SHC
SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

International Energy Agency
Energy Conservation in Buildings and Community Systems Programme

IEA SHC Task 40/ECBCS Annex 52

Towards Net Zero Energy Solar Buildings

http://www.iea-shc.org/task40/

IREC Workshop: Experience on Net-Zero Energy Buildings

Palau Robert, Barcelona, Spain

October 3, 2012

Josef Ayoub

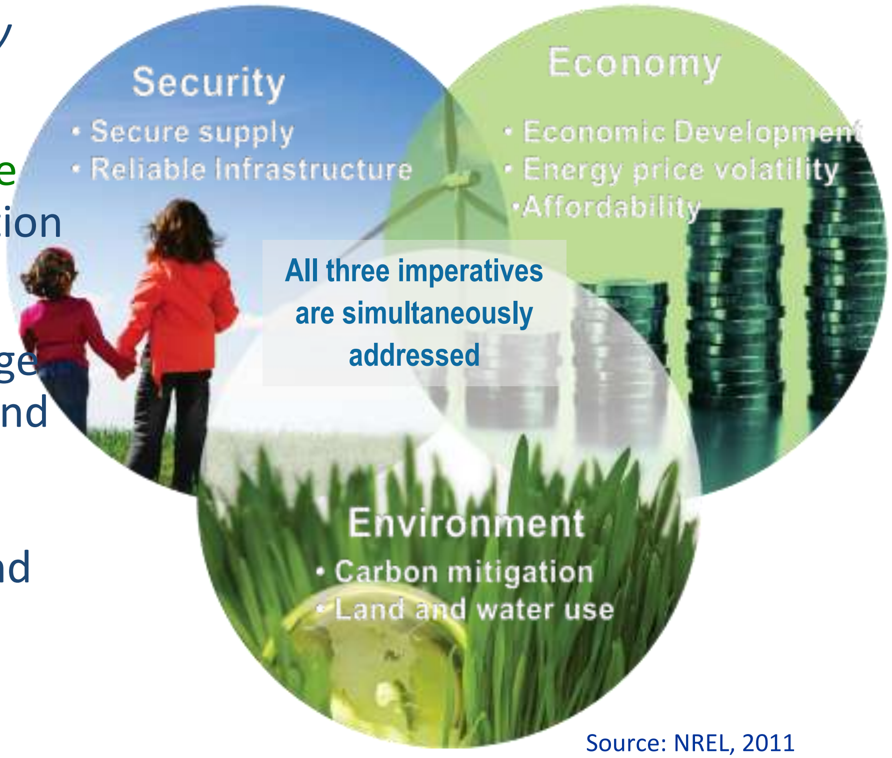
Operating Agent

Natural Resources Canada   Ressources naturelles Canada

NET ZEB

Achieving a Sustainable Energy Future in Buildings

- Energy use in buildings worldwide accounts for over 40% of primary energy use and 24% of greenhouse gas emissions *(Promoting Energy Efficiency Investments, IEA, Paris. 2008)*
- Simply increasing energy supply will not solve the current energy supply and security situation and associated environmental problems.
- Given the challenges related to climate change and resource shortages, making residential and non-residential buildings more energy- and resource-efficient while maintaining thermal comfort and cost-effectiveness represents and enormous opportunity to save money and reduce pollution
- Radical improvements in the energy performance and use of renewables in buildings are required



Source: NREL, 2011

Context

- Currently, a prominent vision proposes so called "net zero energy" (USA), "net zero carbon" (UK) or "EQuilibrium" buildings (Canada)
  - A maze of definitions

1. Low energy house
2. High performance buildings
3. Energy saving house
4. Ultra low energy house
5. Zero energy house
6. Zero energy buildings
7. Passive house
8. Zero heating energy house
9. Plus energy house
10. Zero carbon house
11. Emission free house
12. Carbon free house
13. Energy self sufficient
14. BREEAM building
15. EQuilibrium house
16. Green building
17. Very low energy house
18. Climatic active house

  - Although these terms have different meaning and are poorly understood, several IEA countries have adopted this vision as a long-term goal of their building energy policies – EPBD Recast (2010) – 71 definition to-date.

European Parliament on Zero Energy Building Regulation

- In connection to revision of Energy Performance of Buildings Directive (EPBD which came into force in 2003) the Parliament stated:
  - By 31 December 2018 at the latest EU Member States must ensure that all newly-constructed buildings produce as much energy as they consume on-site - e.g. via solar panels or heat pumps
  - Parliament also wants Member States to set intermediate national targets for existing buildings, i.e. to fix minimum percentages of buildings that should be zero energy by 2015 and by 2020 respectively
  - Members define zero-energy buildings as *"where, as a result of the very high level of energy efficiency of the building, the overall annual primary energy consumption is equal to or less than the energy production from renewable energy sources on site"*

Examples from Europe

Zero Energy or Plus, Germany

Solar Siedlung Vauban Freiburg, Germany

Low energy buildings – 15 kWh = 4.75 kBtu per ft^2 per year.

Large solar photo PV systems.

Feed in tariffs guaranteed by German government.

These building produce much more than they use!

Passive House Technology

Frankfurt/M Germany Sophienhof
FAAG/ABG Frankfurt Architect Fuessler

160 dwellings

14 767 m²

15 kwh / m² per year = 4.75 kBtu

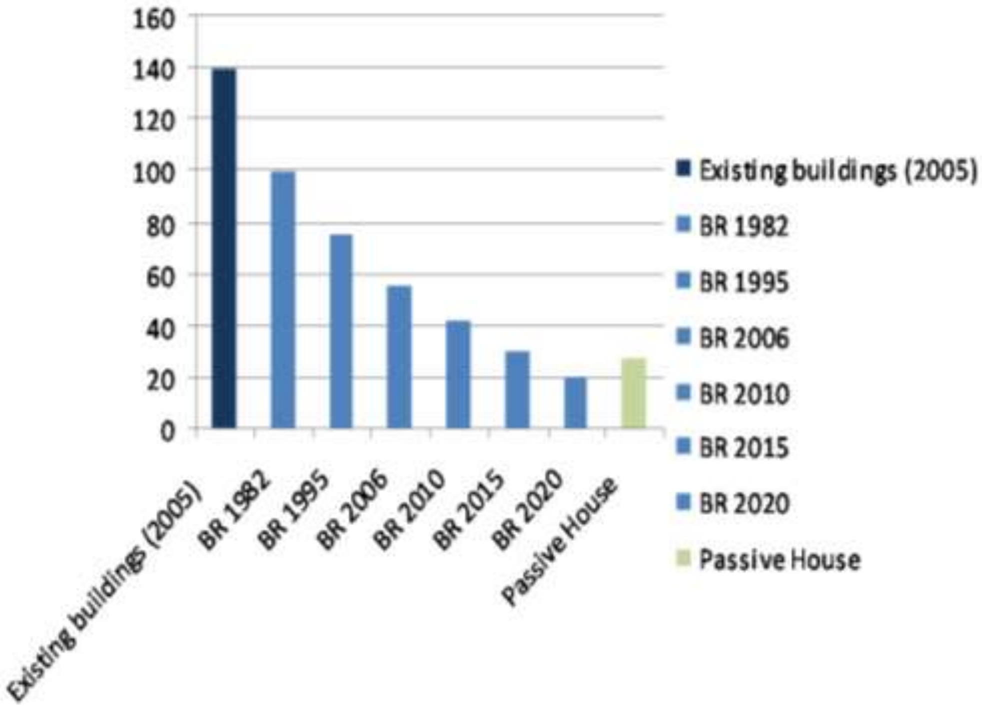
Extra costs
= 3-5% of the total costs

Payback = 9 – 10 years

Step-wise approach in Denmark

Demand in Danish Building Codes

Gros energy including heating, cooling ventilation and hot sanitary water



- Introduced in Parliament 2008
- Zero in 2030
- Plus Energy 2040

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EnerPos Building, Université de la Réunion, France

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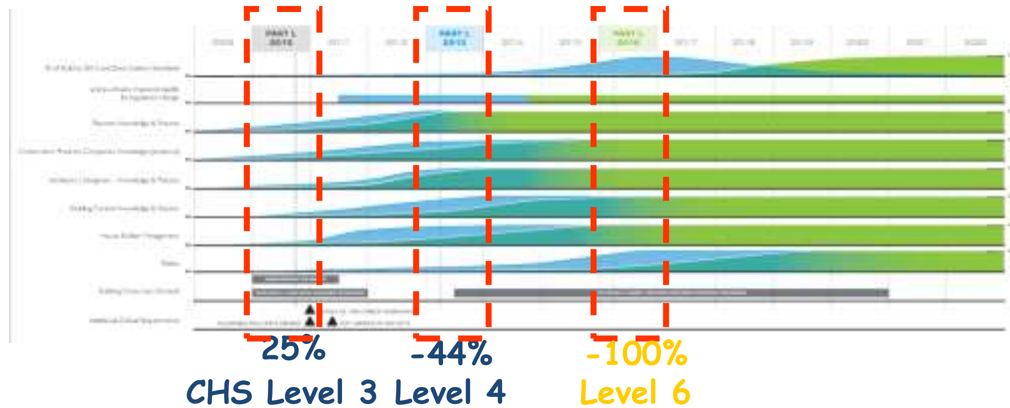
Zero Carbon Buildings

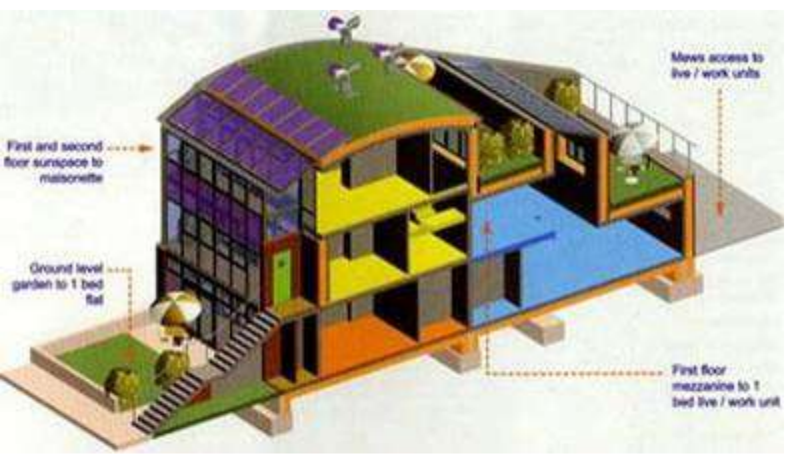
BedZED, London, UK

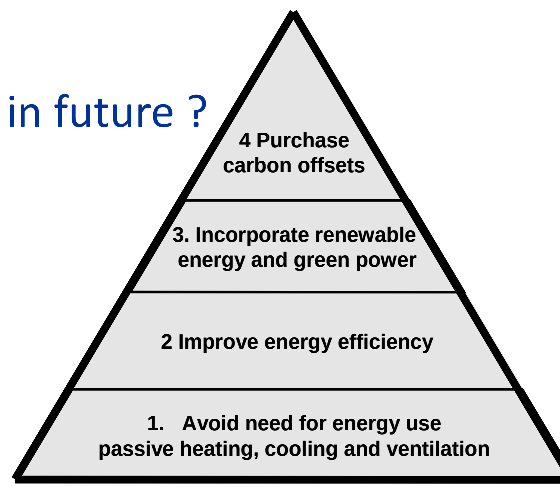
Zero Carbon Buildings have been on agenda in UK since 2005.



(CHS- Code for Sustainable Housing)

How to ensure CO_2 neutral in future ?





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United States

- Colorado State leading in innovation

EQuilibrium Housing Initiative in Canada

- Started in 2007 – Government – Industry lead
- Minimum to R-2000 Standard (sets a series of house performance requirements that are in addition to those required by the buildings codes)
- Demonstrate 15 NZE homes across the country
- Houses presently being monitored








EcoTerra Equilibrium House

140 sq. m. plus 90 sq.m. basement

Prefabricated house (4 units)

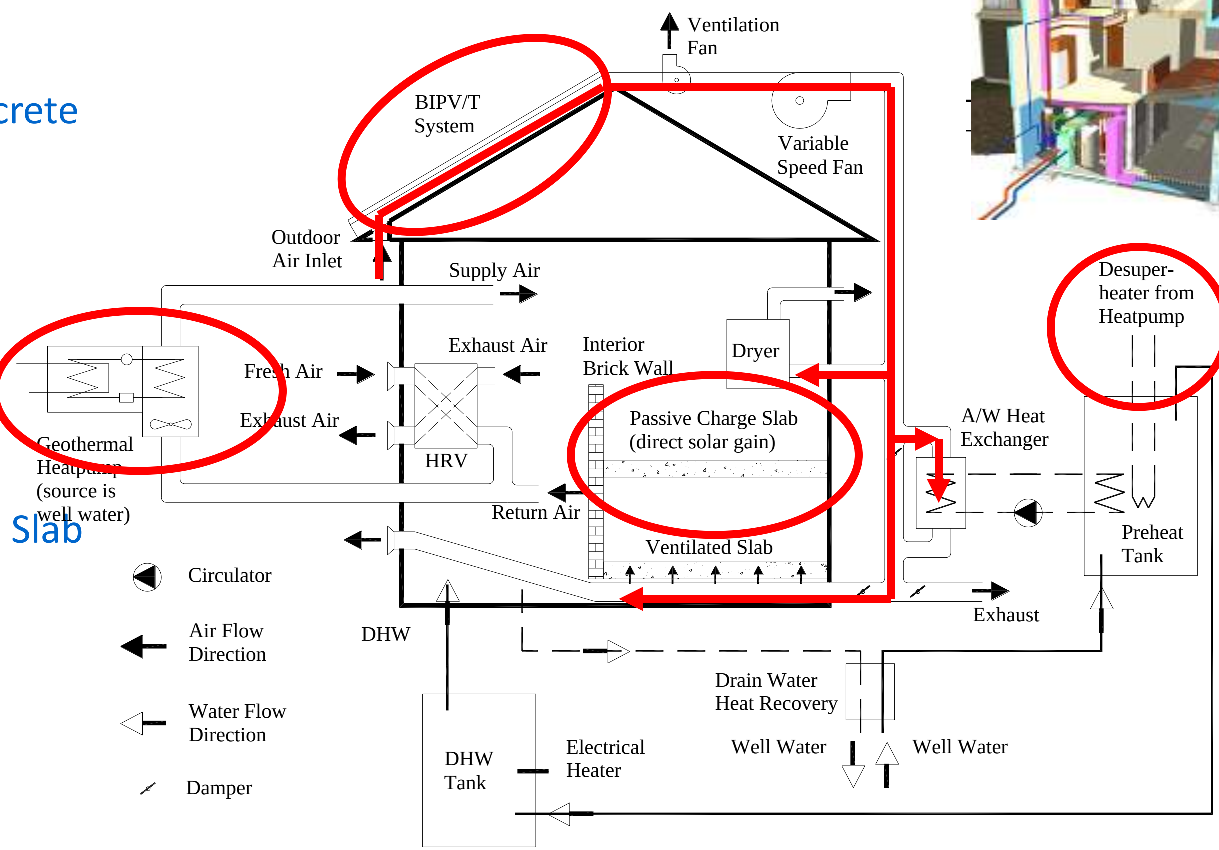
Passive solar design:
Optimized triple glazed windows and mass

3-kW Building-integrated photovoltaic-thermal system

Ground-source heat pump

Key features of EcoTerra House

- **Passive Solar Heating**
  - Large south-facing windows (RSI 1)
  - Passive Charge Concrete Slab & Brick Wall
  - Motorized Blinds
- **BIPV/T**
  - PV panel Cooling
  - Drying Clothes
  - DWH heating
  - Ventilated Concrete Slab heating
- **Geothermal HP**
  - Forced-Air Space heating/cooling
  - DWH heating



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The way forward

- What is missing is a clear understanding of definitions and international agreement on the measures of building performance that could inform "zero energy" building policies, programs and industry adoption.

IEA Structure

IEA Governing Board

CERT - Committee on Energy Research and Technology

Fusion Power Co-ordinating Committee

IMPLEMENTING AGREEMENTS

Env. Safety, Econ. Aspects
Fusion Materials
Large Tokamaks
Nuclear Tech. of Fusion
Textor
Reversed Field Oinches
Stellarator
ASDEX Upgrade
Sperical Tori (fortcoming)

Working Party on Fossil Fuels

IMPLEMENTING AGREEMENTS

Clean Coal Centre
Clean Coal Science
Enhanced Oil Recovery
Fluidised Bed Conversion
Greeenhouse Gas R&D
Multiphase Flow Science

Advisory Group on Oil & Gas Technology

Working Party on Renewable Energy Technologies

IMPLEMENTING AGREEMENTS

Hydrogen
Bioenergy
Geothermal
Hydropower
Ocean Energy
Photovoltaic Power
Solar Heating/Cooling
SolarPACES
Wind Turbines

Working Party on Energy End-Use Technologies

IMPLEMENTING AGREEMENTS

Advanced Fuel Cells
Advanced Materials Transp.
Advanced Motor Fuels
Hybrid/Electric Vehicles
Demand Side Management
Buildings/Communities
District Heating/Cooling
Energy Storage
Heat Pumps
Energy Cons./Emissions Red.
Process Integration
Pulp & Paper
Superconductivity

Hydrogen Co-ordination Group

Experts Group on R&D Priority-Setting and Evaluation

Ad Hoc Group on Science and Energy Technologies

INTER-SECTORAL IMPLEMENTING AGREEMENTS

- Climate Technology Initiative (CTI)
- Energy and Environmental Technologies Information Centre (EETIC)
- Energy Technology Systems Analysis Programme (ETSAP)
- Energy Technology Data Exchange (ETDE)

Annex 52/Task 40 Overview

- **Objective:** To provide a clear definition and international agreement on the measures of building performance that could inform “zero energy” building policies, programs and industry adoption
- **Scope:** Residential, non-residential, clusters, different climates.
- **Means:**
  - **Subtask A:** Definitions and Implications
  - **Subtask B:** Design Processes and tools
  - **Subtask C:** Solution Sets (Adv. Design, Eng., Tech.)
  - **Subtask D:** Dissemination and Outreach
- **Period: Oct. 2008 – Sept 2013**

Our vision
A world in which buildings consume zero net energy

World Business Council for Sustainable Development

R&D work program

Subtask	Leaders	Objective	Sub-activities
A: Definitions & Implications	K. Voss (DEU) R. Lollini (ITA) [A. Napolitano, ITA, Withdrew Fall 2011]	*to establish an internationally agreed understanding on NZEBs based on a common methodology*	**A1:** NZEB Definitions framework **A2:** Monitoring, verification & compliance **A3:** Grid interaction
B: Design Processes & Tools	A. Athienitis (CAN) L. O'Brien (CAN) [A. Hirsch, USA, downgraded level of effort Fall 2011]	*to identify and refine design approaches and tools to support industry adoption of innovative demand/supply technologies for NZEBS*	**B1:** Document processes and tools currently being used to design NZEBs and under development by participating countries **B2:** Select/refine pre-concept design, feasibility tools linked to STC Solution Sets (primarily rolled into B1) **B3:** Develop tools guide, worked examples of projects to support industry adoption (Source Book Vol. 2)
C: Solution Sets (Advanced Design Engineering, Technologies)	F. Garde (FRA) M. Donn (NZL)	*to develop and test innovative, whole building net-zero solution sets for cold, moderate and hot climates with exemplary architecture and technologies that would be the basis for demonstration projects and international collaboration*	**C1:** NZEB STC Database **C2:** Analysis Matrix **C3:** Research Analysis of themes undertaken **C4:** Vol. 3 STC Source Book of Solution sets
D: Dissemination & Outreach	OA / All National Experts	*to support knowledge transfer and market adoption of NZEBs on a national and international*	**D1:** ANNEX/Task webpage, Database **D2:** Prepare/Disseminate Vols. 1, 2, 3 **D3:** Establish PhD network **D4:** Outreach (workshops, conferences, other)

R&D work program

Task 40/Annex 52: Towards Net Zero Energy Solar Buildings (NZEBs)					Lead Country: Canada Operating Agent: Josef Ayoub
Objective	The objective of the task is joint international research to advance NZEBs to practical reality in the marketplace by developing a common understanding and methodology, guidelines, tools and innnovative solution sets and a source book that would be the basis of national demonstrations that would support broader industry adoption.				
Scope	The scope includes **new and existing buildings** (residential and non-residential initially), clusters of buildings and small settlements for the different climates (cold, moderate and hot) of participating countries. The work **focuses on an analysis of existing examples** and the **development of optimized, innovative whole building solutions** that will be the basis of advanced, practical demonstrations, with exemplary architecture, **that aim to equalize their small remaining annual energy needs by building integrated heat or power generation in combination with the interaction with utility structures.**				
Subtasks	**A Methodologies, Analysis & Implications**	**B Technology, Simulation & Tools**	**C Advanced Building Design & Engineering** **C1 Non-Residential Concepts**	**C2 Residential Concepts**	**D Dissemination Activities**
Lead country/STL Co-Lead	Germany: Karsten Voss Italy: Assunta Napolitano	USA: Paul Torcellini Canada: Andreas Athienitis	NZL: Michael Donn France: François Garde	TBD	All: Subtask Leaders Committee
Subtask Objectives	To develop an international definition and understanding of NZEBs based on a common methodology that considers large-scale implications, credit systems for grid interaction (heat, cool, power) and relevant ISO/CEN standards.	To identify and investigate innovative demand/supply technologies, to simulate impacts on buildings and to produce a suite of NZEB tools and database to support industry adoption.	To develop innovative, whole building net-zero solution sets for cold, moderate and hot climates with exemplary architecture that would be the basis for national demonstration projects; to document NZEB design options in terms of market application and lifecycle energy and CO2 implications; and to develop guidelines and tools for industry adoption of integrated designs and concepts		To support knowledge transfer and market adoption of NZEBs on a national and international level
Means	The review and analysis of existing NZEBs definitions (site / source energy, exergy, emissions, costs, etc.) with respect to the demand, the supply, the grid interaction and the mismatch.	A technology focused review of existing NZEB concepts for cold, moderate and hot climates and identification of technological improvements considering sustainability, economy and future prospects.	Documenting and analyzing existing NZEBs, benchmarking with near NZEBs and other very low energy buildings (new and existing) and undertaking lifecycle assessment and optimization studies with respect to material/resource use and technologies for participating countries.		Establishing an NZEB web page, within the IEA SHCP framework, and an NZEB database that can be expanded and updated with the latest projects and experiences.
	Analysis of the energy, emission and energy cost balance for existing NZEBs and near zero buildings.	Investigation of advanced building integrated passive (incl. shading), active solar system concepts and cogeneration technologies (micro CHP) for warm, moderate and cold climates.	Development of advanced integrated design and engineering solutions, including shading systems for control of solar gains, in close cooperation with builders, planners, manufacturers and clients that would lead to the development of practical demonstration projects.		Producing a NZEB source book including example buildings from all investigated building types and climates.
	A study on the grid interaction (power/heat/cool) and analysis of the time dependent energy mismatch.	Investigation of advanced storage (heat,cool electricity) and integration with utility grids as well as advanced controls and load management technologies.	Developing typical NZEB solution sets with respect to building types and cold, moderate and warm climates and to document design options in terms of market application and lifecycle energy and CO2 implications		Establishing an education network for student, summer schools and contributions to the Solar Decathlon and similar activities.
	The development of a harmonized NZEB methodology and definition based on experience from existing approaches and relevant CEN/ISO standards	Detailed simulations of these innovative technologies in connection with building energy loads, solar gain control, energy storage, controls and utility grids.	With Subtask B, develop NZEB projects that integrate engineering solutions and exemplary architecture - in close cooperation with architects, builders, planners, manufacturers, clients and utilities – as the basis for national demonstrations projects.		Workshops, articles and features in industry magazines to stimulate market adoption.
	The development of a monitoring and verification concept for checking the annual balance in practice (energy, emissions, costs).	The development of simplified NZEB tools or interfaces (e.g. spreadsheet or web-based method) linked to a national / international database of building archetypes and technologies.	With Subtask B, develop tools, guidelines and case studies for architects, engineers, manufacturers and clients to support the market adoption of practical, integrated NZEB concepts.		The transfer of task outputs to national policy groups, industry associations, utilities, academia and funding programmes.
Results	Harmonized methodology, definition and monitoring and verification guide (report)	Overview of market available and near market components and systems for different building types and climates.	Best practices, case studies, design guidelines, tools and knowledge for the task sourcebook and database and other dissemination materials.		NZEB source book covering the methodology, technologies, tools, case studies and demonstration projects.
	Study of the technical potential of NZEBs including impacts on grids (report).	A suite of NZEB tools including a data base and user manuals.	Solution sets and designs for national demonstration projects.		NZEB web page and database, papers, special issues of industry magazines.
Dissemination	Dissemination is organised as a shared responibility of all subtasks				

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Task/Annex Member countries

Australia	New Zealand
Austria	Norway
Belgium	Portugal
Canada	Singapore
Denmark	S. Korea
Finland	Spain
France	Sweden
Germany	Switzerland
Italy	UK
	USA

- Between 55 – 60 experts + 15 or so regular participants and contributors
- 90% universities/academia (professors, PhD students)
- National labs (NREL, CanmetENERGY, EURAC, AEE)
- Industry (Samsung, GROCON, others

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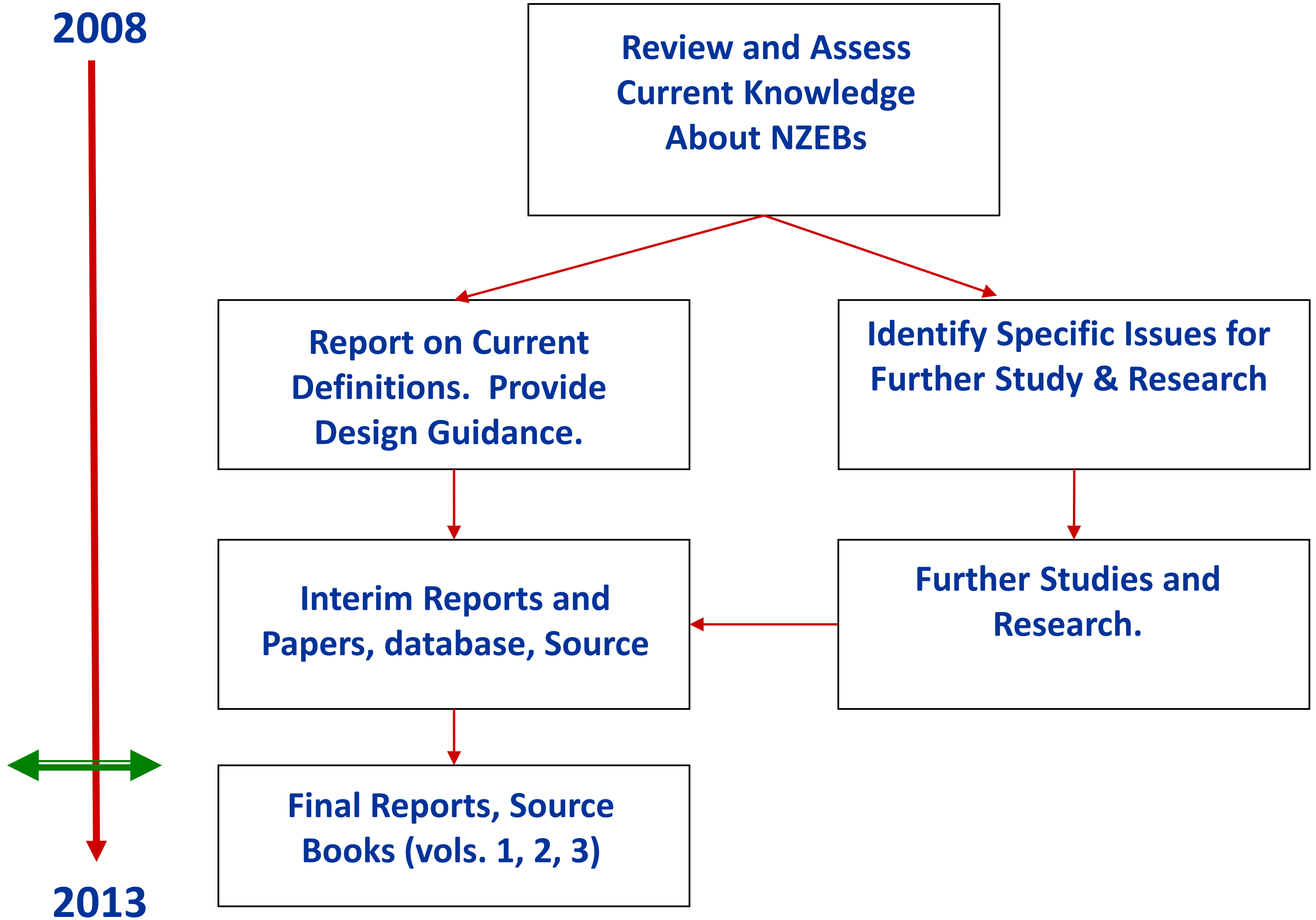
Task 40/Annex52 flowchart



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Planned outputs/deliverables

- Source book (s) targeting specific groups such as national policy, industry and industry associations, utilities, academia, funding programs
  - Vol. 1 - Definition and Methodologies (STA – DEU/ITA)
  - Vol. 2 - Design Tools and Processes (STB – Canada/US)
  - Vol. 3 – Case Studies (France, Canada)
- Databases of over 100 case studies from 19 countries and different climatic conditions
- Stand-alone technical reports, conference papers
- An education network (professional development courses, training material)
- Website ("NZEB Knowledge Centre")

What is known about achieving “zero” in buildings?

Ideas coalescing on a Typical Methodology

Emerging green energy technologies

Last consideration after design, efficiency, and conservation have been optimised

An energy education

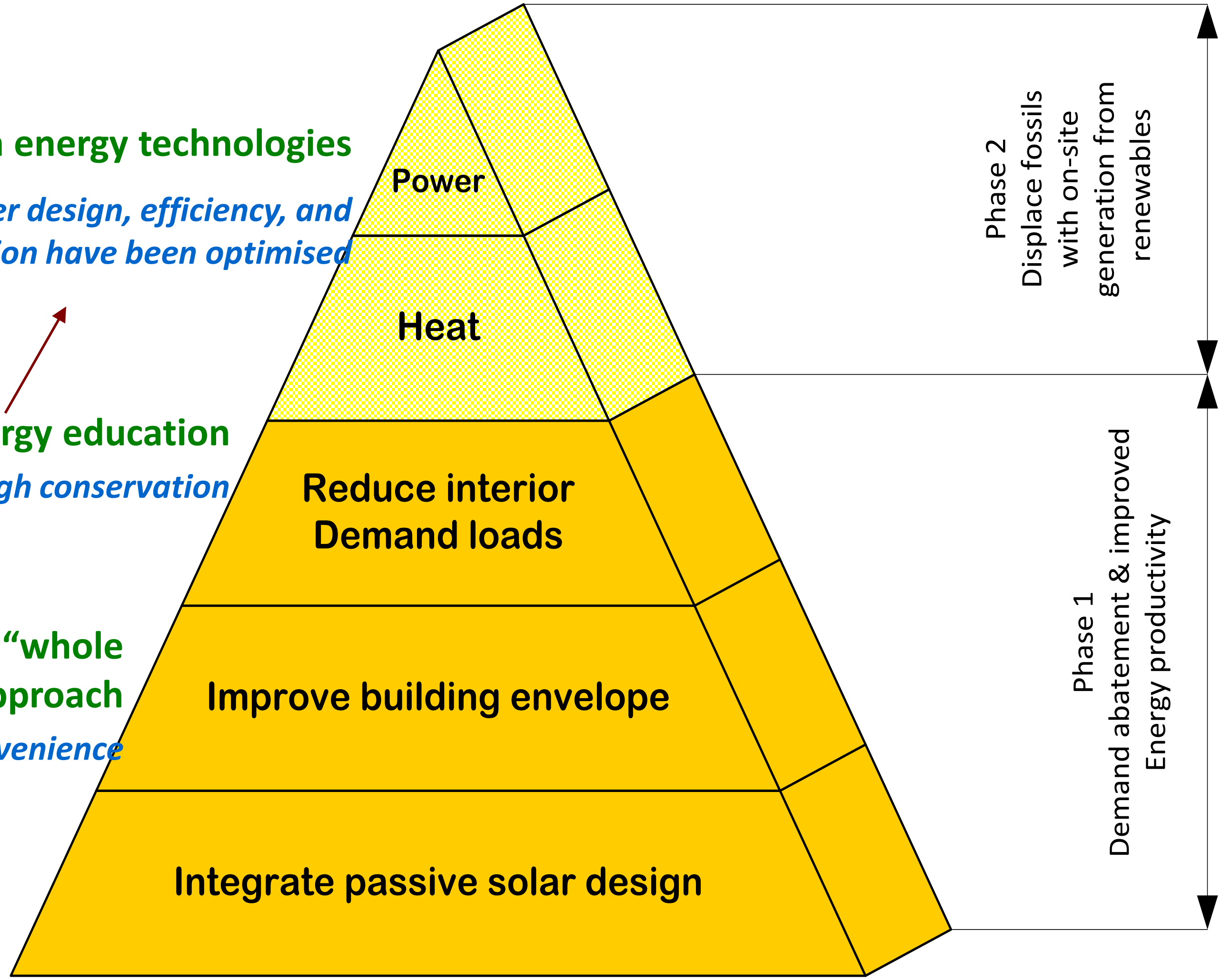
Reduce energy use through conservation

Dispelling the cost myth – "whole building" approach

Deliver efficiency W/O inconvenience

The value of good design

Invest in doing it right!



Pogharian/Ayoub

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Towards net-zero energy

BUILDING SYSTEMS	CURRENT BUILDINGS	FUTURE SMART NET-ZERO ENERGY BUILDINGS
Building fabric	Passive, not designed as an energy system	Optimized for passive design and integration of active solar systems
Heating & Cooling	Large oversized systems	Small systems optimally controlled; integrated with solar, CHP; Communities: seasonal storage and district energy
Solar systems /renewables	No systematic integration – an after thought	Fully integrated: daylighting, solar thermal, PV, hybrid solar, geothermal systems, biofuels
Building operation	Building automation systems not used effectively	Predictive control to optimize comfort and energy performance; online demand prediction

Subtask A: Definitions - Approach

Net Zero Site Energy Building

A site ZEB produces at least as much energy as it uses in a year, when accounted for at the site.

Net Zero Source Energy Building

A source ZEB produces at least as much energy as it uses in year, when accounted for at the source.

Net Zero Energy Costs Building

In a cost ZEB, the amount of money the utility pays the building owner equals to the amount the owner pays the utility

Net Zero Energy Emissions Building

A net-zero emissions building produces at least as much emissions-free renewable energy as it uses from emissions-producing energy sources

Net-Zero Energy Home/ Zero Net Energy Building

Energy consumption = energy production (grid connection)

Net-Zero Exergy Building

Both quantity and quality of energy is taken into consideration

Net-Zero Carbon Building/Zero Carbon Building

CO_2 free energy use.

Definitions - Energy supply system

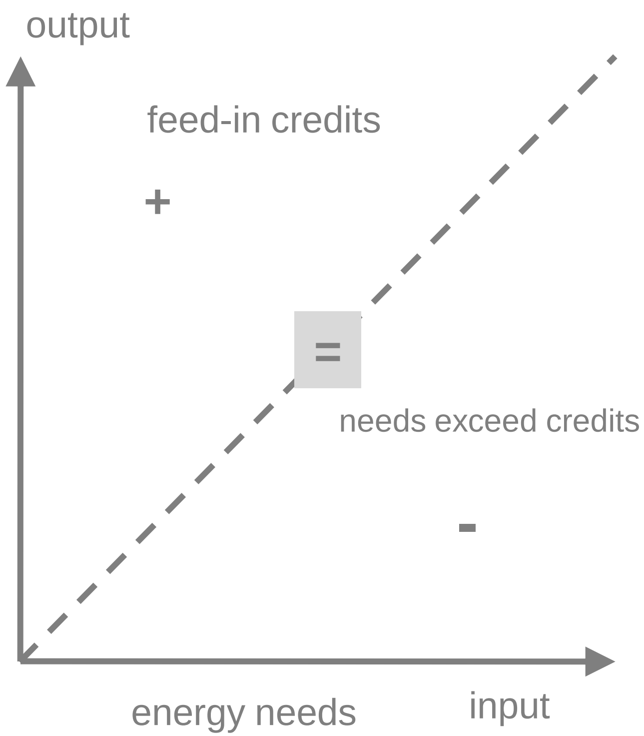
- Off-grid/self sufficient/ autonomous building

Zero Stand Alone Buildings are buildings that do not require connection to the grid or only as a backup. Stand alone buildings can autonomously supply themselves with energy, as they have the capacity to store energy for night-time or wintertime use

- On-grid/grid-connected building

Zero Net Energy Buildings are buildings that over a year are neutral, meaning that they deliver as much energy to the supply grids as they use from the grids. Seen in these terms they do not need any fossil fuel for heating, cooling, lighting or other energy uses although they sometimes draw energy from the grid

STA: Definition Framework



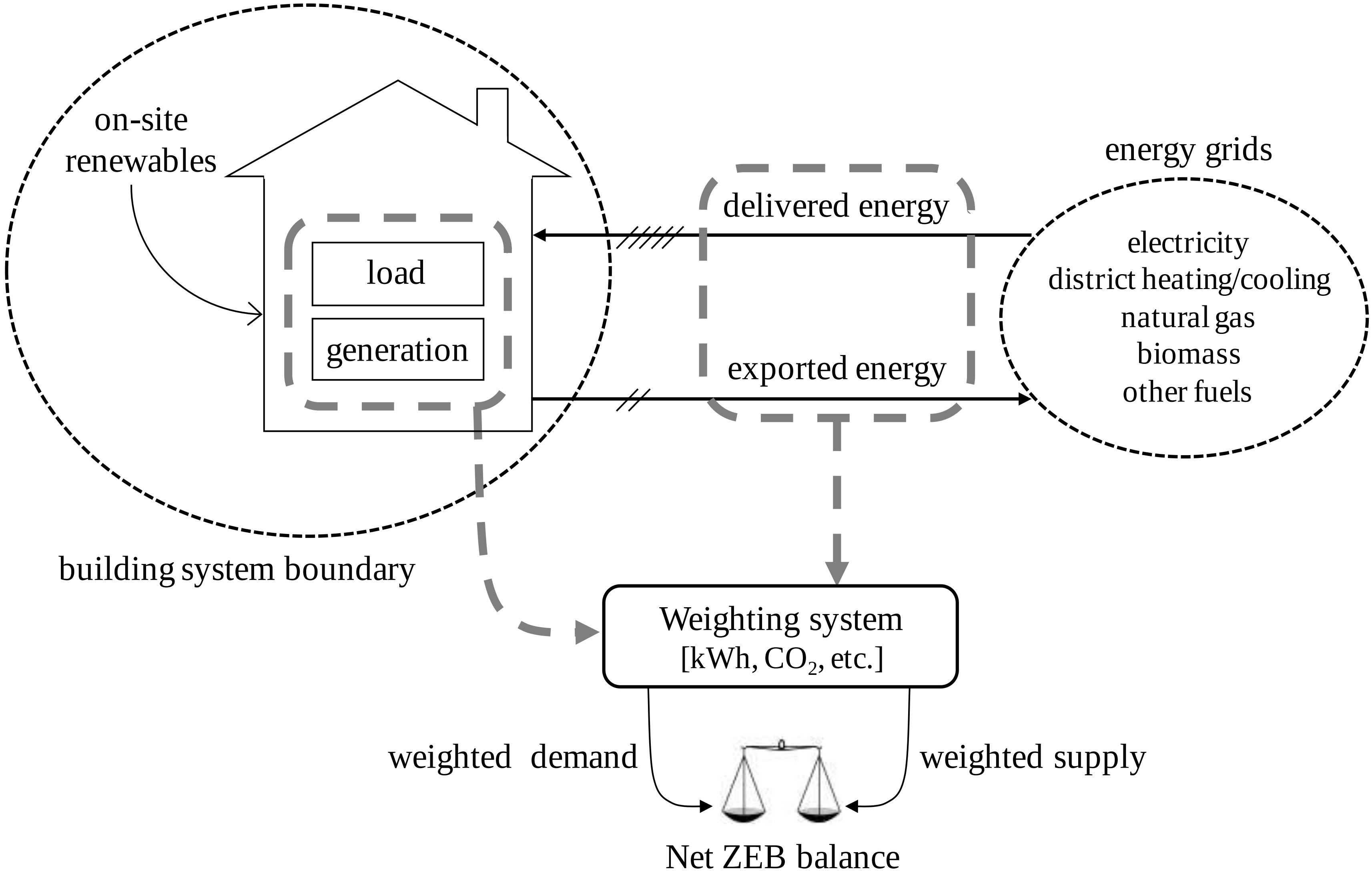
METRIC
- final energy
- primary energy, n. r.
- primary energy, total
- carbon emission
- exergy
- costs

BALANCE BOUNDARY
- HVAC, DHW & lighting

\+ appliances & central services
\+ electro mobility
\+ embodied energy

BALANCE PERIOD
- operation year
- total period of utilization
- life cycle

Terminology



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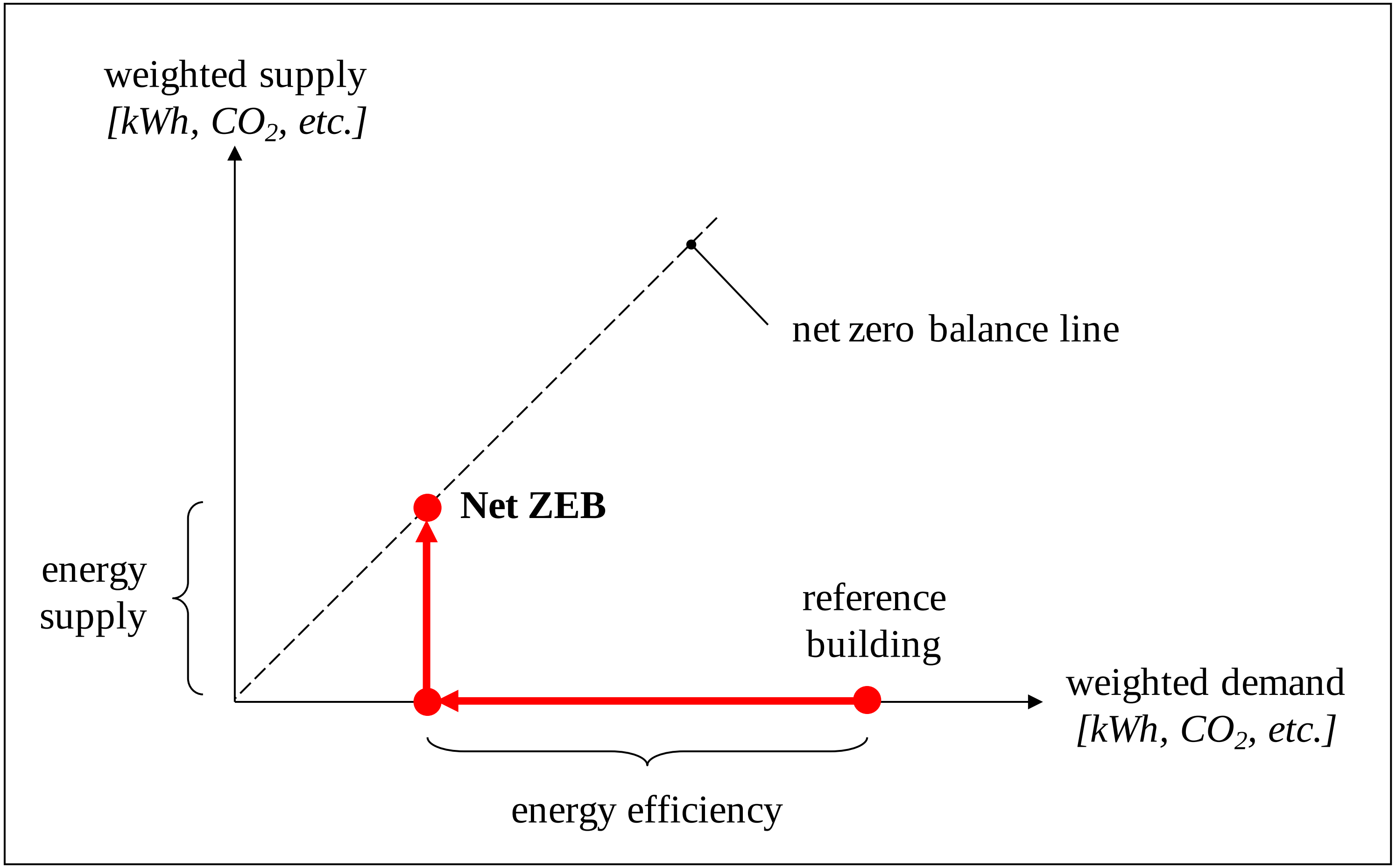
The balance concept (Igor Sartori)



Net ZEB balance: | weighted supply | – | weighted demand | ≥ 0

Measurement & Verification Protocol

Joint Project - Task 40/Annex 52
Net Zero Energy Buildings

Measurement and Verification protocol for Net Zero Energy Buildings

A report of Subtask A

IEA Task 40/Annex 52 Towards Net Zero Energy Solar Buildings

Net ZEB evaluator tool

A Net Zero Energy Building is the "building system" delimited by set physical boundaries, connected to any energy infrastructure, which balance between its weighted energy loads and supplies is zero.

		Net ZEB limited	Net ZEB primary	Net ZEB strategic	Net ZEB carbon
Building system boundary	Balance boundary	HEATING DHW COOLING VENTILATION AUXILIARIES BUILT-IN LIGHTING (only non residential buildings)	HEATING DHW COOLING VENTILATION AUXILIARIES BUILT-IN LIGHTING PLUG LOADS	HEATING DHW COOLING VENTILATION AUXILIARIES BUILT-IN LIGHTING PLUG LOADS	HEATING DHW COOLING VENTILATION AUXILIARIES BUILT-IN LIGHTING PLUG LOADS
Weighting system	Metric	PRIMARY ENERGY	PRIMARY ENERGY	Whichever metric desired	CARBON EMISSION
	Symmetry	SYMMETRIC	SYMMETRIC	SYMMETRIC or ASYMMETRIC	SYMMETRIC or ASYMMETRIC
	Time dependent accounting	STATIC OR QUASI-STATIC	STATIC OR QUASI-STATIC	STATIC OR QUASI-STATIC	STATIC OR QUASI-STATIC
Net ZEB balance	Energy efficiency	NATIONAL/LOCAL ENERGY EFFICIENCY REQUIREMENTS ARE FULFILLED	NATIONAL/LOCAL ENERGY EFFICIENCY REQUIREMENTS ARE FULFILLED	ANY NATIONAL/LOCAL ENERGY EFFICIENCY REQUIREMENTS HAS TO BE FULFILLED	ANY NATIONAL/LOCAL ENERGY EFFICIENCY REQUIREMENTS HAS TO BE FULFILLED
	Energy supply	ON SITE GENERATION DRIVEN BY ON/OFF SITE SOURCES	ON SITE GENERATION DRIVEN BY ON/OFF SITE SOURCES	ON/OFF SITE GENERATION DRIVEN BY ON/OFF SITE SOURCES	ON SITE GENERATION DRIVEN BY ON/OFF SITE SOURCES

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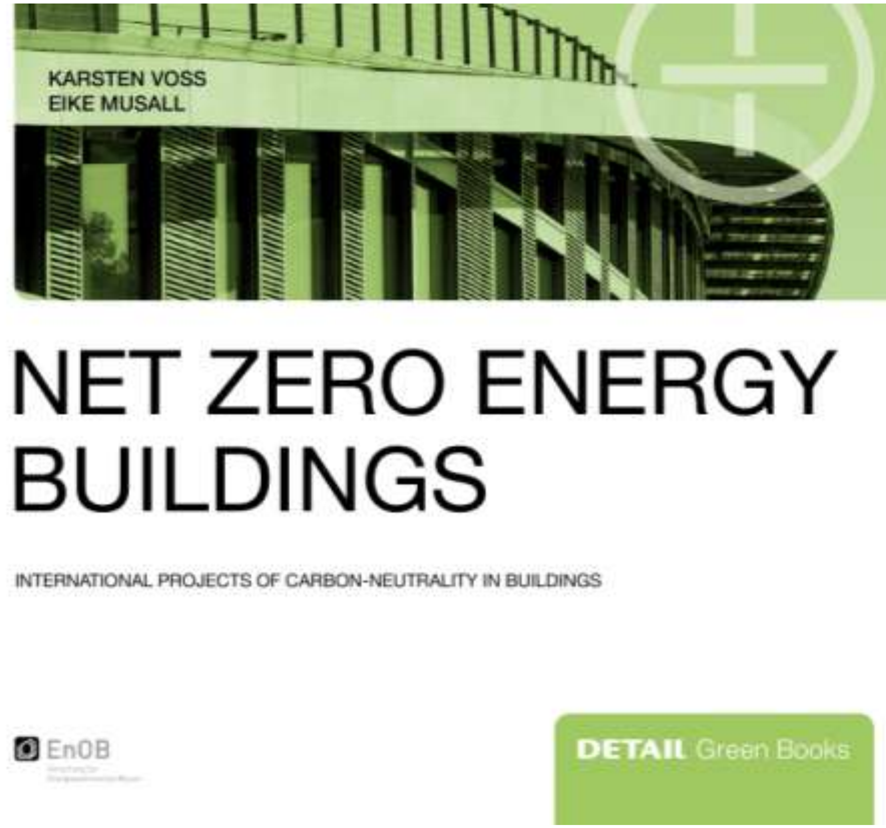
Nullenergiegebäude
Klimaneutrales Wohnen und Arbeiten im internationalen Vergleich
Karsten Voss
Eike Musall
EnOB
DETAIL Green Books

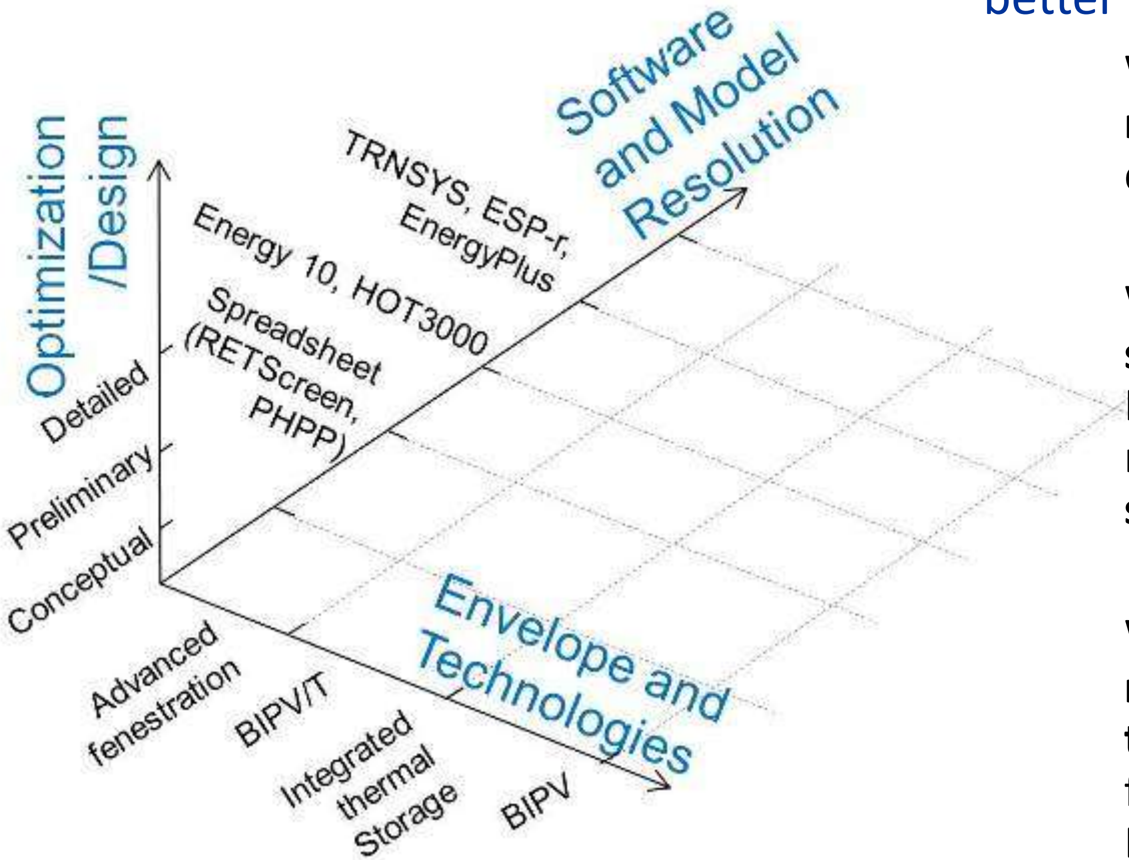

KARSTEN VOSS
EIKE MUSALL
NET ZERO ENERGY BUILDINGS
INTERNATIONAL PROJECTS OF CARBON-NEUTRALITY IN BUILDINGS
EnOB
DETAIL Green Books

World Wide Net ZEB Map

Continuous integration of relevant projects, future integration of ST C project analysis and research spread sheets

See: http://www.enob.info/en/net-zero-energy-buildings/map/

Subtask B: Design Process & Tools



- Access to data on technologies and design methodology to give better models

What is the appropriate **model resolution** for each stage of the design?

What is **the role of simple spreadsheet-based tools** (e.g., RETScreen and PHPP) versus more advanced **detailed simulation?**

What other tool **capabilities are needed to model new technologies such as building** fabric-integrated storage (PCMs), BIPV/T?

A detailed look at the design process and tools from real projects to draw general lessons

Framework

1. Document the following:
   - the design process
   - which modeling tools were used and how
   - notable features of each building
   - gaps of existing tools in designing NZESBs.
   - building energy use and comfort
2. Study accuracy of modeling tools and use calibrated energy models to analyze building performance
3. Explore opportunities for cost reduction or further energy reduction using optimization tools.

Case Studies selected

1) EcoTerra House, Eastman (near Montreal), Canada

2)EnerPos , Saint-Pierre, Reunion Island, France

3) NREL Research Support Facilities (RSF), Golden, USA

4) Leaf House, Angeli di Rosara, Italy

EcoTerra^{TM} EQuilibrium House
Demonstration Project

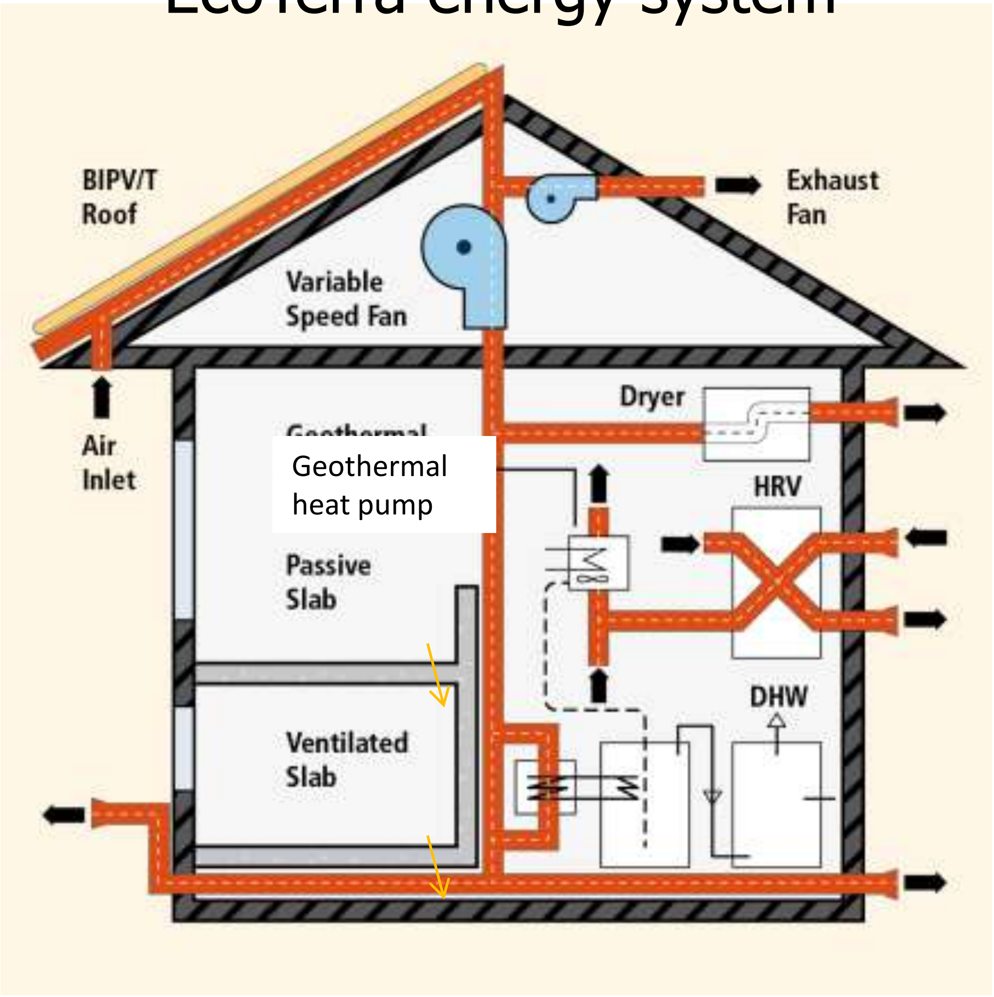
2.8-kW Building-integrated PV-thermal system

Passive solar design: Optimized triple glazed windows and thermal mass

Ground-source heat pump

Passive design and integration with active systems

EcoTerra energy system



Near net-zero house; a higher efficiency PV system covering same area would result in net-zero.

Study of occupancy factors indicated importance of controls.

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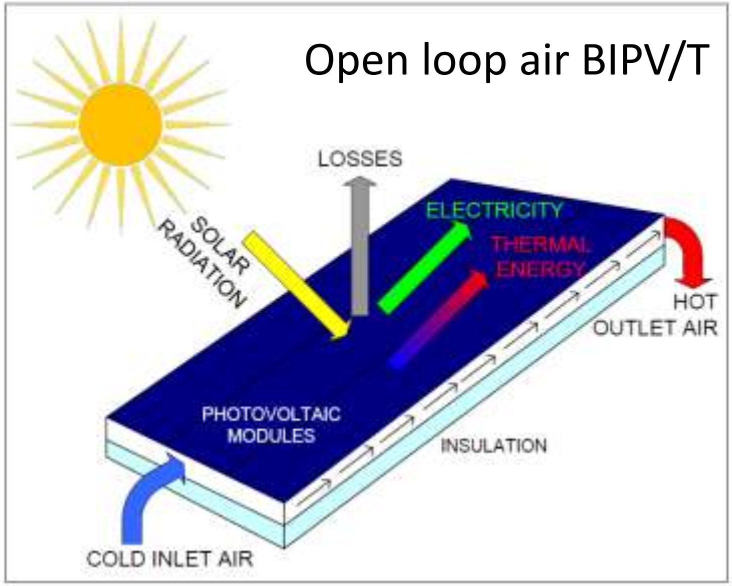
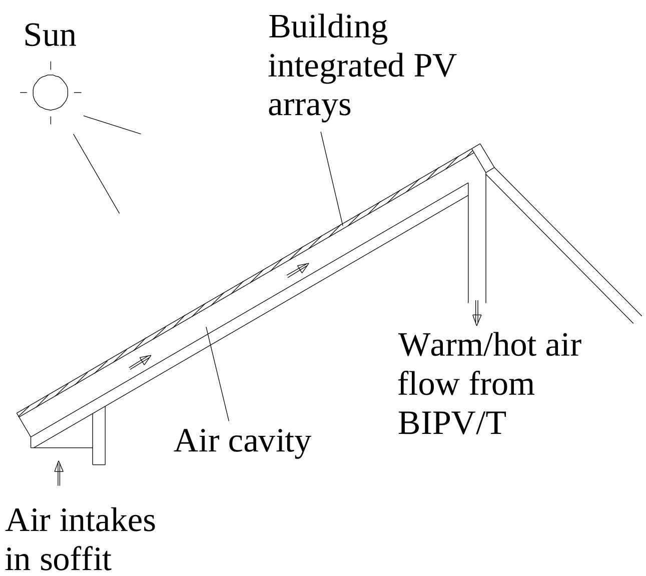
BIPV – integration in EcoTerra

- Building integration: integration with the roof (envelope) and with HVAC
- BIPV/T – (photovoltaic/thermal systems): heat also recovered from the PV panels, raising overall solar energy utilization efficiency
- Heat recovery may be open loop with outdoor air or closed loop with a circulating liquid; possibly use a heat pump

Open loop air BIPV/T



BIPV/T roof construction in Maisons Alouettes factory as one system – a major Canadian innovation



Based on research and simulation models developed at Concordia

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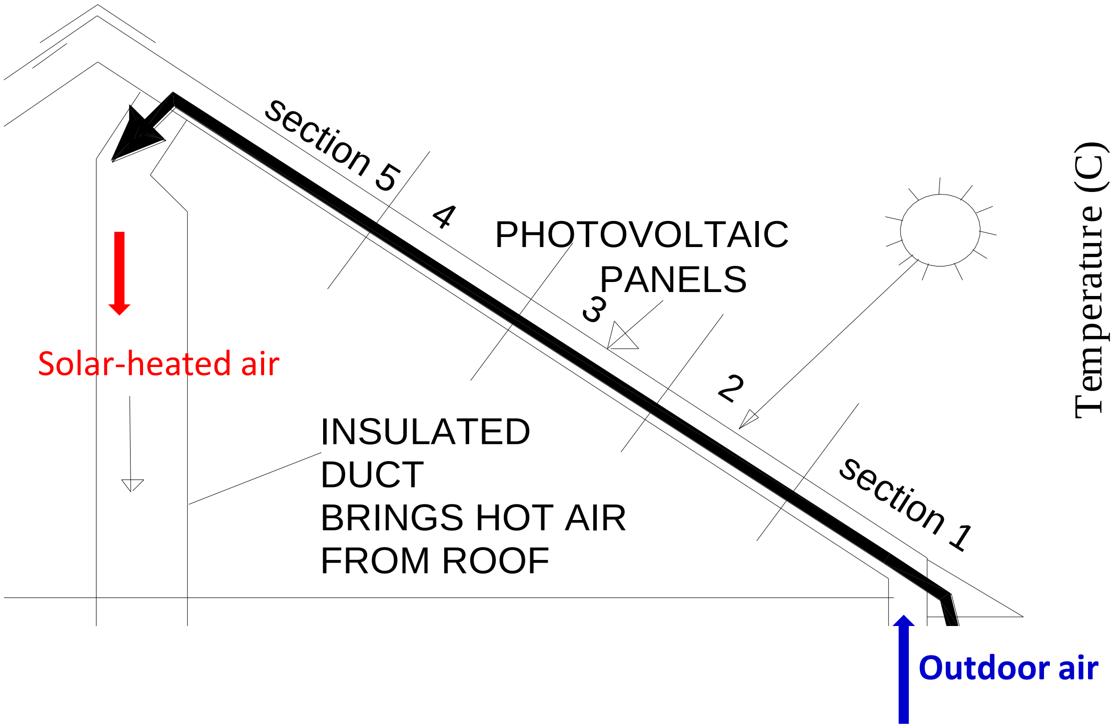
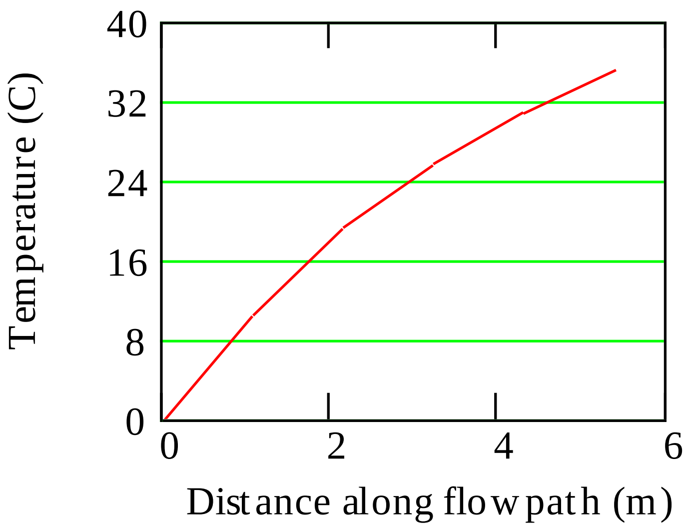
BIPV/T roof in 5 sections for analysis: Energy model





Building simulation: Similar modelling is done at Polytechnique on geothermal systems, Queen's U. on solar cooling, Carleton on seasonal storage and Waterloo/Ryerson on fenestration

Assembly of EcoTerra Modules (in ~ 5 h)

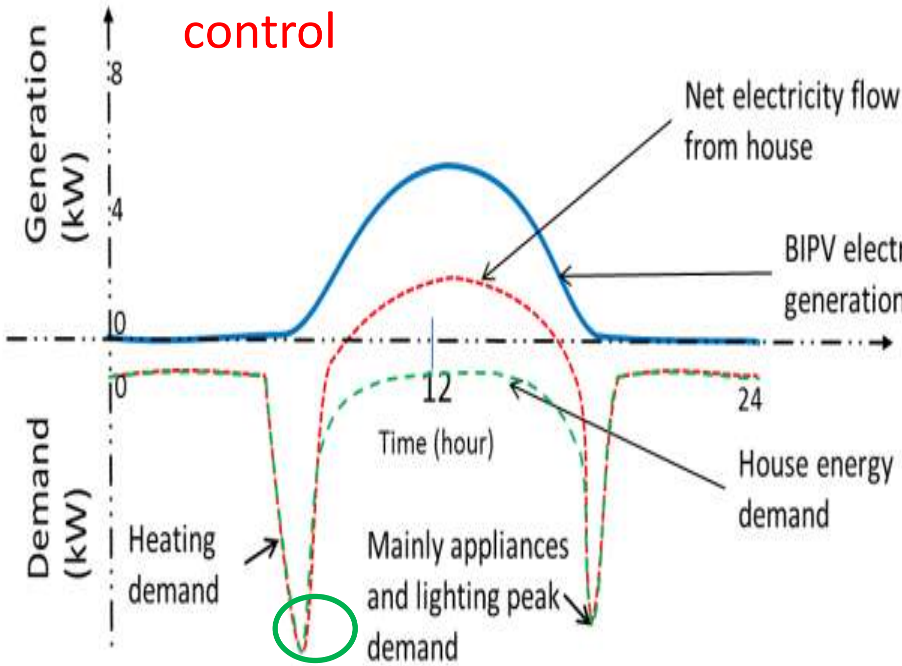
Prefabrication/pre-engineering can reduce cost of BIPV through integration

Built quality is enhanced

Demand/generation profiles and Grid Interaction

STB will study means of reducing peak demand from NZESBs and dynamic mismatch

Peak heating demand can be reduced through predictive control



NZEBs need to be designed to ensure a predictable impact on the grid and to reduce and shift peak demand

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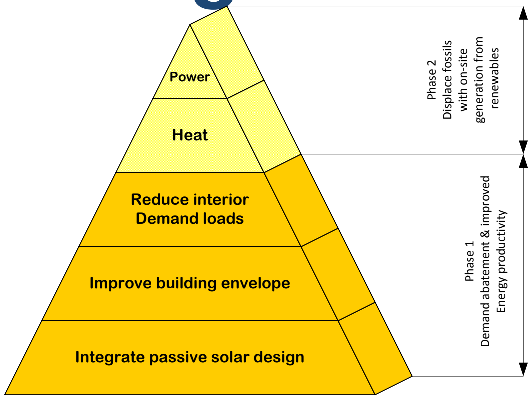
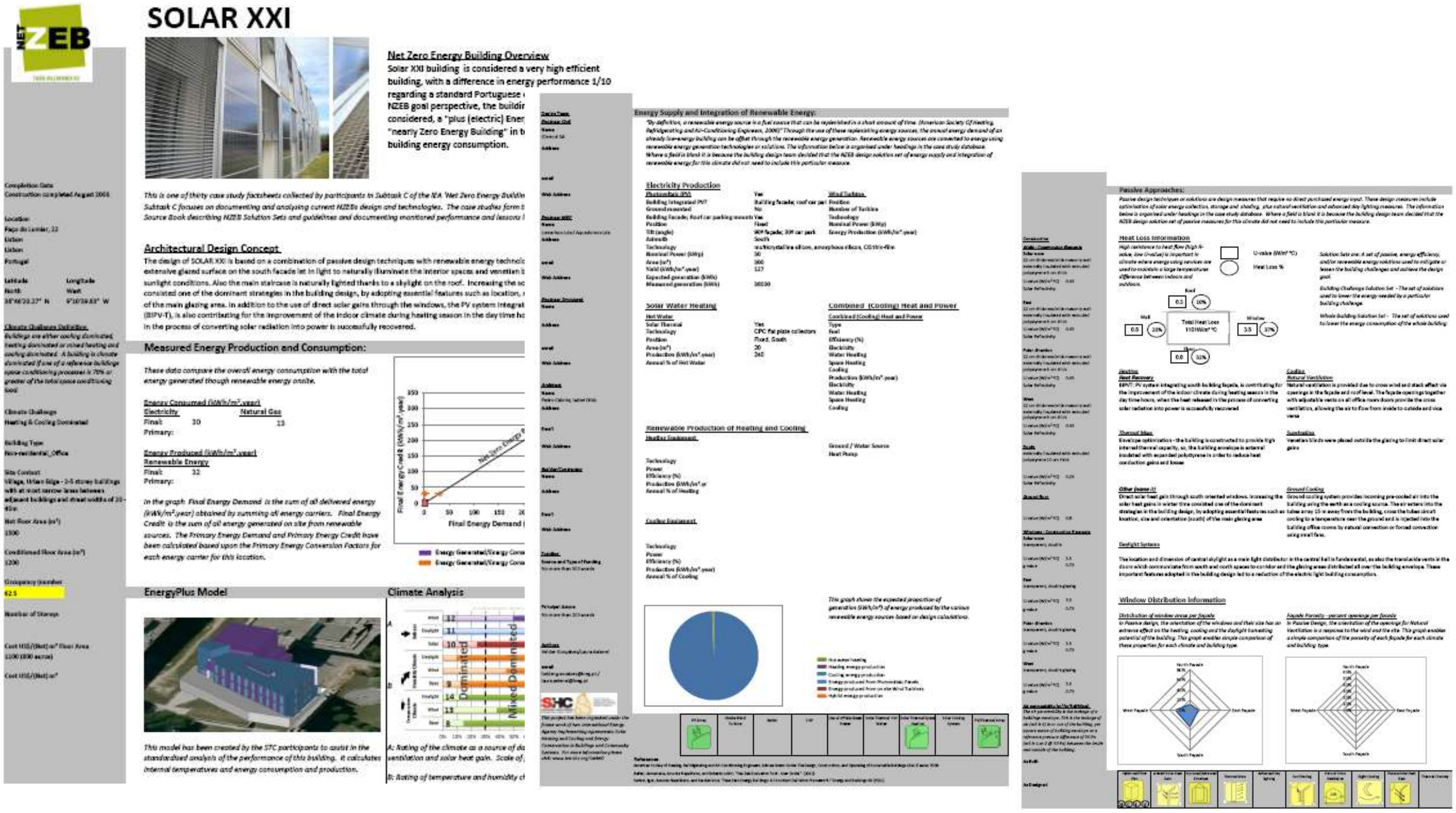
Subtask C: Advanced Building Design, Technologies & Engineering



	Solution Set Categories		
Climate	**Passive approaches & envelope**	**Energy efficient systems**	**Renewable energy**
Heating Dominated	A (Tobias Weiss) NZ (Michael Donn) D (Eike Musall)	ES (Eduard Cubi) DK (Kim Wittchen)	N (Harald N. Rostvik) NZ (Shaan Cory)
Cooling Dominated	UK (Masa Noguchi) F (Francois Garde)	AU (David Waldren) IT (Maddalena)	IT (Alessandra Scognamiglio) F (Aurelie Lenoir)
Heating and Cooling Dominated	IT (Roberto Lollini) PT (Laura Aelenei)	C (Michel Tardif) K (Yang Giyoung)	K (Jun Tae Kim) PT (Daniel Aelenei)

Solution sets – 30 Case studies



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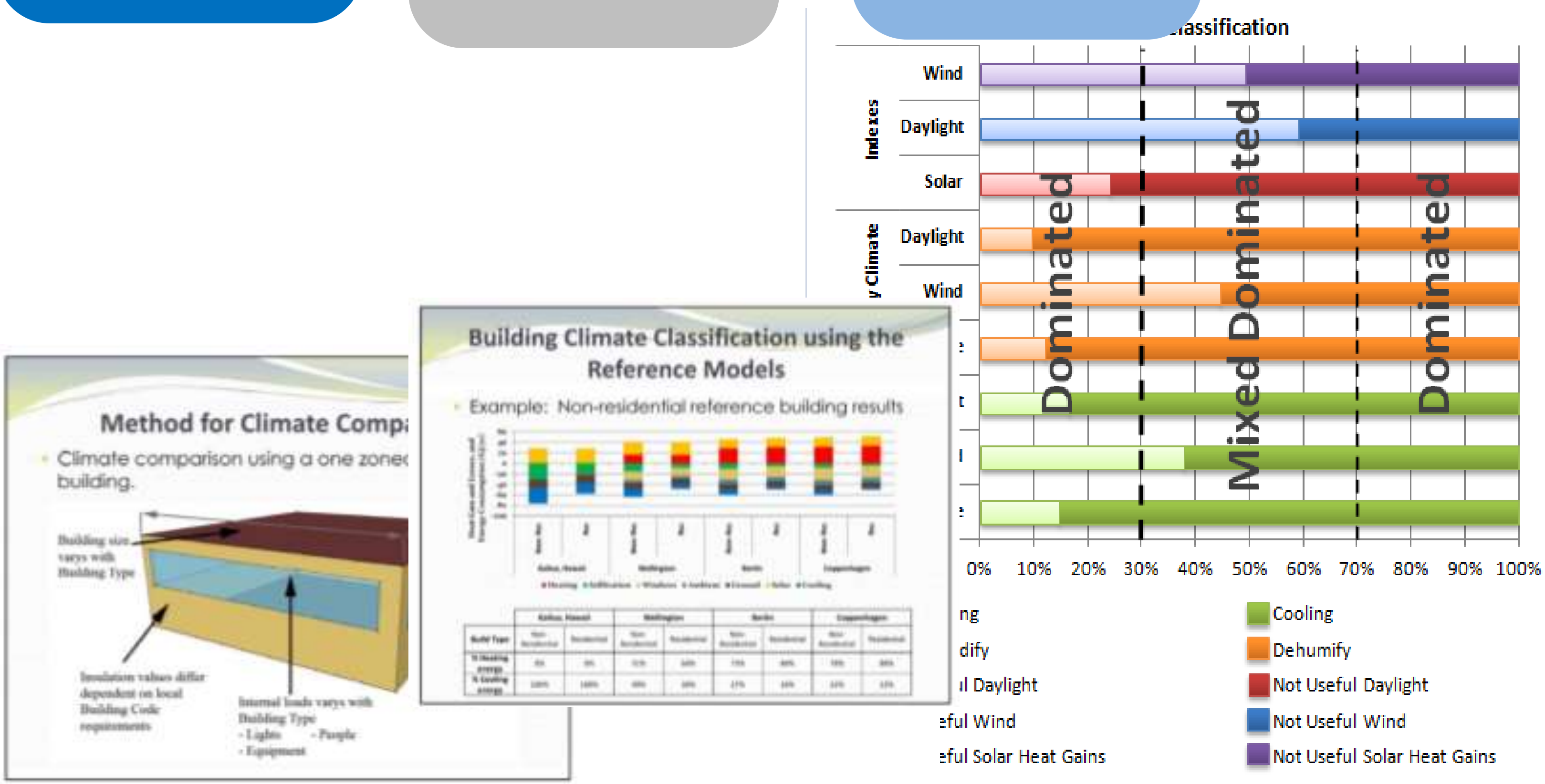
SOLUTION SETS – CLIMATE CLASSIFICATION

HEATING DOMINATED CLIMATE

HEATING AND COOLING DOMINATED CLIMATE

COOLING DOMINATED CLIMATE



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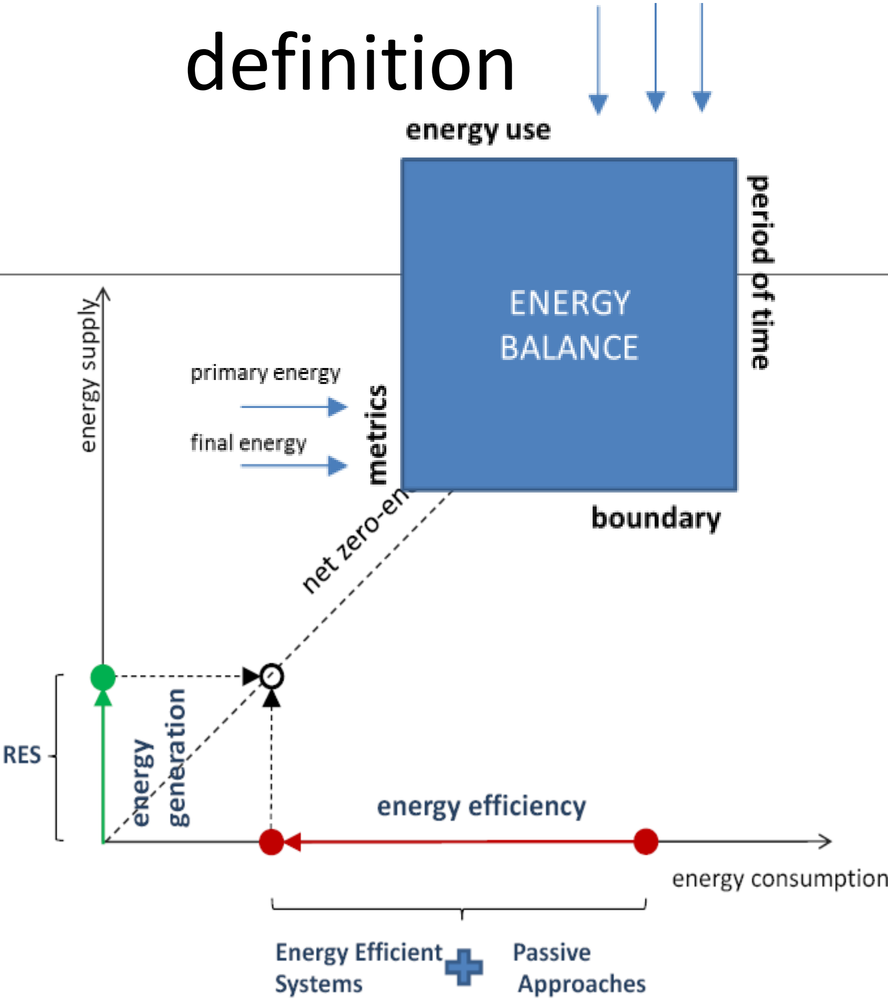
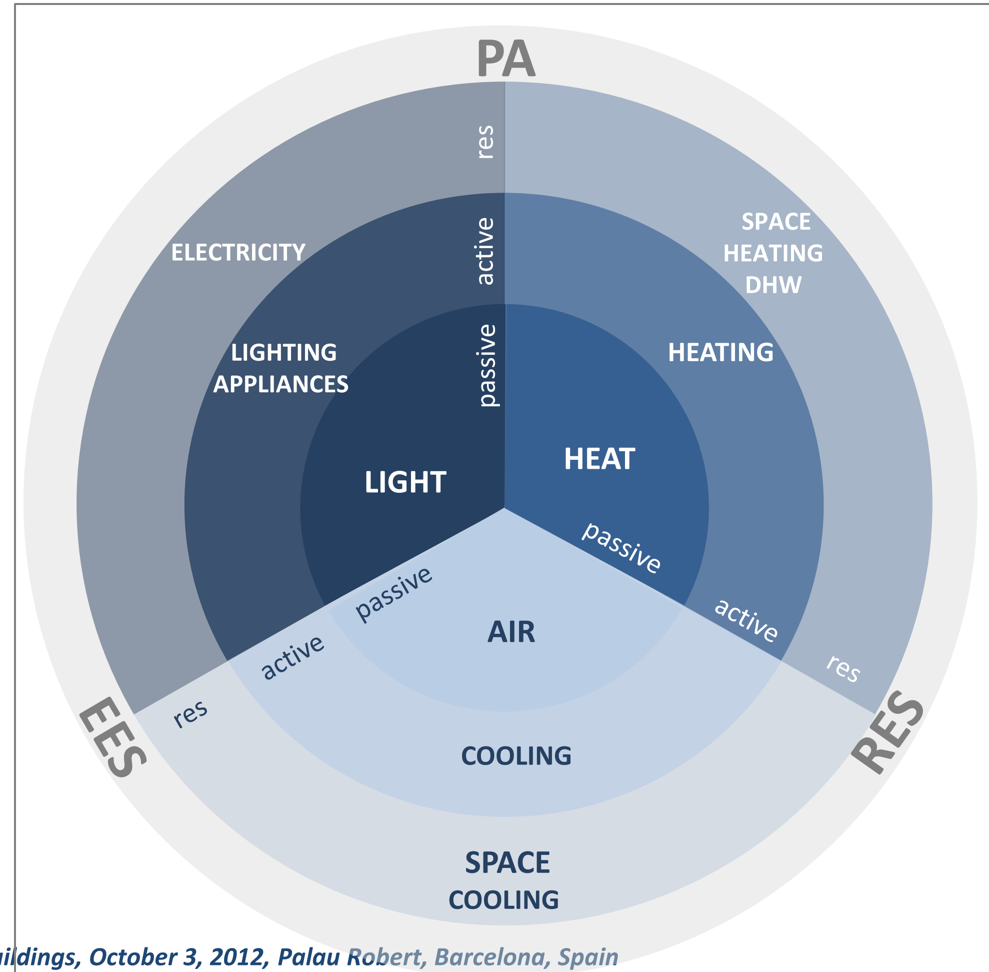
SOLUTION SETS

NZEB definition



NZEB design



SOLUTION SETS

	CHALLENGES	STRATEGIES	MEANS
PASSIVE APPROACHES	HEATING COOLING DAYLIGHTING	PREVENTION REJECTION MODULATION/CONTROL	INSULATION SOLAR PROTECTION LARGE WINDOWS AREA
ENERGY EFFICIENT SYSTEMS	HEATING COOLING ARTIFICIAL LIGHTING PLUG LOADS	HVAC DESIGN EQUIPMENT SIZING	HVAC LOW EXERGY SYSTEMS …
RENEWABLE ENERGY SYSTEMS	EXPORT ELECTRICITY HEATING/COOLING DHW	POWER GENERATION HEAT GENERATION CHP	PV SOLAR COLLECTORS GEOTH.HEAT PUMP

Matrix of design solutions

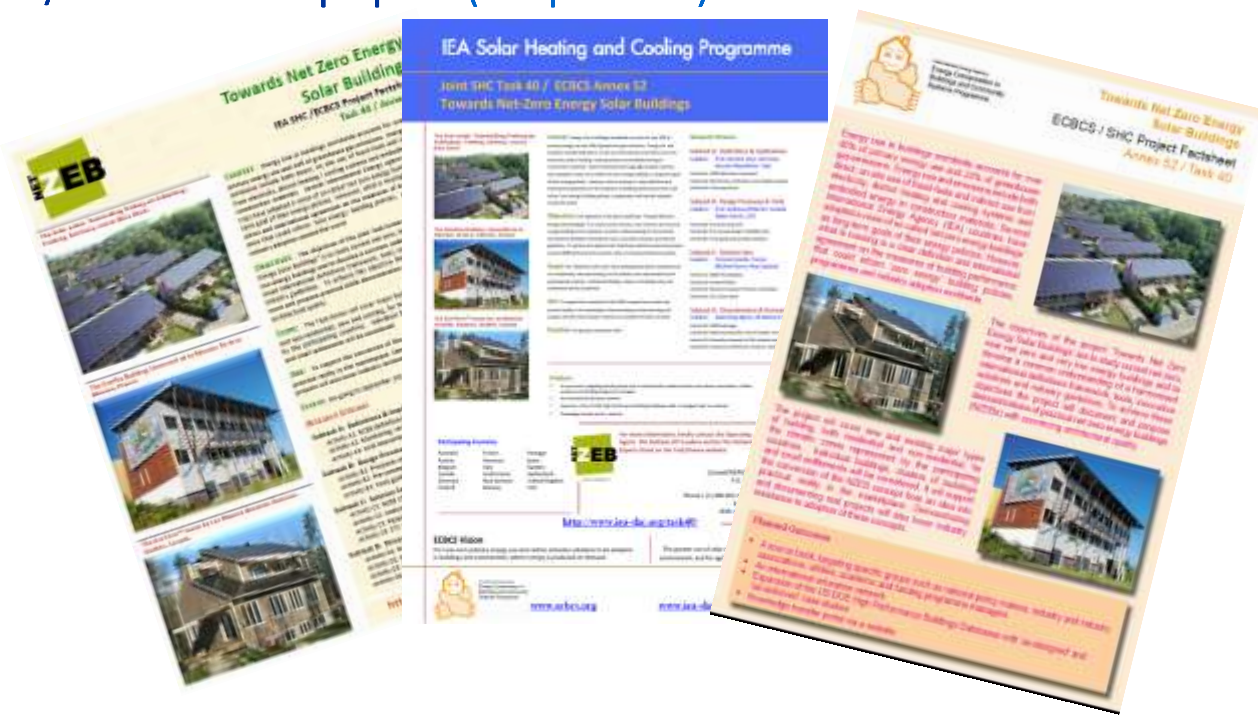
Passive Approaches

Energy Efficiency Systems

Renewable Energy Systems — geothermal heat pump; other (air heat pump, biomass, CHP); photovoltaic; solar thermal collectors

Subtask D: Dissemination & Outreach

- Task website: http://www.iea-shc.org/task40
- Task flyers / info brochures
- Technical Reports
- Work/conference papers(13 posted)



Thank you

Operating Agent

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