Energy Efficiency and Energy Independence

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Kiev, Ukraine
March 23

There are different reasons why countries care about energy efficiency?

- Energy cost
- Energy security
- Independence from fossil fuel imports
- The effects of global climate change

Whatever the drivers are, they stimulate many countries and their communities to set ambitious goals to reduce energy use and to increase the relative amount of energy derived from renewable energy sources.

Setting Energy Goals in an Energy Master Plan

- Clearly define long- and short-term energy goals, as well as important limitations and other priorities, e.g., energy efficiency, energy supply security, peak power loads, carbon footprint, water availability and conservation goals, etc.
- When setting energy goals, it is important to deferenciate between site and primary energy, since this defines technical approaches to be used

Examples of Possible Energy Goals for Ukraine

- Long-term energy goals:
  - by **2020 energy independance from fossil fuel** based energy imports;
  - **site energy use reduction** in national (community) building stock by **30% by 2025** compared to 2012,
  - **increase energy use from renewable energy** sources to 10% in the overall energy mix by 2025 .
- Short-term energy goals:
  - reduce site energy use in existing building stock **by 10% by the next heating season;**
  - reduce energy waste with electricity generation by 5% by the end of 2015.

Some important areas for improvement in the building stock

- <u>Short-term projects:</u>
  - **Existing building stock winterization** (air leakage remediation, install entrance vestibules, install thermostats on radiators) – less than 6 months simple payback
  - **HVAC systems and controls commissioning** – less than a year simple payback
  - Containerized reciprocal engine co-generation units plugged-in existing district heating networks
  - Lighting systems retrofit: fixtures and controls – 2-3 years simple payback

Some important areas in building stock(Cont)

- Mid-term projects:
  - Conduct energy audits of buildings with a significant energy use and implement projects including bundles of technologies with a payback under 5 years; **IEA Annex 46 provides case studies and guidelines for e- audits**
- Long-term projects:
  - Regional, City-wide and building cluster energy master planning to coordinate energy conversion, distribution and energy end use; **IEA Annex 51 Guideline**
  - Setting building type specific requirement for **Deep Energy Retrofit of buildings undergoing major renovation (>50% site energy use reduction)**
  - **Setting stringent requirements** for source and primary energy use with new construction.

Major Renovation of Building Stock

- Set up Deep Energy Retrofit strategy for the building stock:
- Research in A 61 shows that in the building stock for each building type and climate zone a cost- optimum bundle of energy conservation measures and energy supply measures can be defined
- **These cost- optimized bundles achieve > 50% and up to 80% energy savings in the cost- optimum**
- Partly renovations are spoiling opportunities within 20- 30 years building life cycle period
- By setting up the refurbishment strategy for the building stock the cost- optimum level has to be used as a minimum requirement – best practice examples of such strategies are to be found in DK, Estonia and in new ASHRAE standard 100 .

IEA-EBC Annex 61: International collaboration to establish “Business and Technical Concepts for Deep Energy Retrofit of Public Buildings”

Ukraine is welcome to join – Next experts meeting is in Reading, UK on April 13-15

Some Examples of Deep Energy Retrofit Projects

Residential buildings renovation: 75% energy use reduction
Karlsruhe (Germany)

Residential building renovation:
78% energy use reduction
Freiburg (Germany)

Barracks renovation: 45% energy use reduction, Ft Polk (USA)

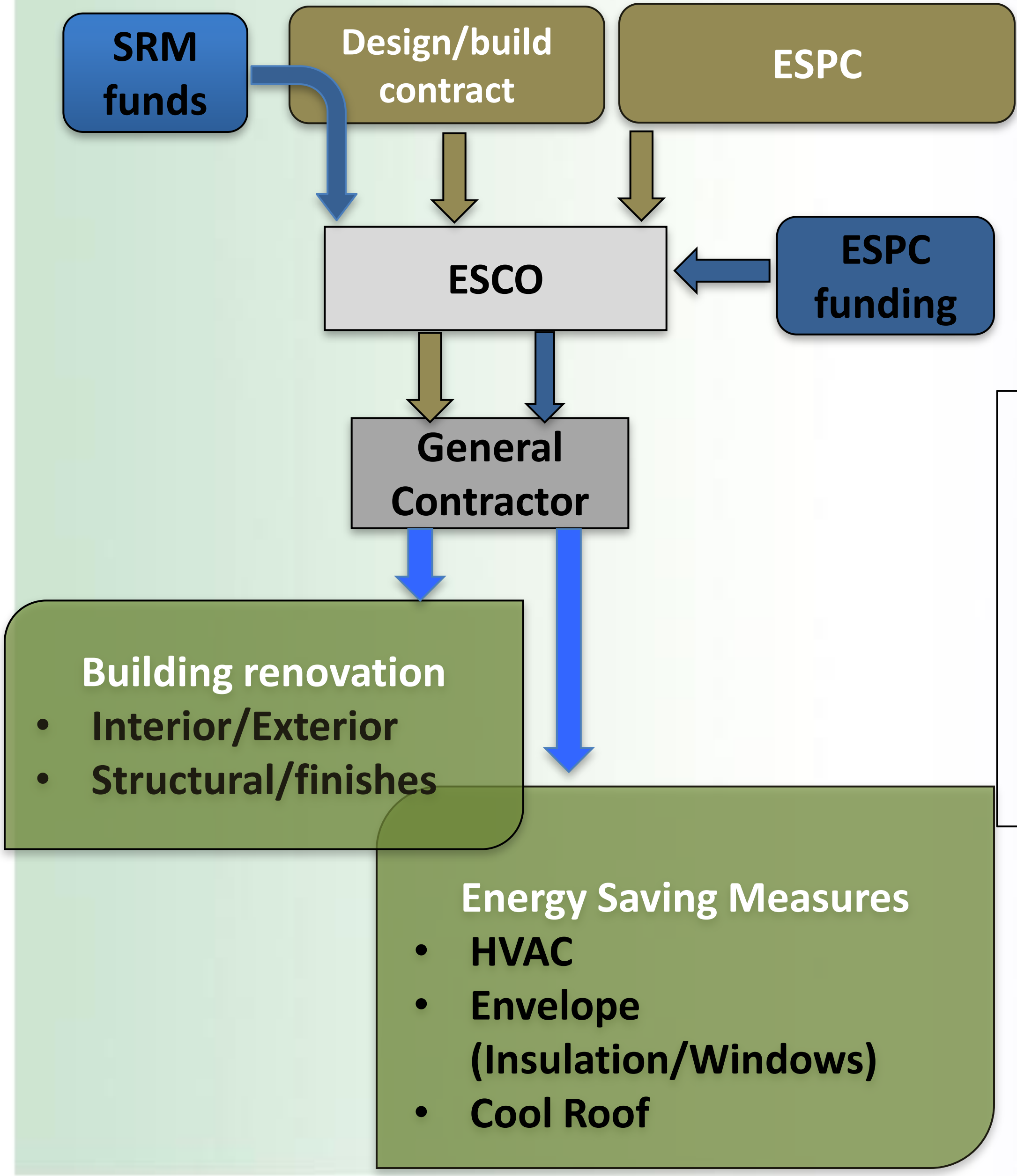
U.S. Buildings with Energy Use Reduced by More than 50% from Pre-Renovation Baseline (NBI, GSA)

Name	Location	Building Type	Size (m^2)	% Over Baseline	Baseline	Measured or Estimated	Project Completion
Home on the Range	Billings, MT	Office	747	79%	ASHRAE 90.1-1999	Measured	2006
Pringle,Creek Painter's Hall	Salem, OR	Office, Assembly	324	68%	Other	Measured	2009
Jefferson Place	Boise, ID	Office, Retail	6750	60%	Pre-data	Estimated	Still in design
King Street Station	Seattle, WA	Transportation	5400	56%	ASHRAE 90.1-2007	Estimated	2010
St. Als RMC South Tower	Boise, ID	Health Care	37080	56%	CBECS	Estimated	Still in design
Johnson Braund Design Group	Seattle, WA	Office	720	51%	Other	Measured	Ongoing
Wayne N. Aspinall Federal Building	Grand Junction, CO	Office, Court House	436	65%	Pre-renovation	Measured	Completed

Bundle of core technologies 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 QA
Lighting and Electrical Systems	Lighting design and efficient technologies and controls, efficient motors, VFD drives
HVAC	High performance fans, furnaces, chillers, boilers, etc.
	DOAS
	HR (dry and wet)
	Duct insulation
	Duct air tightness
	Pipe insulation

Example of Private-Public sector funding model for DER



- ESCO is awarded design/build contract for non-energy-related building renovation, and ESPC for energy-related measures
- ESCO hires a GC, but provides single point of contact for Army

Recommendations

- Decision makers shall **establish specific long- and short-term specific energy goals**: national, regional and local (city-level)
- **Develop an advisory team comprised of national and international energy experts** to establish short term energy projects and long-term energy policy drafts (develop national or temporarily adopt the most relevant international energy standards and guidelines)
- **Conduct energy forum(s) to coordinate technical and financial support from all stakeholders**
- **Involve Ukrainian researchers, engineers, energy planners and other practitioners in IEA Research Programs** (EBC, DHC, SHC, etc) and specific projects, (i.e. EBC Annex 61)

Questions, Comments, Want to be a part of the TEAM?

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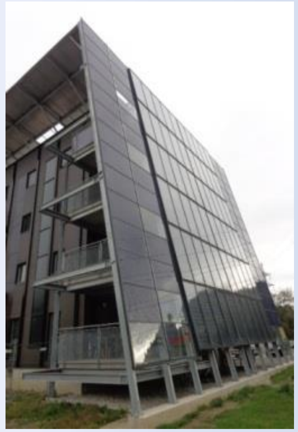
Back-up slides

Selected references

- Zhivov, A., M. Case, R. Liesen, J. Kimman, and W. Broers. 2014. Energy master planning towards net-zero energy communities/campuses. ASHRAE Transactions. Vol. 119(1).
- Zhivov, A.M., R. Lohse, J. Shonder, C. Nasseri, H. Staller, O. Moerck, and M. Nokkala. 2015. Business and Technical Concepts for Deep Energy Retrofit of Public Buildings. ASHRAE Transactions. Vol .120 (2).
- Annex 46. 2011 Energy and Process Assessment Protocol. IEA ECBCS. Annex 46. ASHRAE.
- Annex 46. 2014. Energy Efficient Technologies and Measures for Building Renovation – Sourcebook. IEA ECBCS. Annex 46.
- Annex 51 2013. Case Studies and Guidelines for Energy Efficient Communities. A Guidebook on Successful Urban Energy Planning. Fraunhofer IRB Verlag. ISBN 978-3-8167-9122-5

More Examples of Deep Energy Retrofit Projects

Renovation of the medieval Franciscan monastery in Graz, Austria to Zero Energy building



Renovation of a residential building in Kapfenberg (Austria) – renovated to 85% site energy use reduction

Renovation of a kindergarten in Denmark
Primary energy used reduced from
224 kWh/m²/year to 103 kWh/m²/year

Renovation of a school campus in Aachen. Primary energy use reduced from 240 kWh/m²year to 78 kWh /m² year

Energy Savings and Payback from Energy Retrofits of Various Types

Energy Retrofit Type	**% Energy Savings**	**Simple Payback from Energy Cost Savings**	**Cost $/m² ($/SF)**
Retro-commissioning (mostly HVAC-measures)	10 to 20	4 months to 2.4 years	\$3.30 (\$0.30)
ESCO (HVAC-measures)	20 to 40	3 to 12 years **	\$27.80 (\$2.50)
DER with Integrated design (HVAC and thermal envelope)	30 to 60	7 to 12 years	\$27.80 (\$2.50)
(Sources: Pike Research and LBNL)			

Business options to scale up deep energy retrofit projects:

- One major hurdle to implement a DER strategy is the scarcity of public and private funding
- To foster a DER strategy business models have to be considered which allow for the integration of monetized benefits created by the DER refurbishment to keep the demand for external funding such as bank loans as small as possible.
- Which benefits may be monetized and contribute to the funding of DER projects? ENERGY SAVINGS, MAINTENANCE COST SAVINGS, COMFORT GAIN or THE RESTRUCTURING OF dwelling houses (RENESCO IN LATVIA), increasing residual value

Business options to scale up deep energy retrofit projects:

- ESPC – Energy Saving Performance Contracting: **virtues of performance related business model** in comparison to “owner-directed” business models:
  - **Strong contract based stimulation** for both contract parties to achieve a high cost effectiveness by providing a better savings/investment ratio
  - **Guaranteed energy and maintenance cost savings**
  - **Bankable energy- and maintenance cost savings create revenue streams** which are reliable positions of the funding of deep retrofit projects
  - Cost structure and decision making criteria aligned to life-cycle costs
- **One main target of IEA- Annex 61 is the advancement of existing EPC- related business models for deep retrofit projects**

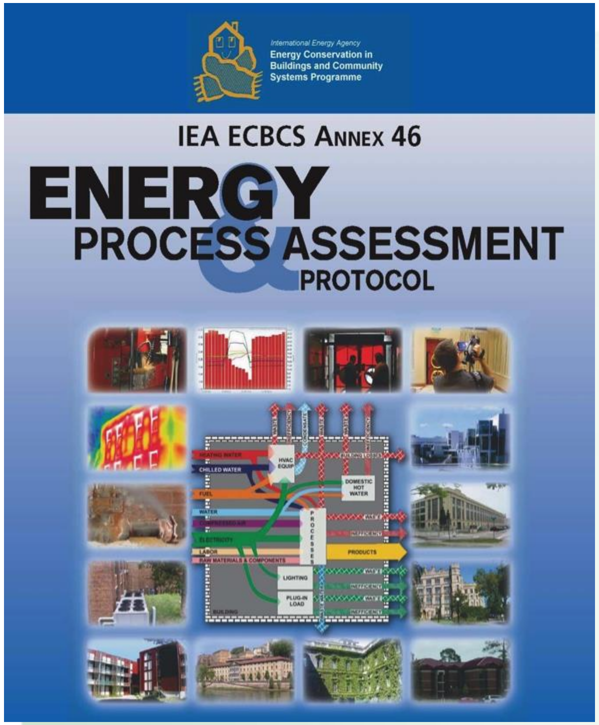
New Construction

- Set National goals for new construction projects
- The Goals can follow implementation of EPBD for different European countries or the ASHRAE Std 90.1 for the USA.

Some Energy Master Planning Tools (see Back-up slides)

– CityGML-SimStadt (University of Stuttgart)
– REOpt (NREL)
– Net Zero Planner (US Army ERDC)
– MODEST
– IEA Annex 51 Tool

IEA ECBCS Program Annex 46 Energy Assessment Protocol

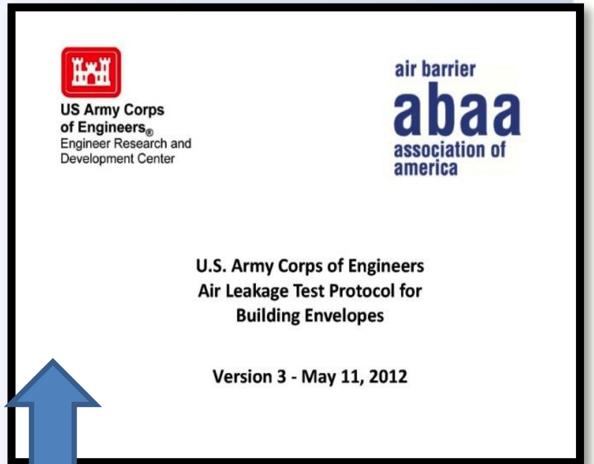


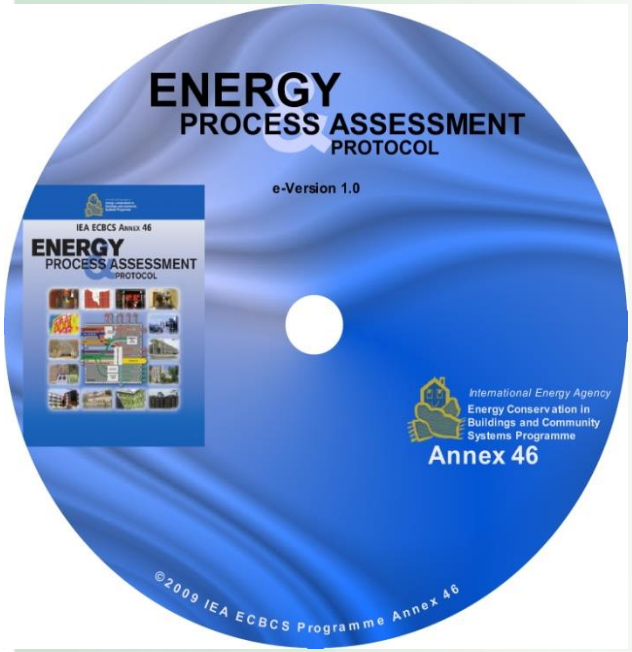
Preface
Introduction

Part I:
Energy Assessment Procedure
Energy assessment as part of energy management
Organizing energy assessment
Energy assessment as a means of continuous improvement
Key players in an energy assessment
Assessment procedure
After the energy assessment
Continuous commissioning

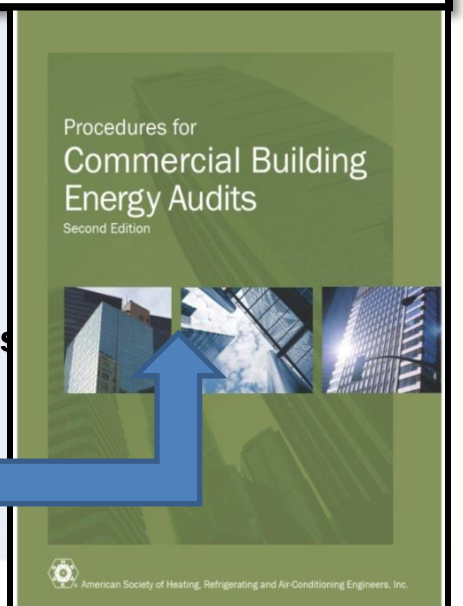
Part II: Energy-saving opportunities
Special features of industrial sites
Special features of non-industrial sites
Typical areas to look for improvement
Glossary
References

APPENDIXES A-O
Total: 380 pp



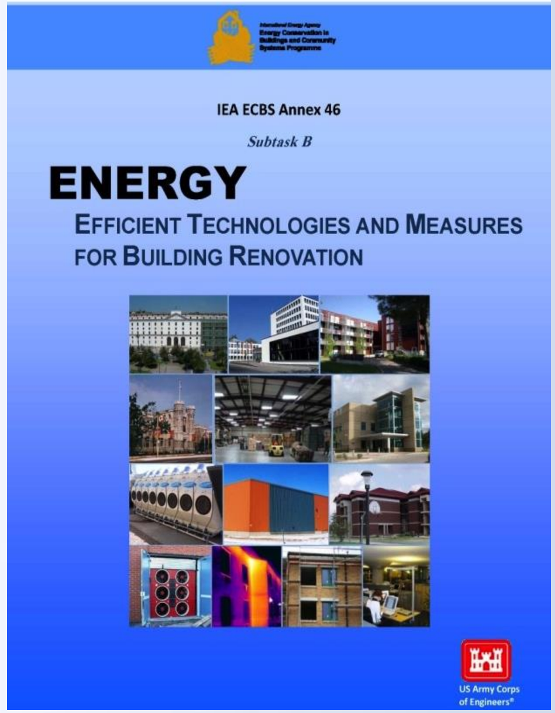


Published by the ASHRAE,
Distributed more than 1000 copies
Referenced in the ASHRAE Std. 100
"Energy Conservation in Existing Buildings
Referred to in the ASHRAE Guide.

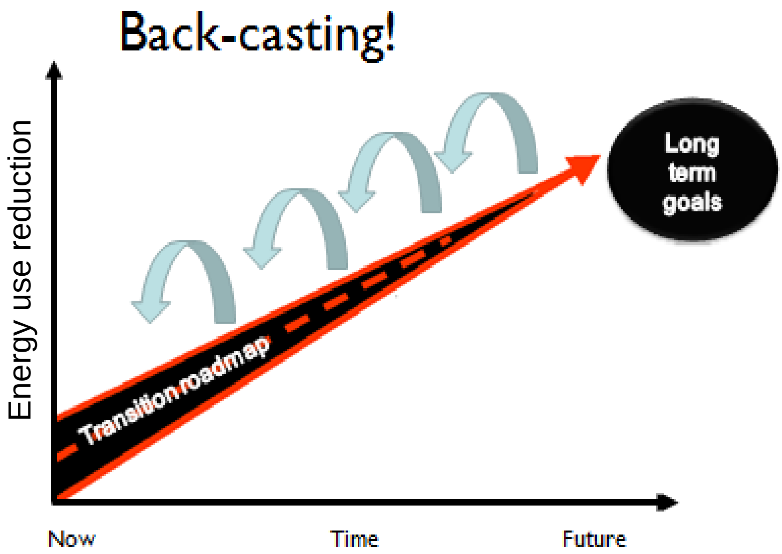


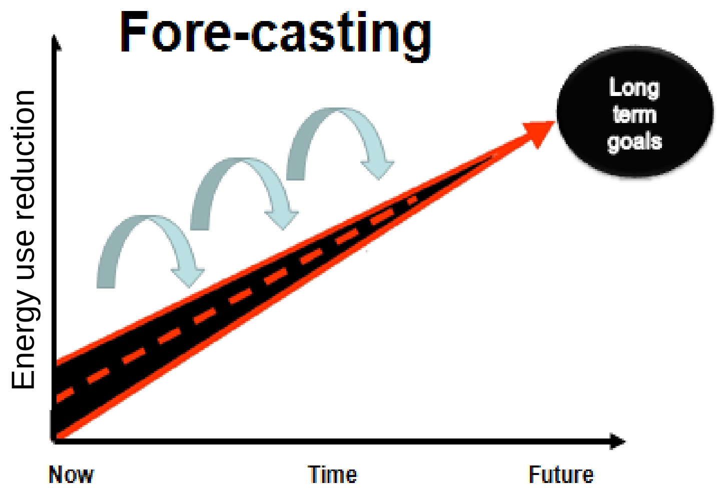
IEA ECBCS Program Annex 46 "Energy Efficient Technologies and Measures for Building Renovation – Sourcebook"

- Documents ~400 energy efficient technologies and measures
- 76 case studies describing implementation promising energy saving technologies
- Screening results of selected technologies/measures, for representative applications and climate conditions



Back-casting and Fore-casting





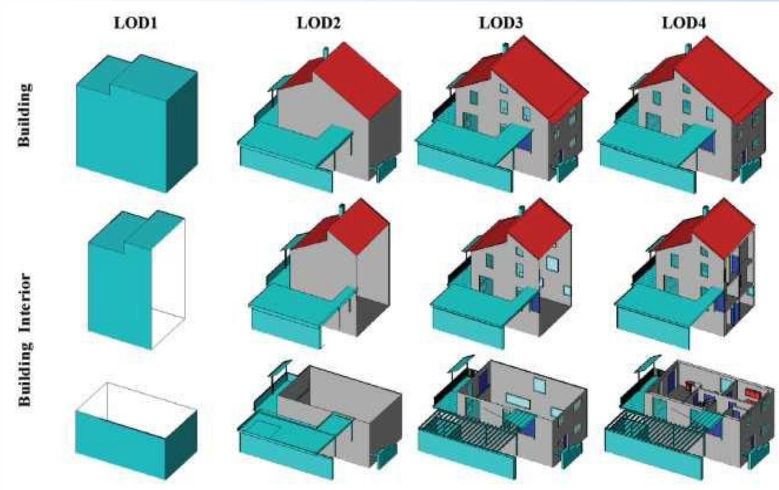
Back-casting - the process of defining milestones and determining necessary steps to reach the final goal.

Forecasting - planning projects to meet milestones defined through the back-casting process: setting project requirements, and optimizing and designing projects and sets of projects in a holistic way that is geared to meeting each milestone. Note: short-term projects shall 100% fit on the roadmap towards the long-term goals.

- ✓ Scale: Large
- Goals &DS
- ✓ Baseline
- Base Case
- Distribution
- Generation
- Cost

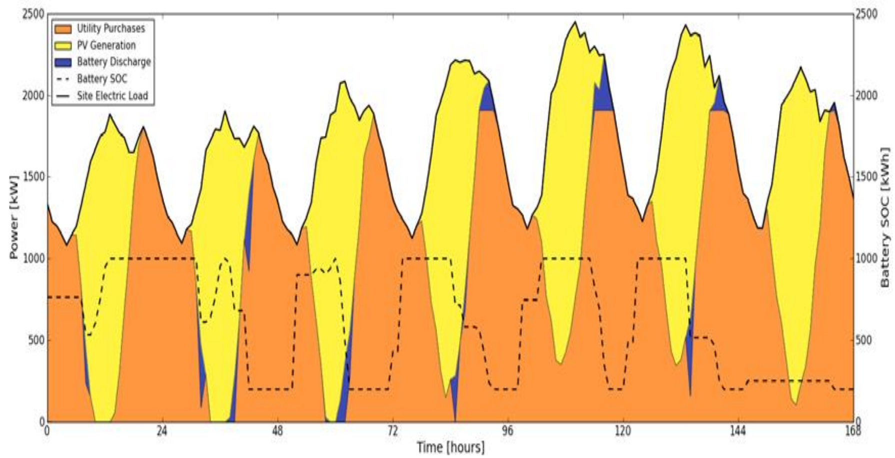
5: CityGML and SimStadt

- Urban heat demand model
- GIS spatial component
- 4 levels of detail
- Detailed data collection better than census data
- Refurbishment information important
- Case study: city of Ludwigsburg, DE and city quarter Ludwigsburg Grünbühl



Renewable Energy Optimization (REopt)

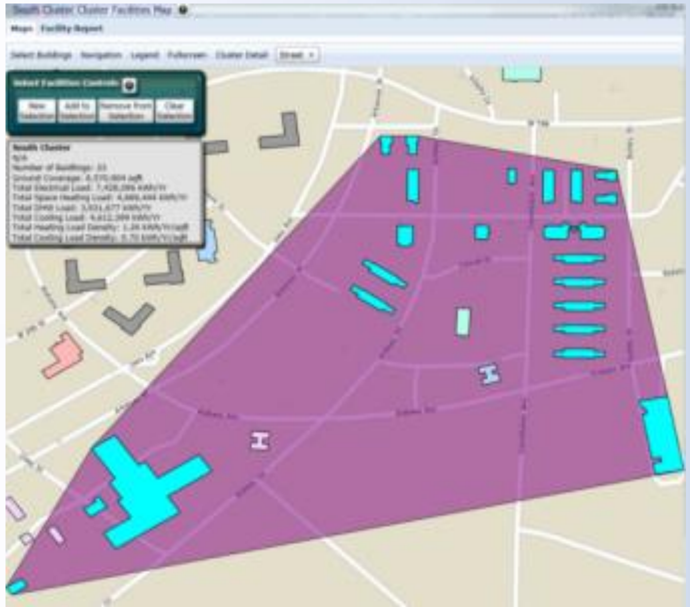
- Energy planning platform
- Multiple technologies (renewable, solar, thermal, CHP, etc.)
- Mixed Integer Linear Programming (MILP) distribution and generation optimization
- Life Cycle Cost

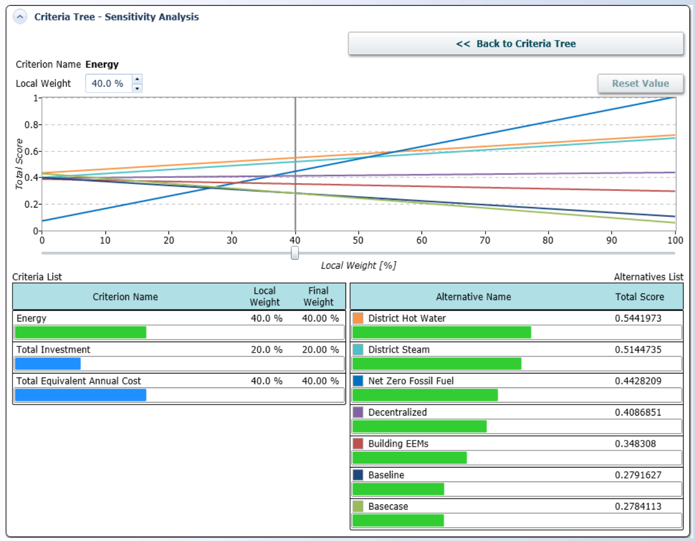


ERDC Net Zero Planner

- ✓ Scale: Medium
- ✓ Goals &DS
- ✓ Baseline
- ✓ Base Case
- ✓ Distribution
- ✓ Generation
- ✓ Cost

- Building energy load estimation using parametric Energy Plus
- Parametric model of energy efficiency measures (EEM)
- Multiple technologies (renewable, solar, thermal, CHP, etc.)
- Distribution and generation optimization using MILP
- Cost estimation
- Multi-Criteria Decision Support (MCDA)
- Case studies: USMA, Portsmouth Naval Shipyard, Fort Hunter Ligget, Schofield Barracks
- Integrates with Master Planning Process

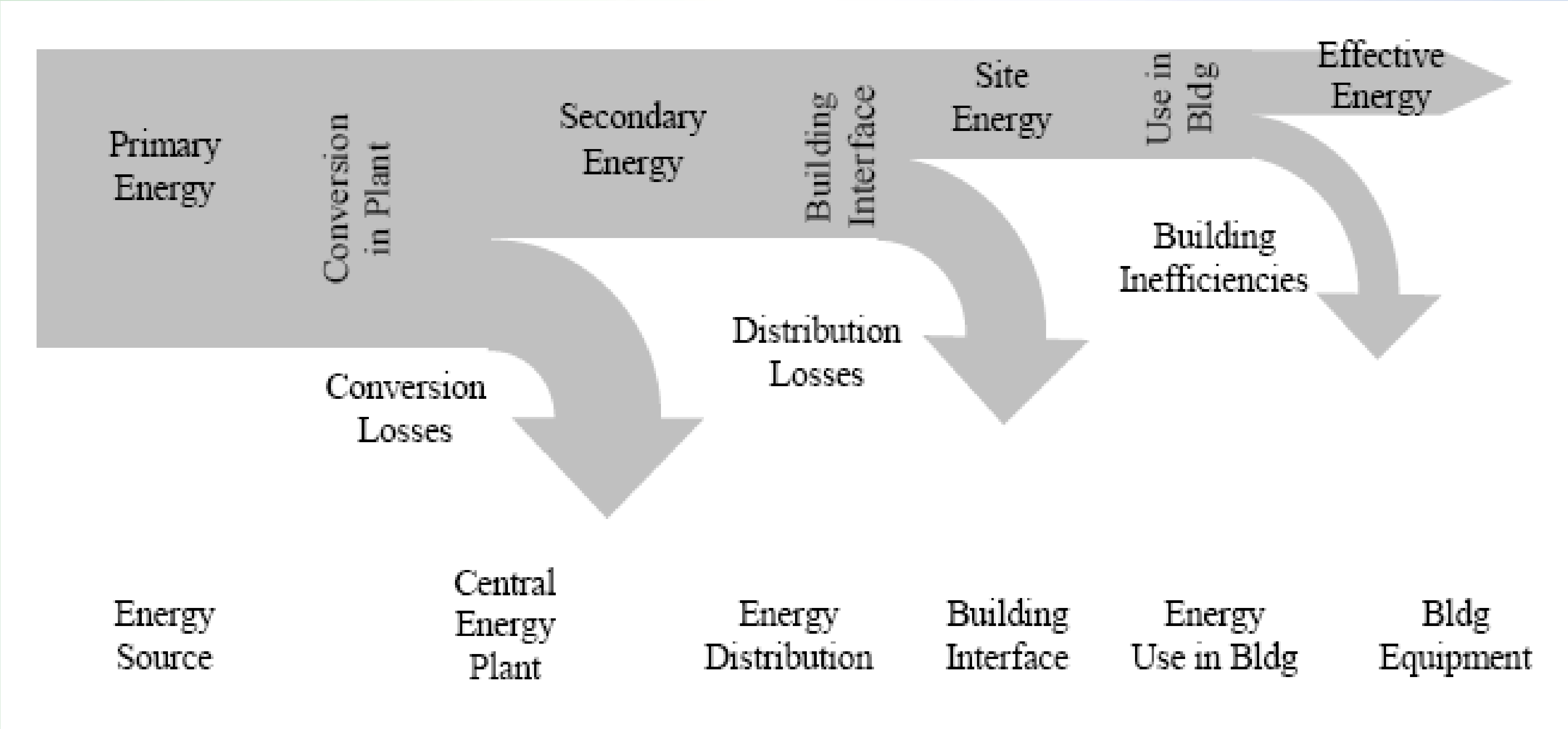




Current National Standards for New Construction and Major Renovation Projects.

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
Canada	National Energy Code of Canada for Buildings 2011 (NECB)	NEBC 2011	NEBC 2011	NEBC 2011
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		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
Latvia	Law On the Energy Performance of Buildings; Cabinet Regulation s No. 348; No. 383; and No. 382.	Latvian Construction Standard LBN 002-01	Latvian Construction Standard LBN 231-03 Latvian Construction Standard LBN 003-01	-
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

Energy Wastes along the Energy Supply Chain from Primary Energy to its Use Inside a Building



The total energy use in the community shall be broken between
-consumption by different users,
-losses in generation,
- losses in conversion and transmission
This is a good starting point for identification of energy wastes and inefficiencies along the chain.