Energy Exchange
Federal Sustainability for the Next Decade
U.S. Department of Energy

How to achieve Deep Energy Retrofit in a cost effective way?

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Annex 61

Business and Technical Concepts for Deep Energy Retrofit of Public Buildings

EBC
Energy in Buildings and Communities Programme

Deep Energy Retrofit (IT-Tool)

Receptors

- Executive decision-makers and energy managers of public and governmental administrations
- ESCOs
- Financing industries
- Energy utility companies
- Designer-, architect- and engineer-companies
- Manufacturers of insulation, roofing materials, lighting, controls, appliances, and HVAC and energy generation equipment, including those using renewable sources.

Subtasks

- **Subtask A:** Bundles of Technology: Prepare and evaluate case studies on existing deep energy retrofit concepts. Develop a guide for achieving financially attractive deep energy retrofits of buildings and building communities.
- **Subtask B -** Develop business models for deep energy retrofit of buildings using combined government/public and private funding

Subtasks (Continued)

- **Subtask C:** Demonstrate selected deep energy retrofit concepts using combined government/public and private funding, and prepare case studies describing completed and/or partially completed projects.
- **Subtask D:** Develop an IT-tool for decision-makers and ESCOs that emphasizes low-risk approaches for early stages of design and decision-making.

Background

- Governments worldwide are setting more stringent targets for energy use reductions in their building stocks
- To achieve these goals, there must be a significant increase in both the annual rates of building stock refurbishment and energy use reduction, for each project (EU: refurbishment rate of 3% p.a., USA: 3% p.a. site energy reduction compared to CBECS 2003 through 2015 and 2.5% between 2015 and 2025)

Current Minimum Energy Related Requirements

Country	Building Energy	Building Envelope	HVAC	Lighting
Austria	OIB Directive Nr.6	OIB RL 6, 2011	EN 1507, EN 12237 ÖNORM H 5057, OIB RL 6, 2011	EN 12464-1 and -2 EN 15193
China	GB50198-2005	GB50198-2005, GB/T 7016-2008	GB 50243-2002 GB50736-2012 GB50198-2005	GB50034-2004
Denmark	Danish Building Regulation 2010, DS Standard 418	Danish Building Regulation 2010	Standard 447 Standard 452	DS/EN ISO 12464-1
Estonia	Ordinance No. 63. RT I, 18.10.2012, 1, 2012; Ordinance No. 68. RT I, 05.09.2012, 4, 2012	EVS-EN ISO 10077, EVS-EN 1026 EVS-EN 12207 EVS-EN 12208	EVS-EN 13779, EN 12237 Ordinance No. 70. RT I, 09.11.2012, 12	Ordinance No. 70. RT I, 09.11.2012, 12
Germany	DIN 18599-1; EnEV 2014	EnEV 2014, DIN 18361 DIN 18355, DIN V 18599/2 DIN 4102, DIN 4108 DIN EN 13162, DIN EN 13163 DIN EN 13164, DIN EN 13165 DIN EN 13167, DIN EN 13171	EnEV 2014, DIN V 18599-2 and 7 DIN 1946-6, DIN EN 13779 DIN 24192 II/III/IV DIN 4108-6, DIN 4701-10, EnEV 2009/2014	DIN 18599-4, DIN 5035 T 1-14
UK	BS EN 15603:2008	Building Regulations-Conservation of Fuel and Power in New Buildings Other Than Dwelling: Part L2A.	BS EN 15727:2010 BS 5422:2009 Non-Domestic Building Services Compliance Guide:2013	BS EN 12464-1:2011
USA	ASHRAE Std 90.1 2010 ASHRAE Std 100 2015	ASHRAE Std 90.1 2010	ASHRAE Std 90.1 2010	ASHRAE Std 90.1 +IESNA recommended practices, 10th edition 2010

Major Renovation: BAU

Examples of calculated % of energy use reduction with major renovation projects from pre-1980 baseline to current minimum energy standards

- USA :
  - Barracks (c.z. 1A – 8) EUI_{site}: **8-16**%
  - Administrative building: EUI_{site}: **8-22**%
- German Administrative Buildings (c.z. 5A) EUI_{site}: **40**%
- Danish School (c.z.6A): EUI_{site}: **19**%;
- Austrian residential building (c.z. 5A): EUI_{site}: **29**%

EU Energy Performance of Buildings Directive (EPBD 2010)

- Member States shall develop policies and take measures such as setting targets to stimulate the transformation of buildings to be refurbished to a nearly zero-energy condition.
- A Member State shall not be required to set minimum energy performance requirements that are not cost-effective over a building's estimated economic lifecycle.
- A nearly zero-energy building is defined as "*a building that has a very high energy performance. The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby.*"
- The term "high performance building" (as used in Austria, Germany, the Czech Republic, and Denmark) was developed by the Passivhaus Institute (PHI) for the German building market, and has the same definition as "nearly zero-energy."

Annex 61 Objectives

- To provide a framework and selected tools and guidelines to significantly reduce energy use (by more than 50%) *public buildings undergoing major renovation*
- To gather and, in some cases, research, develop, and demonstrate *innovative and highly effective bundled packages of ECMs* for selected building types and climatic conditions
- To develop and demonstrate *innovative, highly resource-efficient business models for retrofitting/refurbishing buildings* using appropriate combinations of public and private funding

Annex 61 Definition of Deep Energy Retrofit

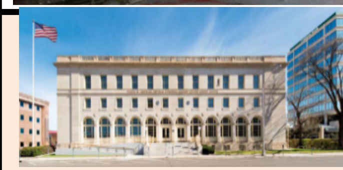
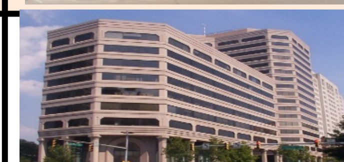
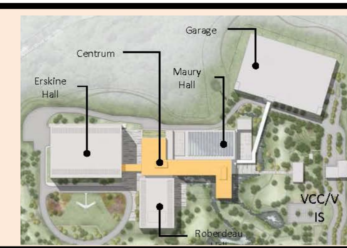
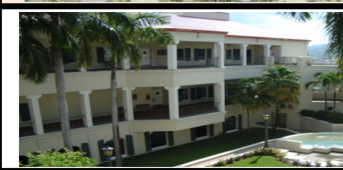
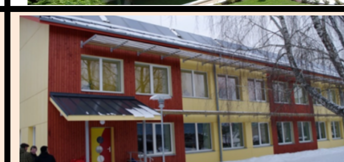
Deep Energy Retrofit (DER) is a major building renovation project in which site energy use intensity has been reduced by at least 50% (including plug-loads) from the pre-renovation baseline.

How to Achieve DER ? European Experience

Measure	Germany	Austria	Denmark
Wall insulation	12-24 cm (0.20-0.10 W/m^2K)	16 -20 cm (0.20 - 0.10) W/m^2K	15-30 cm
Roof insulation	20 – 40 cm (0.20- 0.10 W/m^2K)	20 – 40 cm (0.20- 0.10 w/m^2K)	20-40cm
New Windows	0.8-1.1 W/m^2 K	triple glazing (0.70 – 0.90 W/m^2K)	U-value down to 0.5-1.2 W/m^2 K
Unheated basement ceiling insulation	5-20 cm (0.25- 0.10 W/m^2K)	10 – 20 cm (0.20 – 0.10 W/m^2K)	10-20cm
Reduction of thermal bridges	Reduction as good as reasonably possible		Foundation: < 0.15W/mK Windows: < 0.8-0.5 W/mK
Improved building envelope air tightness	n50 value = 1.0 1/h - 0.6 1/h (Low-energy buildings + (Passive houses)	n50 value = 1.0 1/h - 0.6 1/h (Low-energy buildings + Passive houses)	q(50pa): from 4l/s/m^2 to 1.5l/s/m^2
Ventilation system heat recovery	Heat recovery rate: 65 – 80%	Heat recovery rate 65 – 80%	SEL: down to:1.5-1.2kJ/m^3
Solar Thermal Collectors for DHW	Dwellings: 3- 5 m^2 /+500- 800 l storage per residential unit, NRB with 2- 3 m^2 per shower unit + 300-400 l/ storage per unit	In some provinces (e.g. Styria) residential buildings are obliged to have solar thermal collector	Dwellings: 3-5m^2
Advanced lighting system design with day-lighting controls	Dwellings: 10- 12 m^2 high efficient solar evacuated tube collector + > 1,000 l storage/ unit s		With daylight and dimming control.

Annex 61 DER Case Studies

COUNTRY	SITE	BUILDING TYPE	PICTURES
1.Austria	Kapfenberg	Social housing	
2.Germany	Ludwigshafen-Mundenheim	Multi-stories apartment	
3.Germany	Nürnberg, Bavaria	Multi-stories apartment	
4.Germany	Ostfildern	Gymnasium	
5.Germany	Baden-Württemberg	School	
6.Germany	Osnabrueck	School	
7.Germany	Olbersdorf	School	

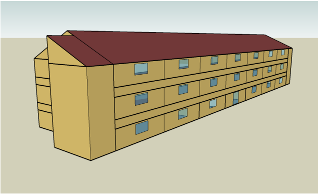
COUNTRY	SITE	BUILDING TYPE	PICTURES
8.Germany	Darmstadt	Office building	
9.Denmark	Egedal, Copenhagen	School	
10.USA	Grand Junction, Colorado	Office Building / Courthouse	
11. USA	Silver Spring and Lanham, Maryland	Federal Building/ Office	
12. USA	Intelligence Community Campus, Bethesda , MD	Administrative buildings	
13. USA	St. Croix. Virgin Islands	Office/Courthouse	
14. Estonia	Kindergarten in Valga	Kindergarten	
15. Latvia	Riga	Multi-family building	

"Core Technology" Bundle for DER

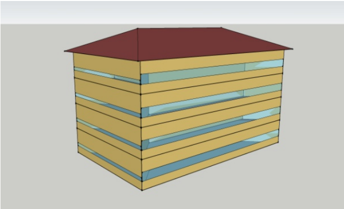
Category	Name
Building Envelope	Roof insulation
	Wall insulation
	Slab Insulation
	Advanced Windows
	Insulated Doors, Vestibules
	Thermal bridges remediation
	Air tightness
	Water/Vapor Barriers
	BE Quality Assurance
Lighting and Electrical Systems	Lighting design and efficient technologies and controls, efficient motors, VFD drives
HVAC	Smaller sized High performance fans, furnaces, chillers, boilers, etc.
	DOAS
	HR (dry and wet)
	Duct insulation
	Duct air tightness
	Pipe insulation

Building Models used by the Modeling Team

USA, ERDC
Climate Zones 1-8



Barracks

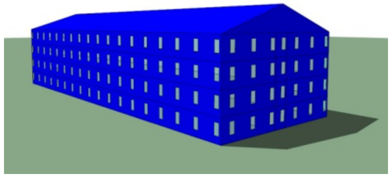


Office, Battalion HQ

Estonia, TTU

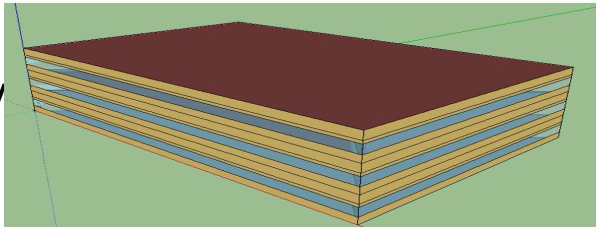
Public housing, Climate zone 6A

USA, ME Group



Dormitory, Climate zone 5B

UK, Reading University



Administrative Building,
Climate zone 4A

Building Models used by the Modeling Team

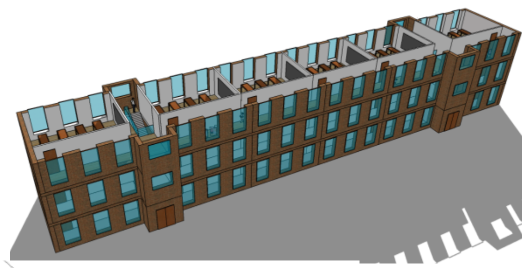
Germany, KEA
Germany, PHI

School Building, Climate Zone 5A

Austria, AEE

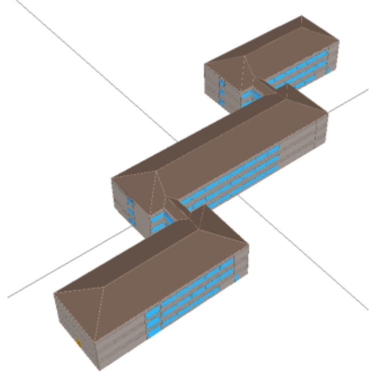
Public housing, Climate Zones 4A and 5A

Denmark, Danish Building Research Institute, SBi



School Building, Climate zone 5A

USA, NREL



Educational Building Complex, Zone 3C

USACE Recommendations for High Performance Buildings

Item	Unit	c.z. 1	c.z. 2	c.z. 3	c.z. 4	c.z. 5	c.z. 6	c.z. 7	c.z. 8
Roof, U-value	BTU/(h*ft²*ºF)	**0.029**	**0.025**	**0.022**	**0.022**	**0.02**	**0.0167**	**0.0154**	**0.0133**
Wall, U-value	BTU/(h*ft²*ºF)	**0.067**	**0.067**	**0.05**	**0.04**	**0.033**	**0.029**	**0.025**	**0.02**
Wall below grade, U-value	BTU/(h*ft²*ºF)	**0.2**	**0.1**	**0.10**	**0.067**	**0.067**	**0.05**	**0.04**	**0.028**
Floors over unconditioned space U-Value	BTU/(h*ft²*ºF)	**0.1**	**0.0416**	**0.0416**	**0.033**	**0.033**	**0.025**	**0.022**	**0.020**
Windows (assembly) thermal transmittance, U-Value	BTU/(h*ft²*ºF)	**<0.35**	**<0.35**	**<0.3**	**<0.3**	**<0.27**	**<0.24**	**<0.22**	**<0.18**
Windows, SHGC		**<0.25**	**<0.25**	**0.25**	**<0.3**	**<0.4**	**NR**	**NR**	**NR**

USACE Proposed Insulation Values Compared

Climate Zone	1A	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	6A	6B	7A	8A
Walls (in order from most to least stringent)															
Wall Insulation Passiv DER R-value	R-19+ R7.5ci	R-19+ R15ci	R-19+ R15ci	R-19+ R20ci	R-19+ R20ci	R-19+ R10ci	R-19+ R25ci	R-19+ R25ci	R-19+ R20ci	R-19+ R30ci	R-19+ R30ci	R-19+ R40ci	R-19+ R40ci	R-19+ R50ci	R-19+ R50ci
WBDG, Army specs—Steel-Framed Walls	R-13+ R7.5ci	R-13+ R7.5ci	R-13+ R7.5ci	R-13+ R7.5ci	R-13+ R7.5ci	R-13+ R7.5ci	R-13+ R7.5ci	R-13+ R12.5ci	R-13+ R12.5ci	R-13+ R12.5ci	R-13+ R12.5ci	R-13+ R18.8ci	R-13+ R18.8ci	R-13+ R18.8ci	R-13+ R18.8ci
90.1-2010 addenda bb—Steel-Framed Walls	R-13+ R7.5ci	R-13+ R7.5ci	R-13+ R7.5ci	R-13+ R7.5ci	R-13+ R7.5ci	R-13+ R7.5ci	R-13+ R10.0ci	R-13+ R10.0ci	R-13+ R10.0ci	R-13+ R10.0ci	R-13+ R10.0ci	R-13+ R10.0ci	R-13+ R10.0ci	R-13+ R10.0ci	R-13+ R10.0ci
189.1–2009—Steel-Framed Walls	R-13+ R5.0ci	R-13+ R5.0ci	R-13+ R5.0ci	R-13+ R5.0ci	R-13+ R5.0ci	R-13+ R5.0ci	R-13+ R10.0ci	R-13+ R10.0ci	R-13+ R10.0ci	R-13+ R10.0ci	R-13+ R10.0ci	R-13+ R10.0ci	R-13+ R10.0ci	R-13+ R10.0ci	R-13+ R10.0ci
ASHRAE AEDG—Steel-Framed Walls	R-13.0	R-13.0	R-13.0	R-13+ R3.8ci	R-13+ R3.8ci	R-13+ R3.8ci	R-13+ R7.5ci	R-13+ R7.5ci	R-13+ R7.5ci	R-13+ R7.5ci	R-13+ R7.5ci	R-13+ R7.5ci	R-13+ R7.5ci	R-13+ R7.5ci	R-13+ R21.6ci
90.1–2007—Steel-Framed Walls	R-13.0	R-13.0	R-13.0	R-13+ R3.8ci	R-13+ R3.8ci	R-13+ R3.8ci	R-13+ R7.5ci	R-13+ R7.5ci	R-13+ R7.5ci	R-13+ R7.5ci	R-13+ R7.5ci	R-13+ R7.5ci	R-13+ R7.5ci	R-13+ R7.5ci	R-13+ R7.5ci
Roofs (in order from most to least stringent)															
Roof Insulation Passi DER R-value	R-25	R-30	R-30	R-35	R-35	R-25	R-45	R-45	R-35	R-55	R-55	R-70	R-70	R-80	R-90
WBDG, Army specs—Roofs insulation above deck	R-25	R-25	R-25	R-25	R-25	R-25	R-30	R-30	R-30	R-30	R-30	R-40	R-40	R-40	R-40
90.1-2010 addenda bb—Roofs insulation above deck	R-20	R-25	R-25	R-25	R-25	R-25	R-30	R-30	R-30	R-30	R-30	R-30	R-30	R-35	R-35
189.1–2009—Roofs insulation above deck	R-20	R-25	R-25	R-25	R-25	R-25	R-25	R-25	R-25	R-25	R-25	R-30	R-30	R-35	R-35
ASHRAE AEDG—Roofs insulation above deck	R-15	R-20	R-20	R-20	R-20	R-20	R-20	R-20	R-20	R-20	R-20	R-20	R-20	R-20	R-20
90.1–2007—Roofs insulation above deck	R-15	R-15	R-15	R-20	R-20	R-20	R-20	R-20	R-20	R-20	R-20	R-20	R-20	R-20	R-30

Insulation level for different wall-types (Example for c.z. 5)

Item	Component	Recommendation	
		Assembly Max (2)	Min R-Value (2)
Roof	Insulation Entirely Above Deck	U-0.020	R-50ci
	Metal Building		R-13 + R-13 + R-34ci
	Vented Attic and Other		R-60
Walls	Mass	U-0.033	R-30ci
	Metal Building		R-19 + R-17ci
	Steel Framed		R-19 + R-20ci
	Wood Framed and Other		R-19 + R-14ci
	Below Grade/Basement	U-0.067	R-15ci
Floors Over Unconditioned Space	Mass	U-0.033	R-16 Spray Foam + R-11ci.
	Steel Joist		R-16 Spray Foam + R-13ci.
	Wood Framed and Other		R-19 + R-10ci.
Slab-on-Grade	Unheated	F-0.54	R-10 for 24 in.
	Heated	F-0.44	R-15 for 36 in. + R-5ci below

Windows

Parameter	c.z. 1	c.z. 2	c.z. 3	c.z. 4	c.z. 5	c.z. 6	c.z. 7	c.z. 1
Thermal transmittance, U-value, BTU/(h^{o}F ft^{2}	<0.35	<0.35	<0.30	<0.30	<0.27	<0.24	<0.22	<0.18
SHGC	<0.25	<0.25	<0.25	<0.30	<0.40	NR	NR	NR

Core Technology Bundle Compared

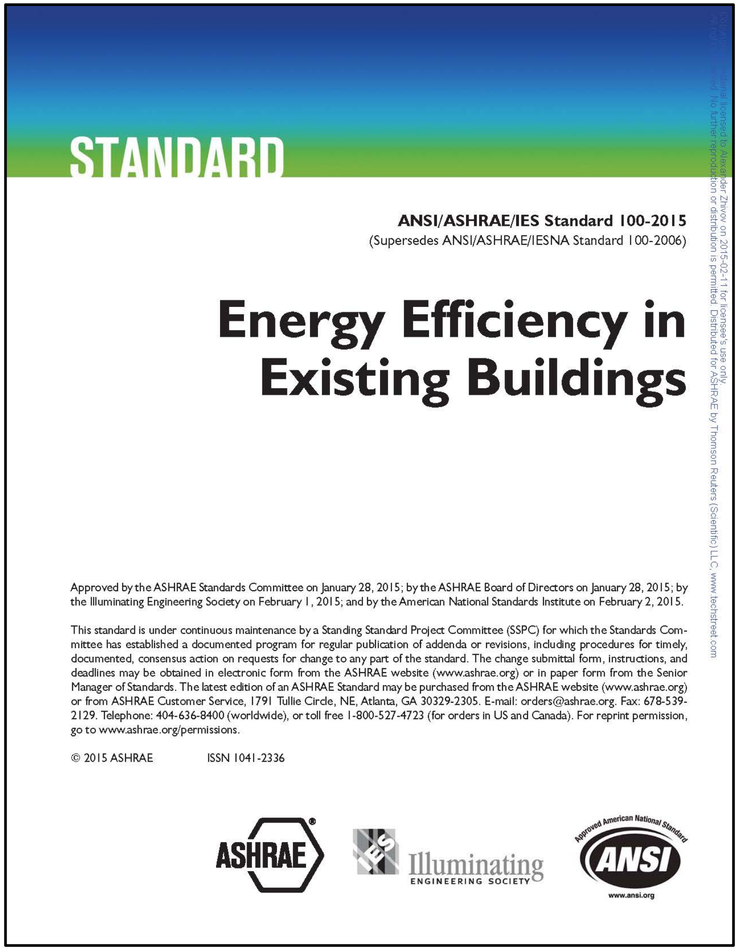
Passive House Institute

- Energy Target: heating < 15kWh/a (site energy), total < 120kWh/a ,
- Insulation levels for BE components < 0.15 $W/(m^2 K)$ – walls and roofs
- Window characteristics < 0.85 $W/(m^2 K)$
- BE air tightness < 0.6ACH @50Pa
- Thermal bridges mitigation
- HR from return air Eff > 75%
- Project component s certification
- Building post occupancy certification

DER

- Site energy Target: 50% from the baseline, but better then the minimum national standard
- Insulation levels for BE components by climate zone
- Window characteristics by climate zone
- BE air tightness (e.g., 0.15 cfm/ft2 @75Pa – USA)
- Thermal bridges mitigation
- DOAS
- HR from return air
- Duct air tightness and insulation levels (current national standards)
- Hot and cold water pipe insulation
- Lighting levels and LPD
- Project Delivery Quality Assurance

+ more than 400 other EEMs



STANDARD

ANSI/ASHRAE/IES Standard 100-2015
(Supersedes ANSI/ASHRAE/IESNA Standard 100-2006)

Energy Efficiency in Existing Buildings

Approved by the ASHRAE Standards Committee on January 28, 2015; by the ASHRAE Board of Directors on January 28, 2015; by the Illuminating Engineering Society on February 1, 2015; and by the American National Standards Institute on February 2, 2015.

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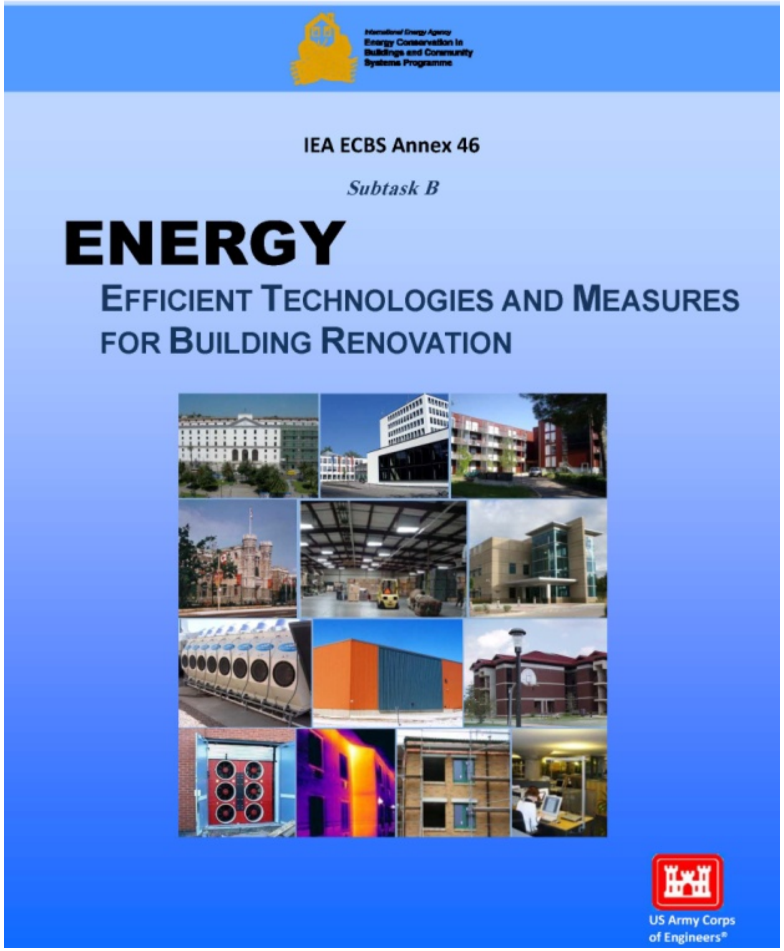

Annex 61 DER Guide - Outline

- **Introduction**
- **What is Deep Energy Retrofit**
- **Energy efficiency technologies and strategies**
- **Core technologies for DER**
- **Building Envelope**
  - Wall and roof cross-sections
  - Insulation types and levels for different climate conditions
  - Thermal Bridges
  - Window types and characteristics for different climate conditions
  - Air barrier requirements
  - Water and Vapor control for different climate conditions
- **Lighting systems**
- **HVAC systems : core requirements to energy efficiency of equipment, HR, ducts and pipes**

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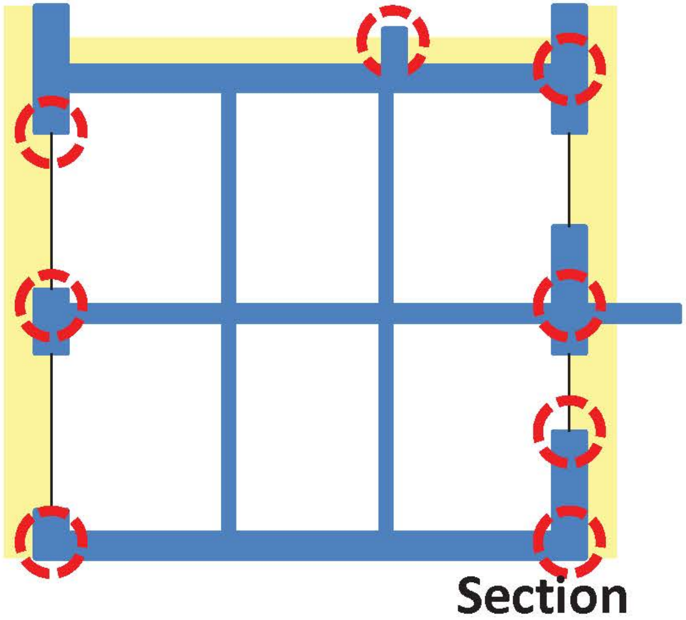
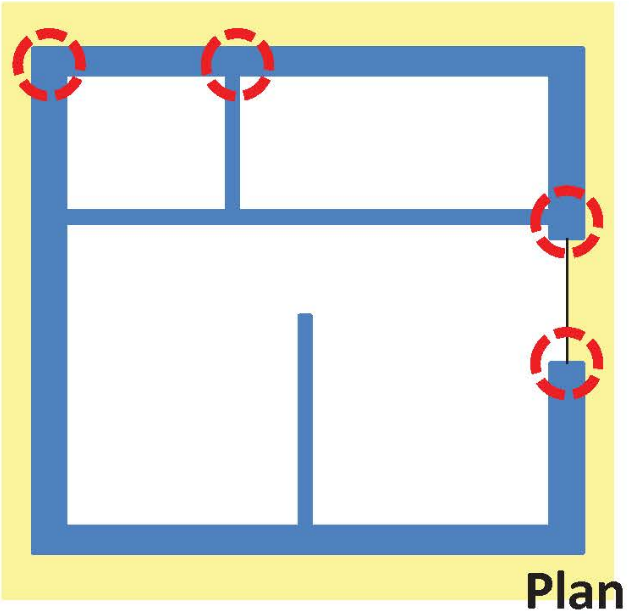
Thermal Bridges





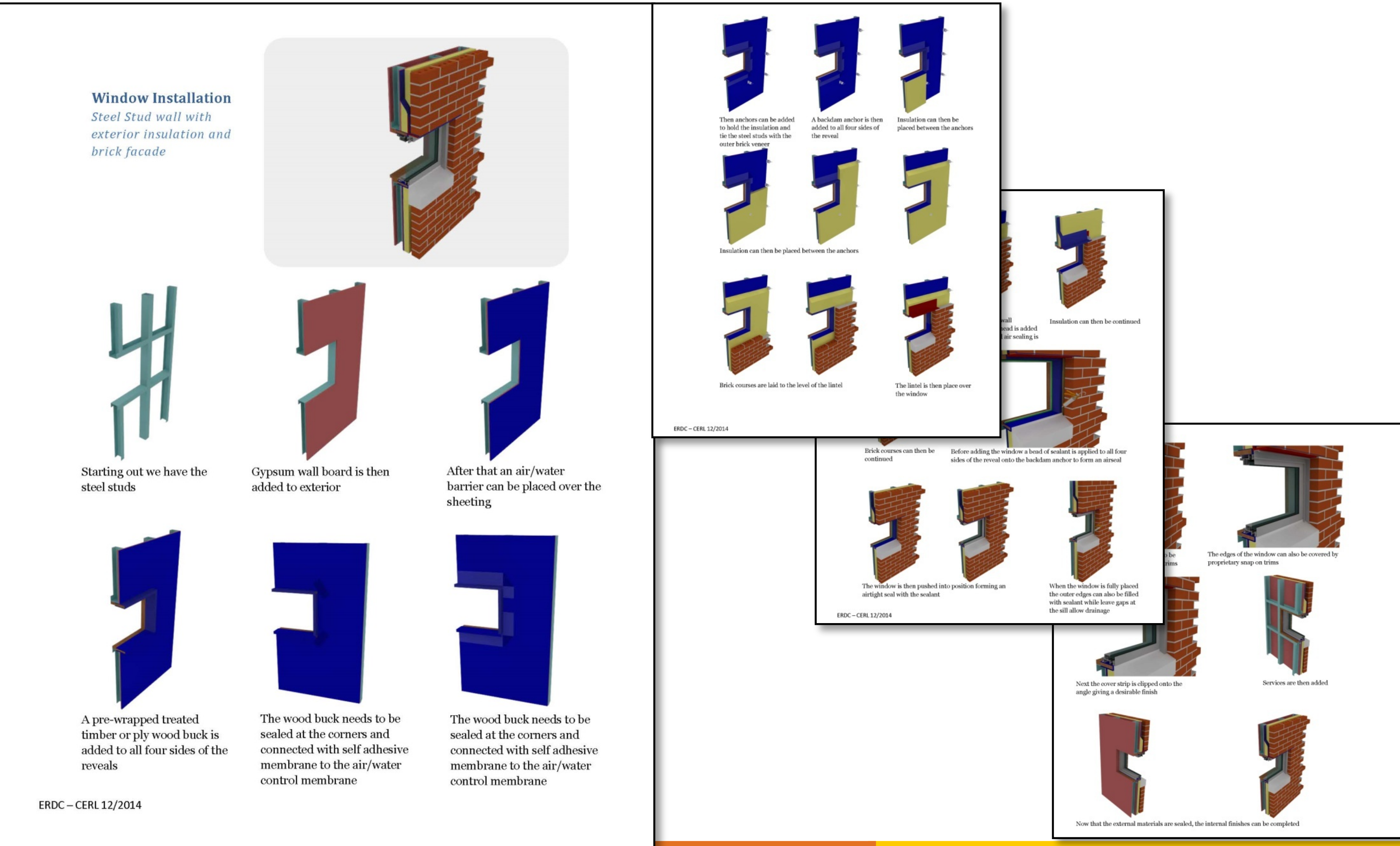
Details of Major Magnitude

1. At Eaves/Ridge
2. Window and Door Fitting – Head, Sill and Jamb
3. At Projections, Shades Or Intermediate Floors
4. Internal Walls to External Walls
5. Intermediate Floors
6. At Grade

Details of Minor Magnitude

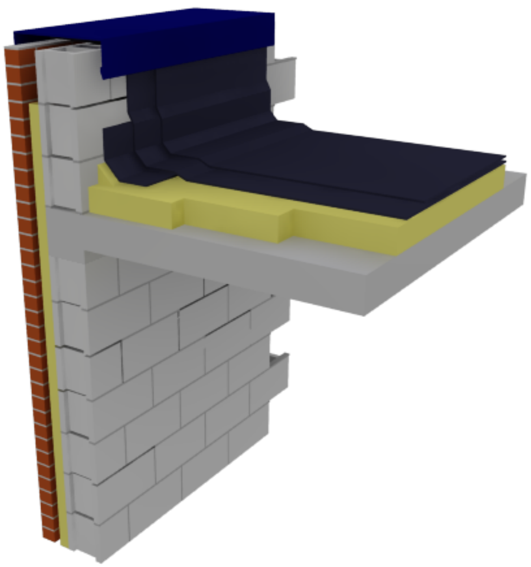
1. Wall Corner – Never Usually an Issue
2. Threshold or Door
3. Duct and Service Connections
4. Penetrations at Installations in Roof; PV or Water Tanks

Example of Window Replacement Sequencing (with improved insulation, air and thermal barriers)

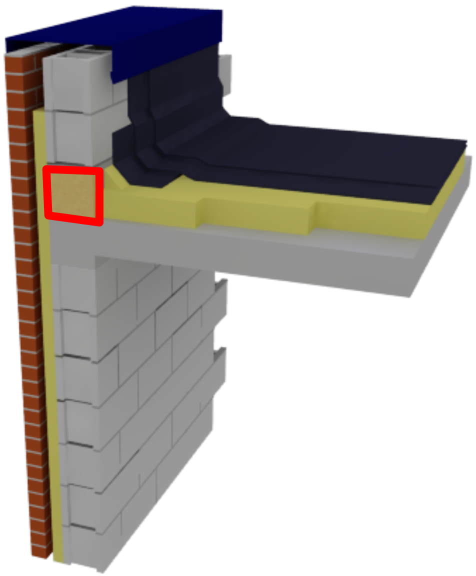


Thermal Bridge Mitigation

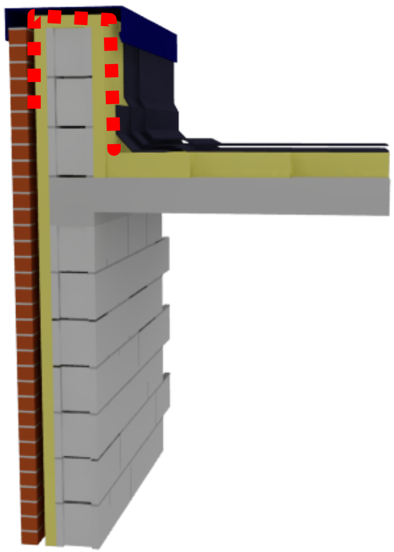
Typical detail poor thermal bridge



Insert thermal break



Wrap the parapet



Building Air Tightness

Country	Source	Requirement*	cfm/ ft^2 at 75Pa
Austria	OIB RL 6, 2011 for buildings with mechanical ventilation	1.5 1/h at 50 Pa	**0.28**
Germany	DIN 4108-2	1.5 1/h at 50 Pa	**0.28**
USA	ASHRAE Standard 90.1 - 2013 USACE ECB for all buildings [21]		**0.25**
USA	USACE HP Buildings and DER proposed requirement		**0.15**
UK	TS-1Commercial Tight	2 m^3/h/m^2 at 50 Pa	**0.14**
CAN	R-2000	1 sq in EqLA @10 Pa /100 sq ft	**0.13**
Germany	Passive House Std	0.6 1/h at 50 Pa	**0.11**

Based on four-story building, 120 x 110 ft, n=0.65.

Lighting – Improved Design and Technology

Lighting Design Guide for Low Energy Buildings – New and Retrofits

Improved Design
Reduced illuminance
Reduced electrical power

RECOMMENDED LIGHTING POWER DENSITY AND ILLUMINANCE VALUES

Space Type	Target Illuminance	Target LPD
Common Spaces		
- Conference Room	40 fc	0.80 W/ft^2
- Corridor	10 fc	0.50 W/ft2
- Dining	20 fc	0.60 W/ft2
- Dishwashing/ Tray Return	50 fc	0.65 W/ft2
- Kitchen/ Food Prep/ Drive Thru	50 fc	0.65 W/ft2
- Living Quarters	5-30 fc	0.60 W/ft2
- Mechanical/ Electrical	30 fc	0.70 W/ft2
- Office (Open)	30-50 fc	0.70 W/ft2
- Office (Enclosed)	30-50 fc	0.80 W/ft2
- Reception/Waiting	15-30 fc	0.50 W/ft2
- Restroom/ Shower	20 fc	0.80 W/ft2
- Server Room	30 fc	0.85 W/ft2
- Serving Area	50 fc	0.70 W/ft2
- Stair	10 fc	0.50 W/ft2
- Storage (general)	10 fc	0.50 W/ft2
- Storage (dry food)	10 fc	0.70 W/ft2
- Telecom / Siprnet	50 fc	1.20 W/ft2
- Vault	40 fc	0.70 W/ft2
Training		
- Readiness Bay	40 fc	0.75 W/ft2
- Training Room (Small)	15-30 fc	0.70 W/ft2
Vehicle Maintenance		
- Consolidated Bench Repair	50 fc	0.60 W/ft2
- Repair Bay/ Vehicle Corridor	50 fc	0.85 W/ft2

Advanced HVAC Systems

- Dedicated outdoor air system (DOAS)
- Heating and Cooling equipment per current national standard (e.g., ASHRAE 90.1-2013)
- Heat recovery (sensible and latent) > 80% efficiency
- Duct air tightness – class C
- Hot and chilled water pipes insulation per current national standard

Quality Assurance Includes

- Detailed technical specification, against which tenders will be made, and verification of understanding of these specifications by potential contractors,
- Specification in SOW/OPR of areas of major concern to be addressed and checked during the bid selection, design, construction, commissioning and post-occupancy phases;
- Clear delineation of the responsibilities and qualifications of stakeholders in this process.

Allowable (Cost Effective) Budget Increase for DER

ΔC = NPV *ΔFirst Cost ($) + NPV *ΔMaintenance ($) +
+ NPV *Replacement ($) + NPV *Δ Energy ($).

$$NPV = \frac{(1+i)^N - 1}{i \cdot (1+i)^N}$$

NPV = Net Present Value function
N = study life in years
i = interest or discount rate

$$\Delta \text{First Cost}_{\text{budget}} = \text{SR}_{\text{energy}} \cdot (\Delta \text{Energy Cost}_{\text{annual}}) + \text{SR}_{\text{maint}} \cdot (\Delta \text{Maintenance})$$

Examples of SR or selected economic project life, interest, discount and escalation rates.

	Interest	Discount	Escalation	5	10	15	20	25	30	35	40	45	50
			Economic Life (yrs)	5	10	15	20	25	30	35	40	45	50
1	0%	0%	0%	5.0	10.0	15.0	20.0	25.0	30.0	35.0	40.0	45.0	50.0
2	6%	0%	0%	4.2	7.4	9.7	11.5	12.8	13.8	14.5	15.0	15.5	15.8
3	6%	0%	3%	4.6	8.7	12.4	15.9	19.2	22.5	25.8	29.2	32.8	36.6
4	6%	0%	6%	5.0	10.3	16.0	22.4	29.7	38.5	48.9	61.7	77.5	97.0
5	6%	2%	0%	4.2	7.4	9.7	11.5	12.8	13.8	14.5	15.0	15.5	15.8
6	6%	2%	3%	4.6	8.6	12.3	15.6	18.6	21.5	24.3	27.0	29.8	32.5
7	6%	2%	6%	5.0	10.2	15.6	21.5	28.0	35.4	43.7	53.3	64.5	77.7
8	6%	4%	0%	4.2	7.4	9.7	11.5	12.8	13.8	14.5	15.0	15.5	15.8
9	6%	4%	3%	4.6	8.6	12.1	15.3	18.1	20.6	23.0	25.1	27.1	29.0
10	6%	4%	6%	5.0	10.1	15.3	20.7	26.5	32.5	39.0	46.0	53.6	61.9
11	6%	6%	0%	4.2	7.4	9.7	11.5	12.8	13.8	14.5	15.0	15.5	15.8
12	6%	6%	3%	4.6	8.6	12.0	15.0	17.6	19.8	21.8	23.4	24.9	26.2
13	6%	6%	6%	5.0	10.0	15.0	20.0	25.0	30.0	35.0	40.0	45.0	50.0
14	6%	8%	0%	4.2	7.4	9.7	11.5	12.8	13.8	14.5	15.0	15.5	15.8
15	6%	8%	3%	4.6	8.5	11.9	14.7	17.1	19.1	20.7	22.1	23.2	24.1
16	6%	8%	6%	5.0	9.9	14.7	19.3	23.7	27.8	31.7	35.2	38.5	41.5

Questions, comments??