Annex 61 Business and Technical Concepts for Deep Energy Retrofits of Public Buildings

Advanced Business and Financial Models for Deep Energy Retrofit (DER) - Introduction

Rüdiger Lohse, co- operating agent Annex 61

Sponsored by the Federal Facilities Council of the National Academies of Sciences, Engineering, and Medicine

In partnership with:

International Energy Agency Secure Sustainable Together

EBC Energy in Buildings and Communities Programme

US Army Corps of Engineers

ASHRAE

U.S. DEPARTMENT OF ENERGY

GSA

September 15-16, 2016
Washington, DC

Most Prevalent barriers for a DER strategy

Lack of performance DATA!!

- **Financial:**
  - to comply with EU 2020 targets values € 60- 100 bn/yr which is at least 3 times of the budget spent in recent years
  - Investment needs will not be attained by "the market" but by combined public funds an other drivers (EEFIG Report)
  - DER and other EE measures are not "investor ready"
  - Business as usual is mostly "salami attacking" picking the low- hanging fruits first

Business Model:
  - Existing "owner directed" business model create split incentives and do not support energy and life- cycle cost efficiency, savings and other benefits are not bankable (no guarantee)
  - ESCOs leave their "normal scope" and enter into unknown risks
  - EPCs usually consider only energy savings, not capital, maintenance savings

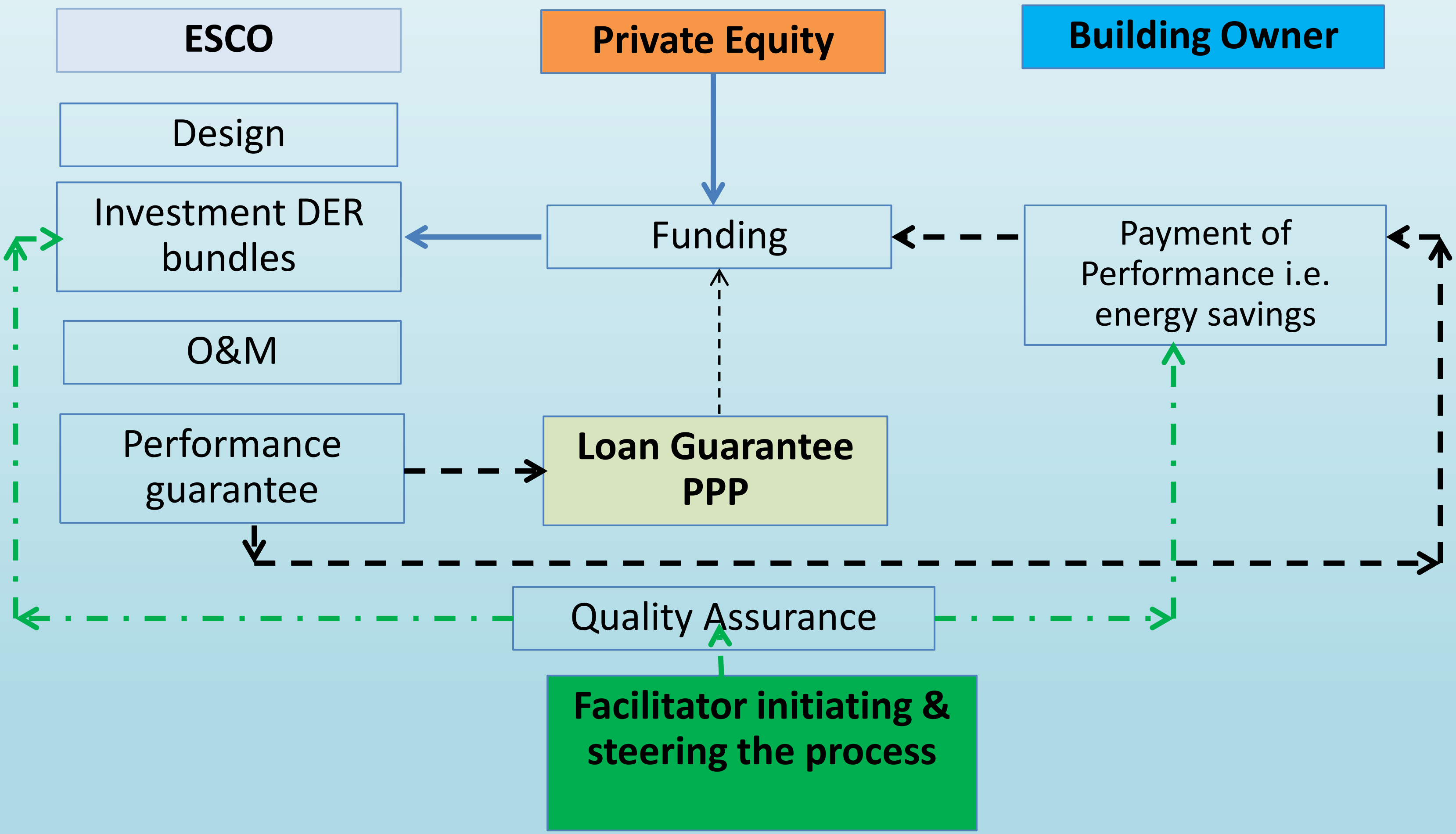
Lack of technical knowledge:
  - While components are well known the bundling and optimization of bundling still needs strong support from r&d

Why business models for DER?

- Business models to carry out DER are necessary….
  - DER demands for more funding (300- 500 €/m²) than the minimum requirements from National building codes
  - With limited financial resources in the public sector funding creates a severe impediment ➔ Business models can contribute to enhance financial capabilities off- balance
  - Business models must incorporate **energy and non- energy life cycle cost (LLC) benefits** such as maintenance etc
  - Business model must target **bankability of the benefits** created by DER (which is currently not the case- nobody in financing cares what your modeling engineer is promising in terms of energy savings) ➔ ***guaranteed savings***
  - Business models will have to integrate **technical and business quality assurance** mechanisms to create the necessary assurance for accountabilty- ***Investor´s Confidence Project*** in the US is providing an useful framework
  - Business models must **integrate private capital to existing funding**- „ from deep retrofit to deep energy retrofit“- buy in ESCO money to carry out the energy related measures➔ issues in combined DR and DER projects in the US- how to overcome those

Business Models for DER: advanced EPC

- **Develop of advanced business model** allocating investments and services between building owner and ESCos, development of financing mechanism by accounting and securing life- cycle costs and benefits ***(table shows new advanced business model for SMESCos in Germany)***



The DER Business Model Guide

- Which are the most prevalent barriers ?
  - Market, legal
- Existing Financial and Business Models
  - How are we implementing DER and EE project today?
  - How are liabilities, risks, revenues and investments allocated?
- Economics of DER projects
  - Cash flow based economics of DER projects
  - Least cost planning path approaches to optimize investment costs
  - How to leverage non- energy related + bankable benefits
  - Design strategies to increase cost effectiveness of DER
- Funding of DER projects
  - Basic and advanced financing models
  - Off- and on balance- EPC going capex=opex pathway
  - Refunding of ESCOs- requirements to projects
- Advanced DER EPC

Draft available for review by November 2016

Today´s Topics and Targets

Policy prospective: How to integrate ambitious DER in the policy framework

- Policies to Energy Efficiency in the building stock
- Future energy efficiency financing models in the US Federal sector

Prospective of major Federal Real Estate agencies: from policies to projects-experiences and way ahead

- Legal Perspectives of Energy Performance Contracting in the Public sector
- About Business Models used by GSA and the US Army

Prospective of Financiers: what is needed to make a project bankable

- Challenges of financing energy performance upgrades
- Standardization of EE investment processes
- Leveraging the real value of DERs
- Experiences form investing in EE in buildings

Panel discussion with ESCO, financier, technical, user and Federal government prospective:

- Major obstacles to increase number and pace in the public sector
- Which role is seen for private investors
- How to improve cost effectiveness of DER

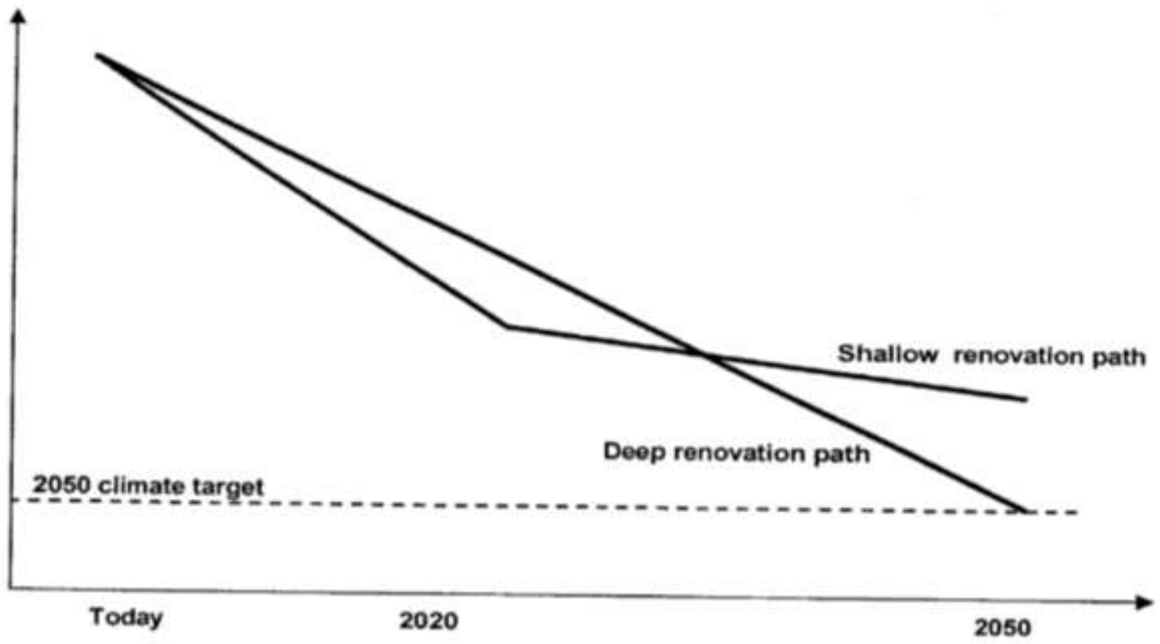
Questions, comments??

Ruediger.Lohse@kea-bw.de

Why?

- 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% of the total buildings floor area p.a., USA: 3% p.a. site energy reduction compared to CBECS 2003 through 2015 and 2.5% between 2015 and 2025)

How to Meet Energy Goals?

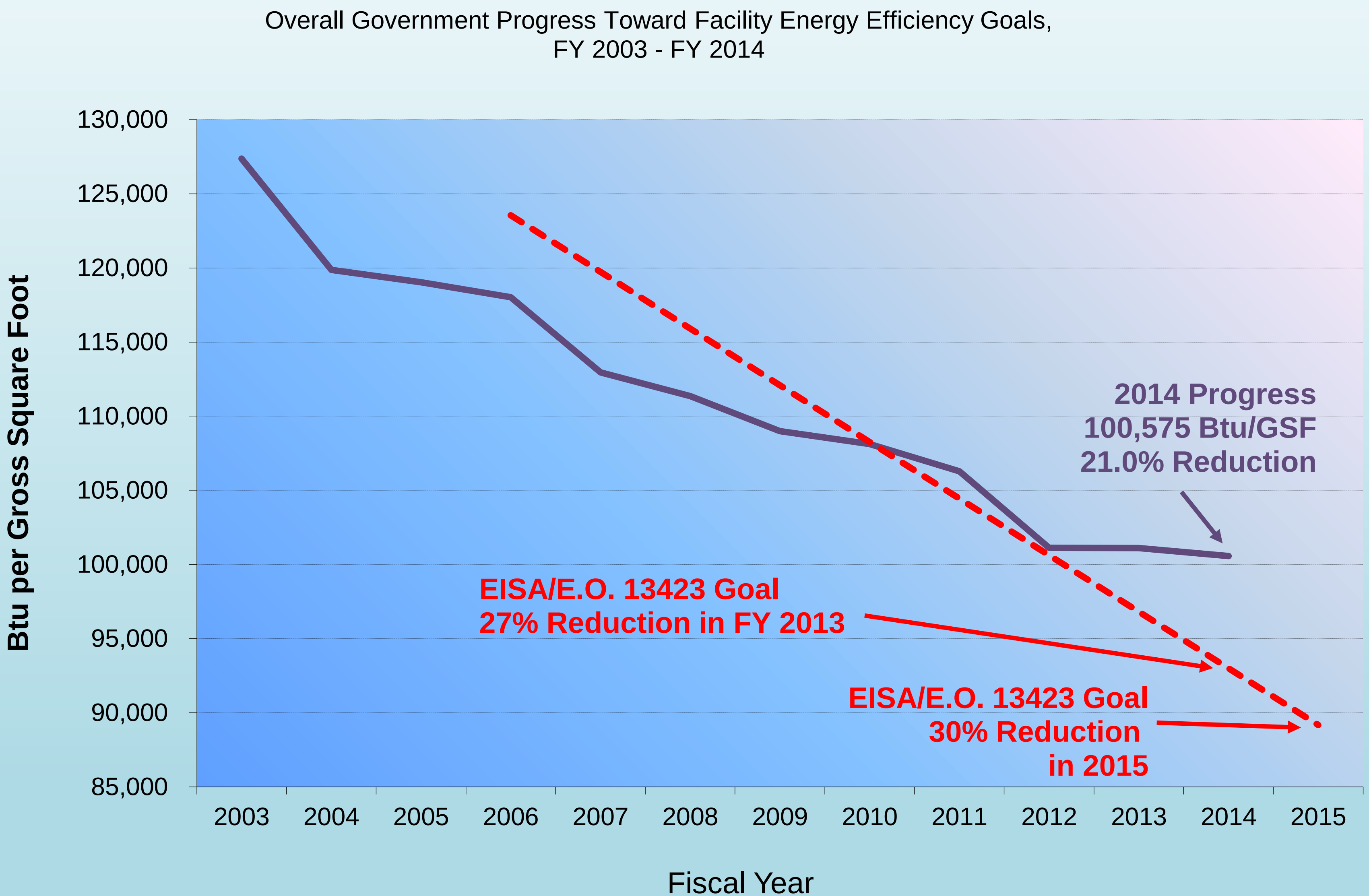


The speed trap of shallow renovation (from "Economics of Deep Renovation," *Ecofys* 2011

Spending available annual budgets for many cheaper shallow renovations Vs fewer, more expansive deep energy renovations may lead to unwanted, irreversible long-term consequences.

Looks better for short-term decisions, but may well fail to achieve long-term energy goals.

U.S. Federal Facilities: Energy Intensity (Btu/GSF) Reduction Vs. Goal



PRELIMINARY DATA

Major Renovation: Business as Usual

Examples of calculated % of energy use reduction (including plug-loads) 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**%

Annex 61 Business and Technical Concepts for Deep Energy Retrofits of Public Buildings

www.iea-annex61.org

Annex 61 Objectives

- To provide a framework and selected tools and guidelines to significantly reduce energy use (by more than 50%) in *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 buildings* using appropriate combinations of public and private funding

Annex 61 team

- **Austria** – AEE
- **Belgium** – Factor 4
- **China** - Chongqing University
- **Denmark**:
  - Danish Building Research Institute, Aalborg University Copenhagen
  - Cenergia Energy Consultants
- **Estonia:**
  - Tallinn University of Technology
  - University of Tartu
- **Finland** – VTT
- **Germany:**
  - KEA
  - Institute for Housing and Environment
  - PHI
  - Energetic Solutions
- **Ireland** – PHA
- **Latvia** - Riga Technical University
- **The Netherlands** – KAW
- **UK**
  - Reading University
  - SPIE
- **USA**
  - US Army (ERDC/CERL, USACE, POM AG)
  - DOE FEMP
  - GSA
  - RMI
  - NBI
  - ME Group
  - Honeywell International
  - Morrison Hershfield
  - Anis Building Enclosure Consulting
  - Camroden

Annex 61 Structure, Objectives and Deliverables

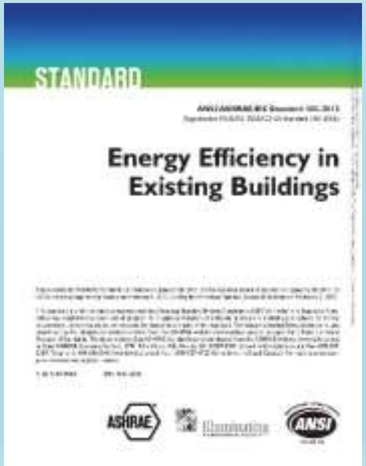
Operating Agents: Dr. Alexander Zhivov (USA) and Mr Rüdiger Lohse (DE)		
Subtasks	**Objectives**	**Deliverables**
Subtask A Co-leads: Dr. Ove Mørck, DK Dr. A. Zhivov, USA	Prepare and evaluate case studies of existing DER concepts. Develop a guide for achieving financially attractive DERs of buildings and building communities.	***DER – Case Studies*** ***DER – Technical Guide***
Subtask B Co-leads: Mr. Rüdiger Lohse, DE Mr. John Shonder, USA Mr. Cyrus Nasseri, USA	Develop business models for DER/refurbishment of buildings and building groups using combined government/public and private funding	***DER – Business and Financial Guide***
Subtask C Leader: Mr. Cyrus Nasseri, USA	Demonstrate Selected Deep Energy Retrofit Concepts using combined government/public and private funding, and prepare case studies.	***DER – Report on Case Studies***
Subtask D Co-leads: Mr. Rüdiger Lohse, DE Mr. Heimo Staller, AT	Develop an IT-tool for Decision Makers and ESCOs	***Web-based IT-tool kit***

Annex 61 Scope

- Buildings with low internal loads (e.g., offices, barracks, dormitories, public housing, educational buildings, **undergoing MAJOR RENOVATIONS**
- Historic/listed buildings **are excluded**
- Buildings with high internal loads (e.g., dining facilities, hospitals, data centers) **are excluded**

USA

- **UFC 1-200-02** “High Performance and Sustainable Buildings: For new construction and major renovation Energy Efficiency requirement is to perform 30% better than ASHRAE 90.1-2007. Army gives an option to alternatively do 12% better than 90.1-2010
- **ASHRAE Standard 90.1 Scope**: ….new portions of the building (existing), new systems and equipment in existing building**…doesn’t apply to major renovation** of existing buildings.
- Major renovation **is not a part of the 10 CFR 433** “ENERGY EFFICIENCY STANDARDS FOR NEW FEDERAL COMMERCIAL AND MULTI-FAMILY HIGH-RISE RESIDENTIAL BUILDINGS”
- New ASHRAE Standard 100-2015: EUI targets for 53 building categories, are based on top 25% of the exiting building stock per CBECS 2003.



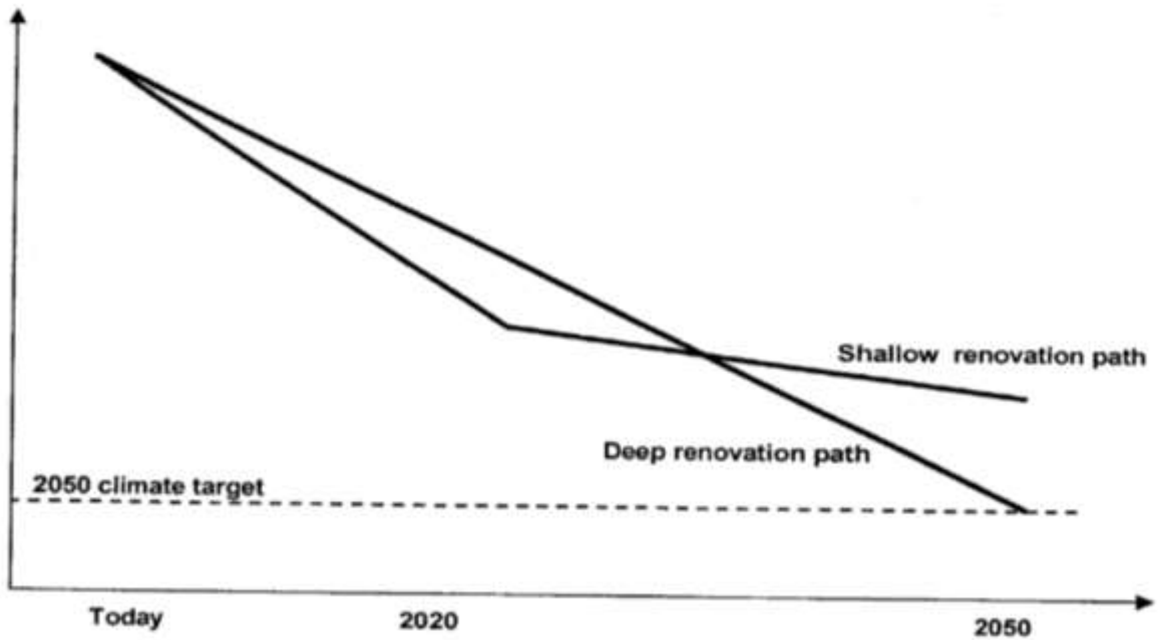
EU Energy Performance of Buildings Directive (EPBD 2010)

- Member States shall develop policies to stimulate the transformation of buildings to be <u>refurbished to a nearly zero-energy condition.</u>
- A nearly zero-energy building is defined as "*a building that has a very high energy performance. ….*"
- 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."

Deep Vs Shallow Energy Retrofit

- Typical Energy Efficiency Improvement Projects are planned as:
  - A part of major building renovation*
  - A part of minor building renovation
  - Utilities modernization projects
  - Mechanical and electrical equipment/systems replacement
  - System retro commissioning: 10-20% energy savings
  - Dedicated energy projects using ESPC or UESC contracts: ~ 20-40% energy savings

How to Meet Energy Goals?

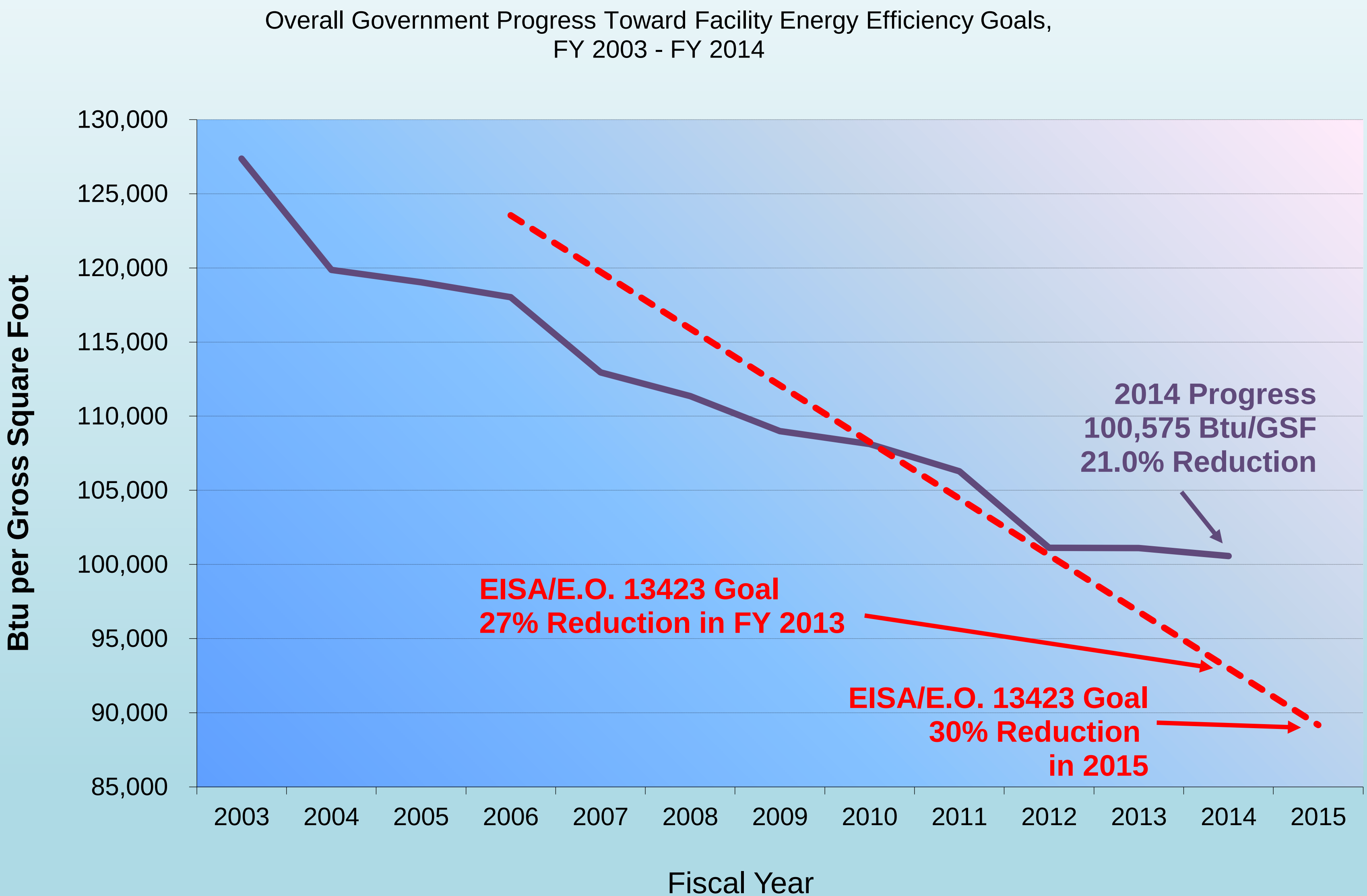


The speed trap of shallow renovation (from "Economics of Deep Renovation," *Ecofys* 2011

Spending available annual budgets for many cheaper shallow renovations Vs fewer, more expansive deep energy renovations may lead to unwanted, irreversible long-term consequences.

Looks better for short-term decisions, but may well fail to achieve long-term energy goals.

U.S. Federal Facilities: Energy Intensity (Btu/GSF) Reduction Vs. Goal



PRELIMINARY DATA

Major Renovation: Business as Usual

Examples of calculated % of energy use reduction (including plug-loads) 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**%

Major Renovation and Deep Energy Retrofit

Most common reasons for major renovations:

- Extension of the useful life requiring overhaul of its structure, internal partitions, and systems
- Repurposing of the building
- Bringing the building to new or updated codes
- Remediation of environmental problems (mold and mildew), improvement of the visual or thermal comfort, or indoor air quality
- Adding to the value with improvements to increase investment (increasing useful space and/or space attractiveness/quality) resulting in a higher sale or lease price.

Timing a DER to coincide with a major renovation is best:

- Building is typically evacuated and gutted;
- Scaffolding is installed;
- Single pane and damaged windows are scheduled for replacement;
- Building envelope insulation is replaced and/or upgraded;
- Most of mechanical, electrical lighting, and energy conversion systems will be replaced
- ***A significant sum of money covering the cost of energy-related scope of the renovation designed to meet minimum energy code is already budgeted anyway.***

Definition of DER

Annex 61 team has collected and documented 26 case studies from Austria, Denmark, Estonia, Germany, Ireland, Montenegro, The Netherlands and the USA in which site energy has been reduced by 50% or better.

Based on anaysis of trends in policies from around the world and best practices including those, documented in case-studies, IEA EBC Annex 61 team has proposed the following definition of the Deep Energy Retrofit:

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

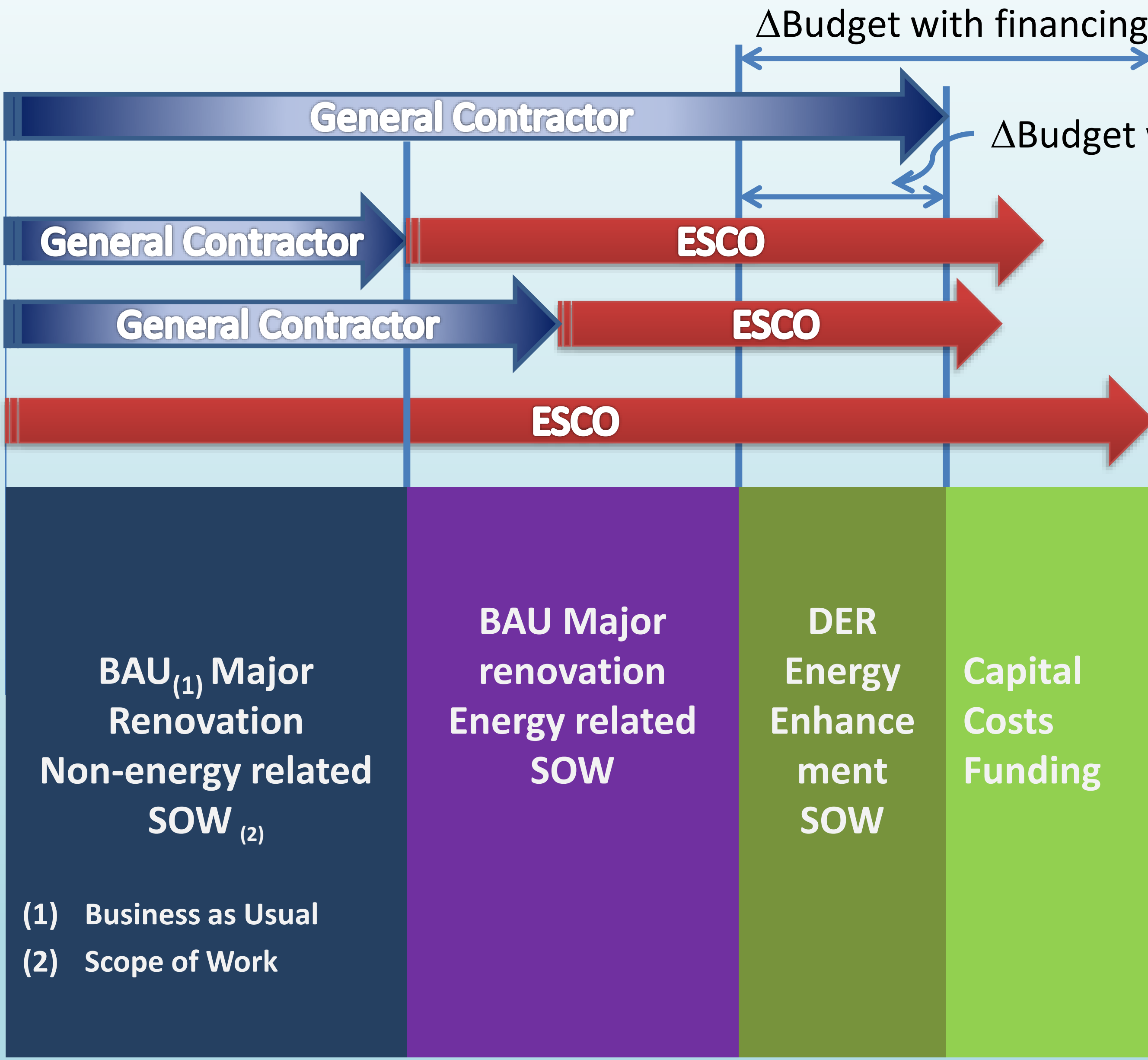
“Core Technologies” Bundle for DER

Category	Name	Source for characteristics
Building Envelope	Roof insulation	Modeling Results
	Wall insulation	Modeling Results
	Slab Insulation	Modeling Results
	Windows	Modeling Results
	Doors	National the most stringent requirements
	Thermal bridges remediation	DER Guide based on best practices
	Air tightness	National the most stringent requirements
	Vapor Barrier	DER Guide based on best practices
	Building Envelope Quality Assurance	DER Guide based on best practices
Lighting and Electrical Systems	Lighting design , technologies and controls	DER Guide based on best practices
HVAC	High performance motors, fans, furnaces, chillers, boilers, etc	National the most stringent requirements
	DOAS	DER Guide based on best practices
	HR (dry and wet)	National the most stringent requirements
	Duct insulation	National the most stringent requirements
	Duct airtightness	National the most stringent requirements
	Pipe insulation	National the most stringent requirements

DER Technical Guide Objectives

- Provide guidance on **core technologies bundle** for DER focusing on building envelope ECMs, lighting systems, HVAC systems efficiency
- **Technology Characteristics** (e.g., U-values, building and duct air tightness, illumination levels and LPD, etc.)
- **Critical design, construction requirements and recommendations** (how-to and how-not-to)
- **Important architectural details and pictures** for
  - Wall cross-sections
  - BE elements connections
  - Continuous air barrier
  - Vapor Control
  - Thermal bridge remediation
- **Outline Quality Assurance Process**
- **How to make DER Economics work?**

DER Implementation Strategies



This graph shows in which way private funding provided by an ESCO may extend the capacity of limited public funds.

Maximum (Cost Effective) Budget Increase for DER

$$\Delta \text{ Budget}_{max} = \text{NPV} [\Delta \text{ Energy (\$)}] + \text{NPV} [\Delta\text{Maintenance (\$)}] + \text{NPV} [\Delta\text{Replacement Cost (\$)}] + \text{NPV} [\Delta\text{Lease Revenues (\$)}]$$

$$\Delta \text{ Budget}_{max} = SR_E [\Delta \text{ Energy (\$)}] + S_M [\Delta\text{Maintenance}] + S_L [\Delta\text{Lease Revenues}]$$

$$\text{NPV} [\Delta G \times C_G] = [\Delta G]_{t=1} \times C_{G(t=1)} \times (1+e)/d-e) \times [1- (1+e)/1+d)]^N = [\Delta G]_{t=1} \times C_{G(t=1)} S_E$$

S_M and S_L scalars can be calculated and are the uniform present worth factor series that use the discount rate, the same way as SR_E with the escalation rate e=0%.

NPV = Net Present Value function
N = study life in years
d = discount rate
e = escalation rate

Conclusions

- To meet long term energy goals, major renovation of buildings must be combined with DER, targeting at least 50% of building site energy use reduction.
- This reduction in energy use can be achieved by implementing a limited number of market-ready core technologies bundled together.
- The key to making a DER cost effective is to time the retrofit as part of a major building renovation that already has allocated funds including those required to meet minimum energy requirements.
- The proposed method of LCC analysis of DER is based on assumption that allowable budget increase for DER implementation Vs typical major renovation project (meeting minimum legal requirements), shall be based on operational savings (energy, maintenance), mechanical equipment replacement savings AND an increased building value or increased revenue stream from the renovated building.
- When DER is cost effective, additional funding can become available either from the government or public funds or from the private funding sources (using Energy Savings Performance Contract [ESPC] or Utility Energy Service Contract (UESC) models).

Questions?

Alexander Zhivov

Alexander.M.Zhivov@usace.army.mil

Rüdiger Lohse

ruediger.lohse@kea-bw.de