en/Publications/Heritage/BuiltHeritagePolicy/FileDownLoad,24749,en.pdf

Austrian guideline (Austria 2011) “Energieeffizienz am Baudenkmal”. offers 10 basic rules (p.8) form 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 underlined.

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.

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.

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.

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.

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.

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.

7. MATERIALKONFORM Notwendige Ergänzungen im Zuge energetischer Verbesserungen sind in der Materialität möglichst konform mit dem überlieferten Bestand auszuführen.

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.

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 Maßnahmen: lieber weniger und sicher – als viel und riskant.

10. WEITBLICK Maßnahmen 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.

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 advice acts as supporting guidance in the interpretation of Approved Documents L1B and L2B that should be taken into account when determining appropriate energy performance standards for works 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.pdf

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

The two latter were chosen for closer inspection and use within the 3Encult project.

2 With a multidisciplinary team in an iterative approach towards the solution: 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 deleted scratch and promising brought forward – the typical approach of what is known as Integrated Design Process IDP.

2.1 Overall approach

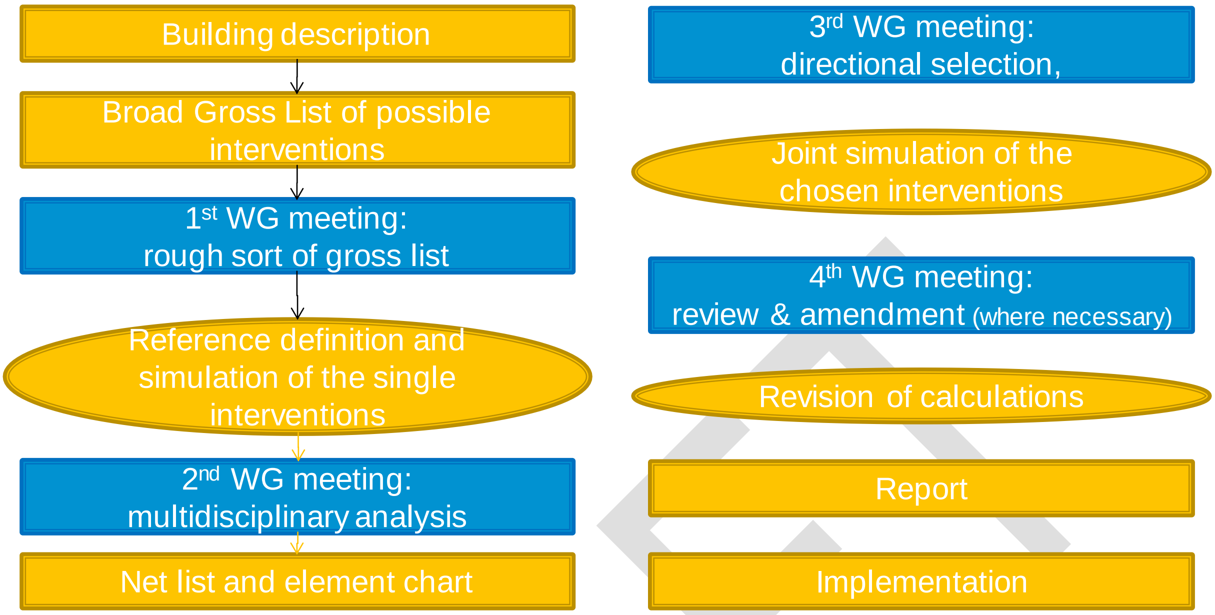
Starting position	Old Material Court to be renovated and used for office purposes.
Objective	1. Reduce **CO_2 emissions** and guarantee high **indoor comfort** with office use, in compliance with conservation and architecture 2. Provide **guideline** for the more than 1000 protected buildings in Denmark 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 halvvalmet 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 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	
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.	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	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.	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** 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	**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	**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	**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 Sachsen ~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 underlinee, that all these aspects determine the sustainability of a solution, not all of them could be assessed in the pilot study.

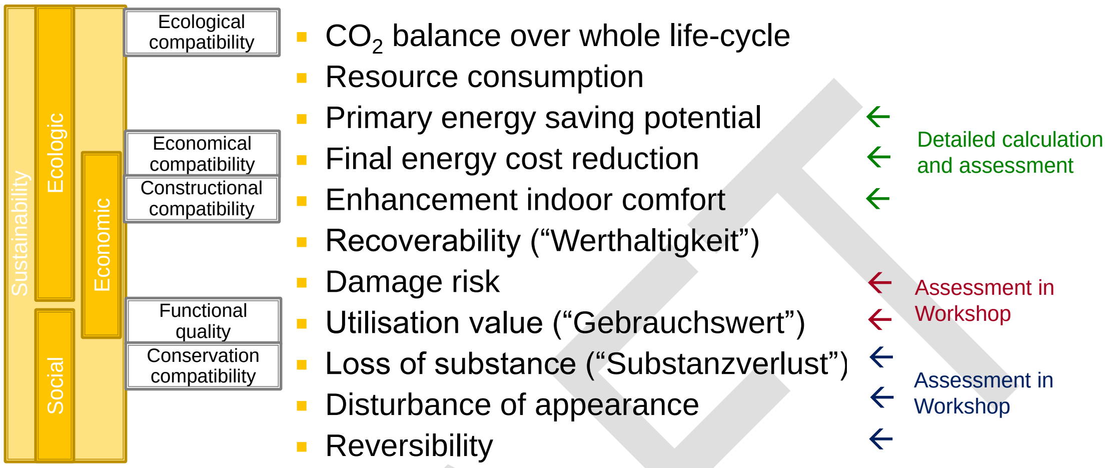


Figure 5 List of assessment criteria

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								Soziales / Kulturelles Kapital		
							Ökonomisches 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	Betriebskostenein-sparung End-energie Heizung (Gas: 0,6Ct/kWh, FW: 0,9Ct/kWh) u. Strom (20Ct/kWh)	Verbesserung der therm. Behaglich-keit, 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	Bewertung	Bewertung	prozentuale Einsparung	prozentuale Einsparung	prozentuale Verbesserung	Bewertung	Bewertung	Bewertung	Bewertung	Bewertung	Bewertung
			Positiv	↑ ++	↑ ++	100% groß	100% groß	100% besser	↑ ++	↑ ++	↑ ++	↑ ++	↑ ++	↑ ++
				↗ +	↗ +				↗ +	↗ +	↗ +	↗ +	↗ +	↗ +
			:	→ 0	→ 0	: :	: :	: :	→ 0	→ 0	→ 0	→ 0	→ 0	→ 0
				↘ -	↘ -				↘ -	↘ -	↘ -	↘ -	↘ -	↘ -
			Negativ	↓ - -	↓ - -	0% klein	0% klein	0% gleich	↓ - -	↓ - -	↓ - -	↓ - -	↓ - -	↓ - -
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.

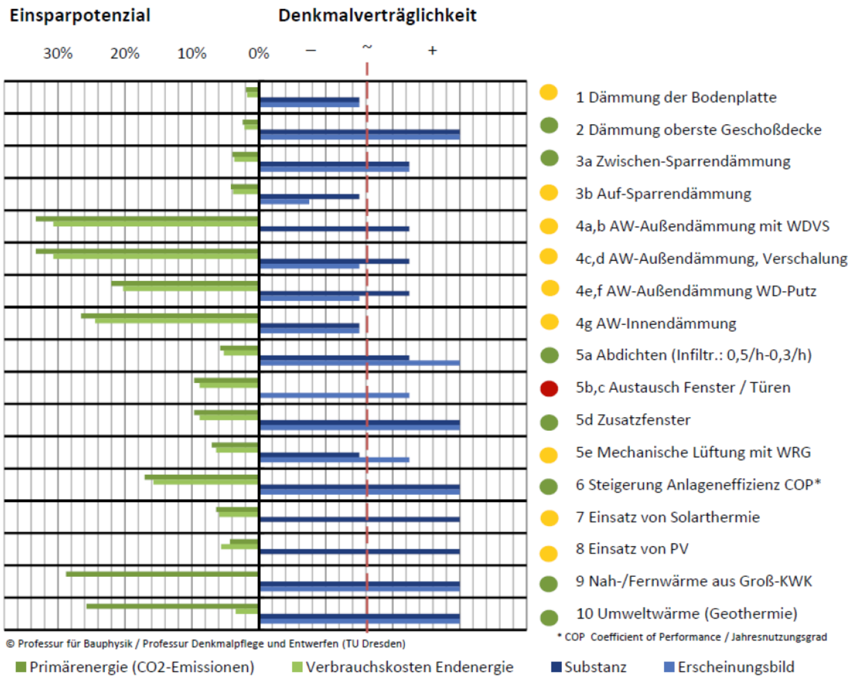


Figure 8 Visualisation of energy reduction potential and conservation compatibility criteria

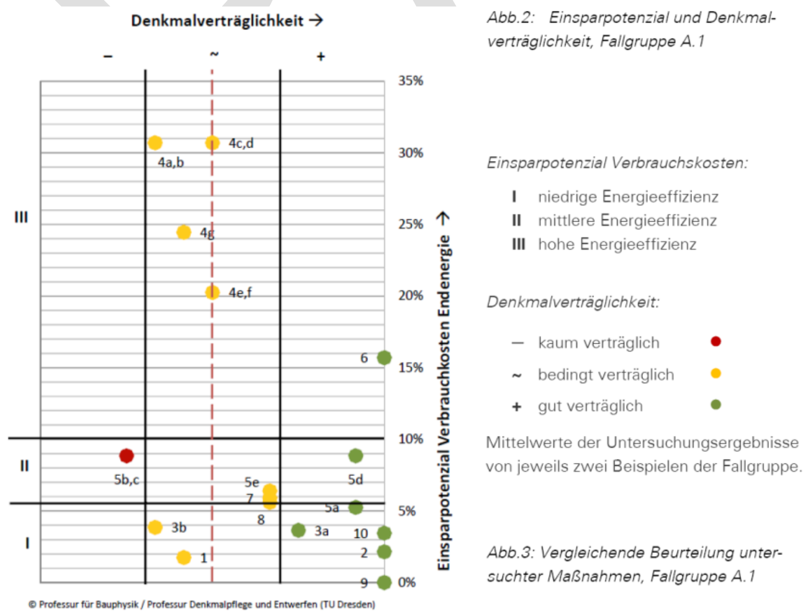


Figure 9 Visualisation of energy performance and conservation compatibility criteria

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 "cruel" 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.

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