Design issues For Net Zero Energy Buildings

LNEG
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GOVERNO DE PORTUGAL | MINISTÉRIO DA ECONOMIA E DO EMPREGO

Summary

1. Context

Building regulation/Policy requirements

Scientific advancements

2. Design issues for NZEB

General ideas

Solar XXI building

context

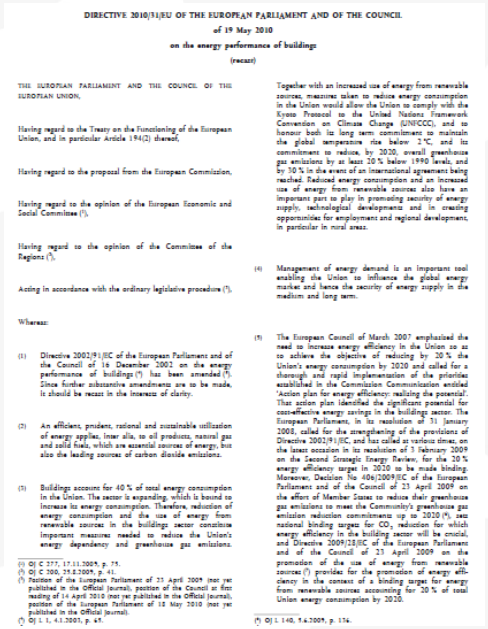
NZEB - International Initiatives

- *IEA Joint Project Solar Heating & Cooling Programme*: Towards Net Zero Energy Solar Buildings (Task 40)
- *World Business Council for Sustainable Development's Energy Efficiency in Buildings* (EEB) project - leading industry-only group
- *World Green Building Council* (WorldGBC) - union on national Green Building Councils
- *Net-Zero Energy Home* (NZEH) Coalition
- *The Zero Energy Commercial Buildings Database*
- *Massachusetts Zero Net Energy Buildings Task Force*
- *Zero Energy Building Research Alliance* (ZEBRAlliance)
- *ASHRAE: Guidance for Net-Zero Energy Design*
- *California's Long Term Energy Efficiency Strategic Plan* includes two "Big Bold Strategies" on zero energy buildings

NZEB - EU Initiatives

- ***DIRECTIVE 2010/31/EU: Recast of Directive on Energy Performance of Buildings 2010***
- *Buildings Performance Institute Europe (BPIE)*
- *Concerted Action (CA) EPBD*
- *BUILD UP* - The web portal was established by the European Commission in 2009
- *Intelligent Energy Europe (IEE)* - a number of ongoing research projects

DIRECTIVE 2010/31/EU
Recast of Directive on Energy Performance of Buildings 2010



DIRECTIVE 2010/31/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL
of 19 May 2010
on the energy performance of buildings
(recast)

THE EUROPEAN PARLIAMENT AND THE COUNCIL OF THE EUROPEAN UNION,

Having regard to the Treaty on the Functioning of the European Union, and in particular Article 194(2) thereof,

Having regard to the proposal from the European Commission,

Having regard to the opinion of the European Economic and Social Committee (1),

Having regard to the opinion of the Committee of the Regions (2),

Acting in accordance with the ordinary legislative procedure (3),

Whereas:

(1) Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 on the energy performance of buildings (4) has been amended (5). Since further substantive amendments are to be made, it should be recast in the interests of clarity.

(2) An efficient, prudent, rational and sustainable utilisation of energy applies, inter alia, to oil products, natural gas and solid fuels, which are essential sources of energy, but also the leading sources of carbon dioxide emissions.

(3) Buildings account for 40 % of total energy consumption in the Union. The sector is expanding, which is bound to increase its energy consumption. Therefore, reduction of energy consumption and the use of energy from renewable sources in the buildings sector constitute important measures needed to reduce the Union's energy dependency and greenhouse gas emissions.

Together with an increased use of energy from renewable sources, measures taken to reduce energy consumption in the Union would allow the Union to comply with the Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC), and to honour both its long term commitment to maintain the global temperature rise below 2 °C, and its commitment to reduce, by 2020, overall greenhouse gas emissions by at least 20 % below 1990 levels, and by 30 % in the event of an international agreement being reached. Reduced energy consumption and an increased use of energy from renewable sources also have an important part to play in promoting security of energy supply, technological development and in creating opportunities for employment and regional development, in particular in rural areas.

(4) Management of energy demand is an important tool enabling the Union to influence the global energy market and hence the security of energy supply in the medium and long term.

(5) The European Council of March 2007 emphasised the need to increase energy efficiency in the Union so as to achieve the objective of reducing by 20 % the Union's energy consumption by 2020 and called for a thorough and rapid implementation of the priorities established in the Commission Communication entitled 'Action plan for energy efficiency: realising the potential'. That action plan identified the significant potential for cost-effective energy savings in the buildings sector. The European Parliament, in its resolution of 31 January 2008, called for the strengthening of the provisions of Directive 2002/91/EC, and has called at various times, on the latest occasion in its resolution of 3 February 2009 on the Second Strategic Energy Review, for the 20 % energy efficiency target in 2020 to be made binding. Moreover, Decision No 406/2009/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020 (6), sets national binding targets for CO_2 reduction for which energy efficiency in the building sector will be crucial, and Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources (7) provides for the promotion of energy efficiency in the context of a binding target for energy from renewable sources accounting for 20 % of total Union energy consumption by 2020.

(1) OJ C 277, 17.11.2005, p. 75.
(2) OJ C 200, 25.8.2005, p. 41.
(3) Position of the European Parliament of 23 April 2009 (not yet published in the Official Journal), position of the Council at first reading of 14 April 2010 (not yet published in the Official Journal), position of the European Parliament of 18 May 2010 (not yet published in the Official Journal).
(4) OJ L 1, 4.1.2003, p. 65.
(5) OJ L 140, 5.6.2009, p. 16.

EPBD Recast

"nearly zero energy building"[…] has **a very high 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 on-site or nearby [EPBD]

Article 9
Nearly zero-energy buildings

- by 31 December 2020, all new buildings are nearly zero-energy buildings;
- after 31 December 2018, new buildings occupied and owned by public authorities are nearly zero-energy buildings.
- draw up national plans for nZEB public sector leading example
  - Interim target by 2015
  - National definition for nZEB/NZEB (including building retrofit towards NZEB levels

Planned initiatives towards nZEB

Country/year	Existing	2010-11	2012-13	2014-15	2016	2020
Austria	66.5 kWh/m²/year (final energy)	-15 %				
Belgium	119-136 kWh/m²/year (primary energy)	-25 %				
Denmark	2010: 52.5-80 kWh/m²/year (primaryl energy)	-25 %		-50 %		-75 %
Finland	65 kWh/m²/year (heating demand)	-15-30 %	- 20 %	Passive house for public		
France	Until 2012: Fossil fuels: 90-130 kWh/m²/year Electricity 130-250 kWh/m²/year (primary energy)		LEB Effinergie 50 kWh/m²/year			Postive E+
Germany	2009: 70 kWh/m²/year (primary energy)		-30%			Climate neutral buildings not using fossil fuels
Ireland	2011: 64 kWh/m²/year (primary energy)	-60 %	CO_2 neutral			
Netherlands	Regulated through EPC factor 2008: ~100-130 kWh/m²/year (primary energy)	-25 %	Climate neutral public building	- 50 %		Energy neutral buildings
Norway	2010:150 kWh/m²/year (net heating demand)			Passive House		ZEB
Sweden	2009:110-150 kWh/m²/year (delivered energy)	-20 %		25 % of all new is ZEB		ZEB
Switzerland	2011: 60 kWh/m²/year (primary energy)			Minergie-P 30 kWh/m²/year (delivered energy)		
United Kingdom	Regulated through CO_2 demands 2010: ~100 kWh/m²/year (primary energy)	-25 %	-44 %	-	Zero Carbon	

B. Atanasiu – Challenges for nearly Zero Energy Buildings

Existing standards

MINERGIE®

Energy consumption for:

heating
cooling
ventilation
DHW

< 42 kWh/m2

effinergie

Energy consumption for:

heating
cooling
ventilation
DHW

< 50 kWh/m2

Passive House

Energy consumption for:

heating < 15 kWh/m2

cooling
ventilation
lighting+appliences

< 120 kWh/m2

NZEB is a standard or a policy requirement ?

Some thoughts

- ✓ A *POLICY REQUIREMENT* with clearly quideness: nearly Zero-Energy Buildings - *high energy performance* - *low energy demand* - that should be cover by a *very significant extend* by energy from *renewable sources*
- ✓ Existing differences between calculation method and requirements (climate conditions, different system boundary, different conversion factors for different energy carriers…)
- ✓ Specific *definition* and implementation in *each country*
- ✓ Need for *more guidance* and common understanding for implementing sustainable *definitions*

design

issues

IEA Joint Project: Solar Heating & Cooling Programme

Task 40 Annex 52
Towards Net Zero-Energy Solar Buildings

(October 2008 - September 2013)

International Energy Agency
Energy Conservation in Buildings and Community Systems Programme

SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

Task 40 ECBCS Annex 52
Towards Net Zero-Energy Solar Buildings

net energy buildings CONFERENCE 2012 zero

NET ZEB TASK 40 / ANNEX 52

Task 40 ECBCS Annex 52

DEFINITIONS

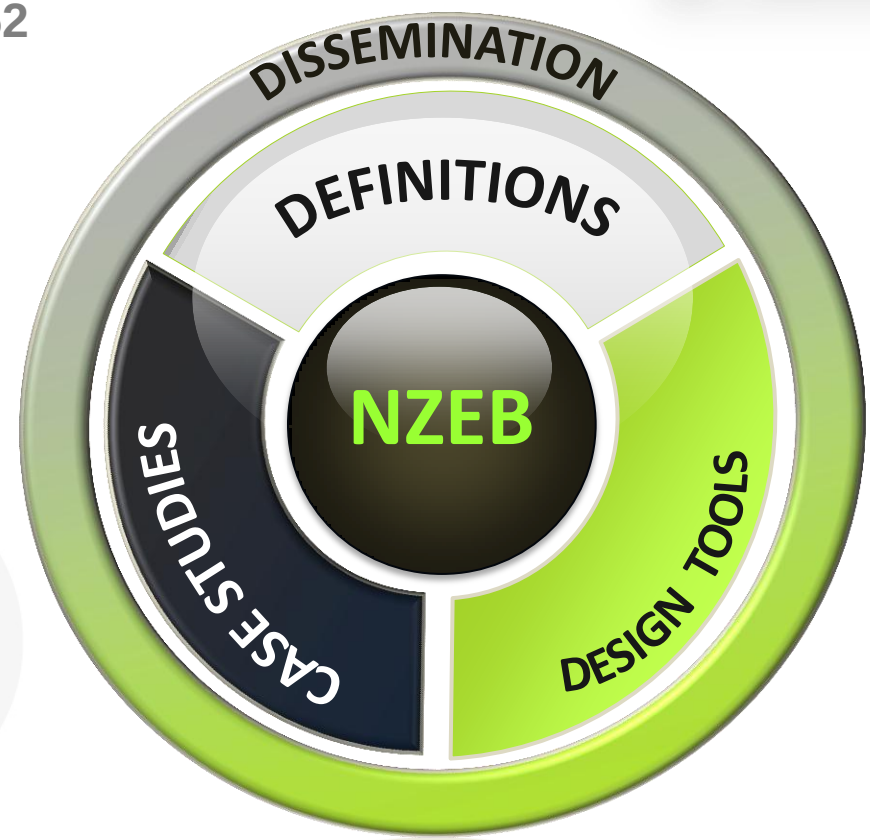
development of a harmonized international definition framework

DESIGN TOOLS

processes and tools currently being used to design NZEBs

CASE STUDIES

investigating advanced integrated design concepts, solution sets of NZEBs



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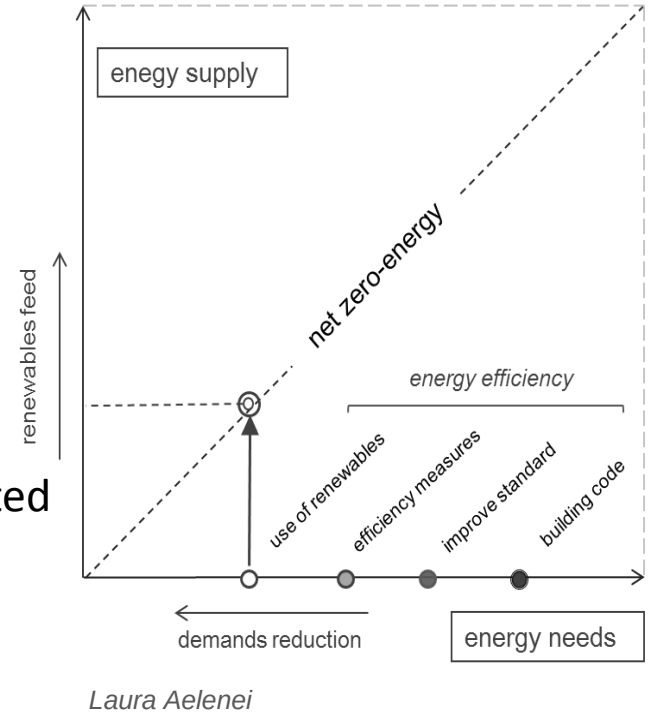
definitions - the basis of NZEB design

Methodology

Efficiency versus Supply



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Metric

- Site energy: *delivered*
- Source energy*: primary*
- Energy costs
- Energy emissions

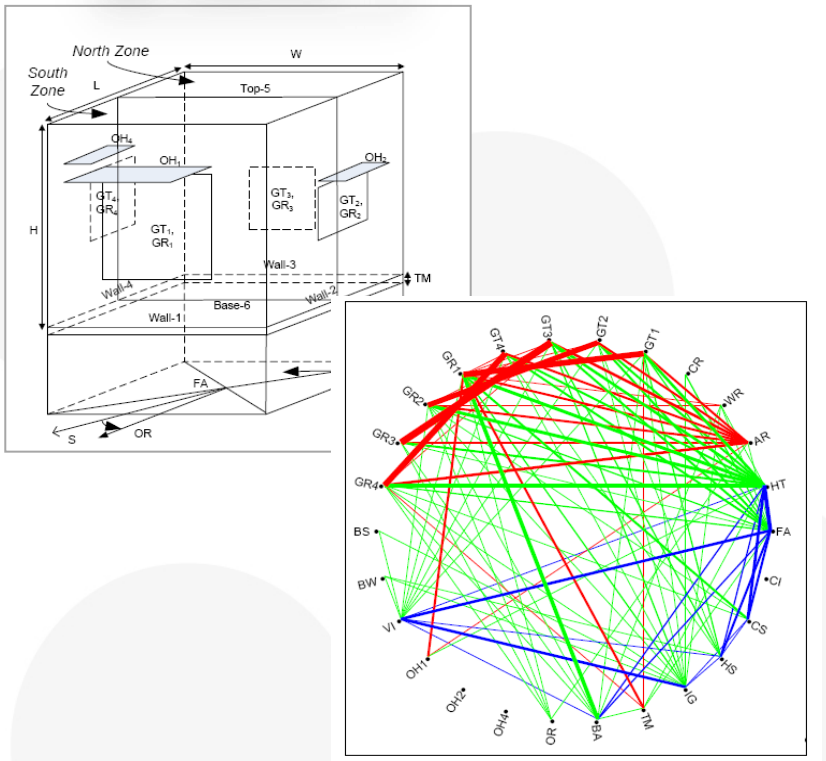
Balance boundary:

- on site - non grid connected
- off site - grid connected
- green energy
- single building
- building cluster

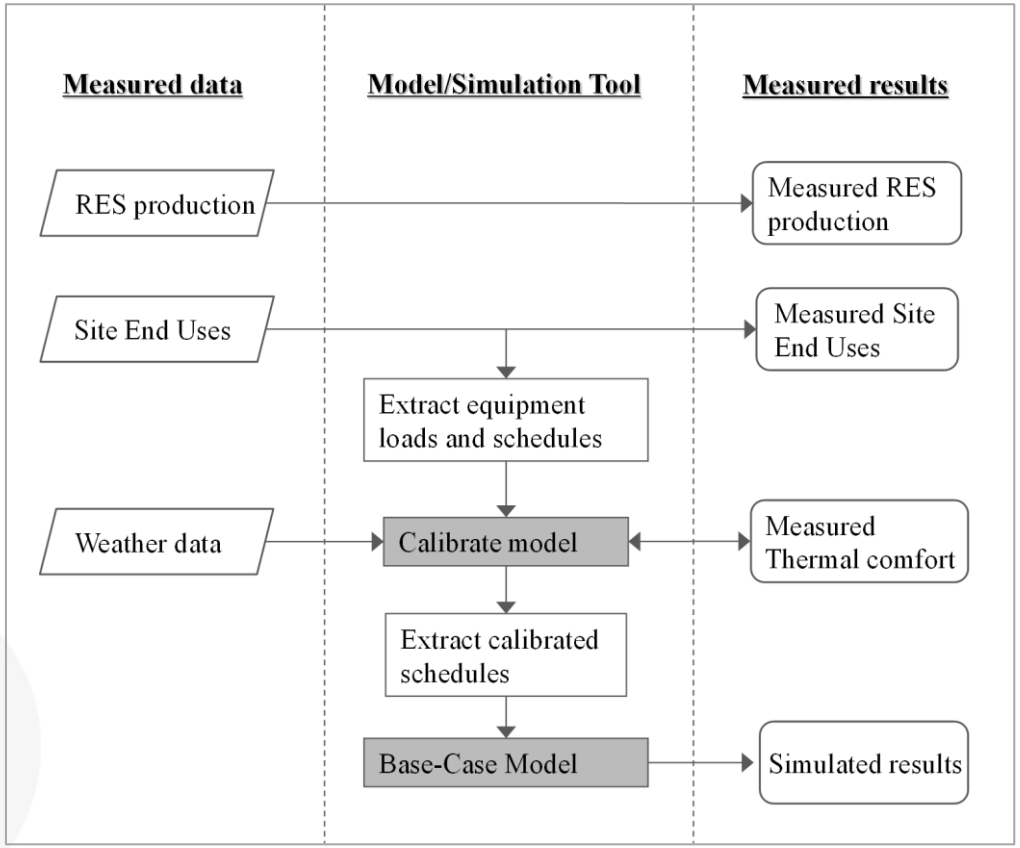
Energy use

- heating
- cooling
- lighting
- DHW
- …

design tools - the mean of the NZEB design



Liam Obrien, Concordia University



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ENERGY PLUS GENOPT TRNSYS

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case studies - the proof of NZEB design

http://www.enob.info/en/site-info/




All these case studies:

- Represent nearly zero, zero or plus-energy buildings
- Energy performance > 50% better than benchmark
- Well documented physical characteristics
- Monitored and simulated energy performance
- Important *lessons learned* from designing, operating, POE

Net Zero Energy Design

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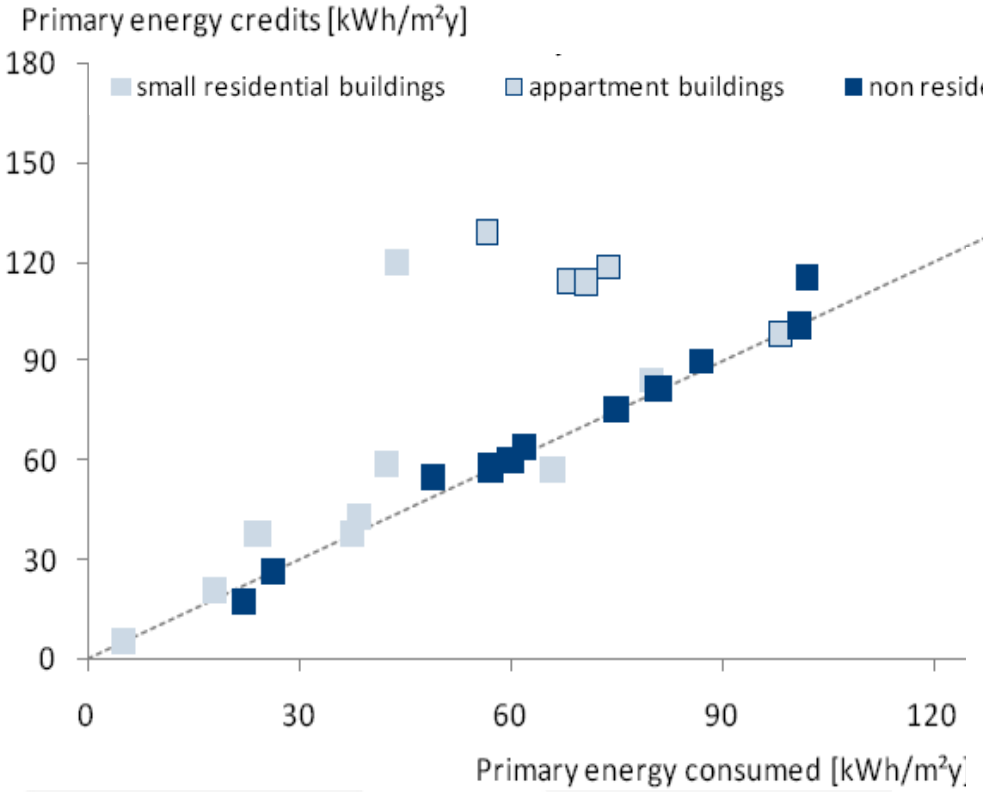
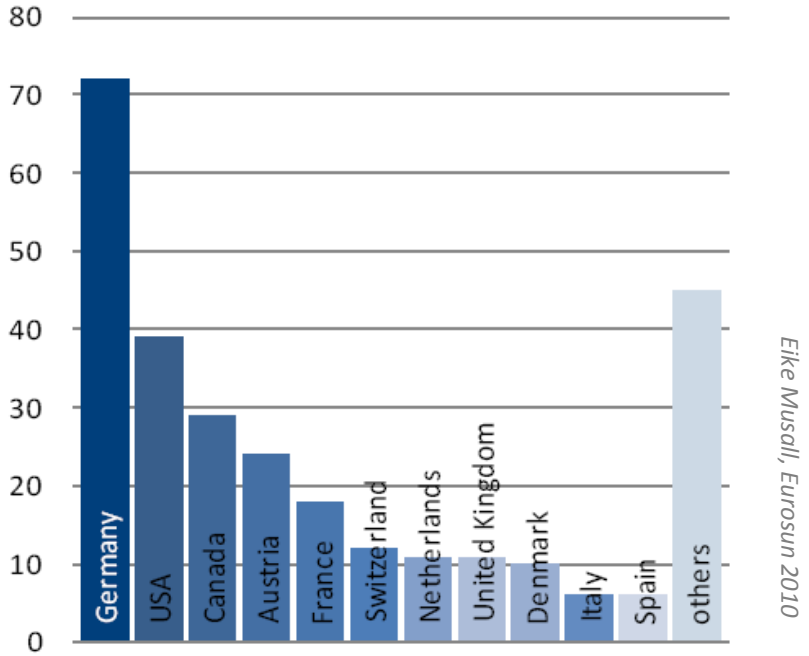
design issues for NZEB

net energy zero buildings CONFERENCE 2012

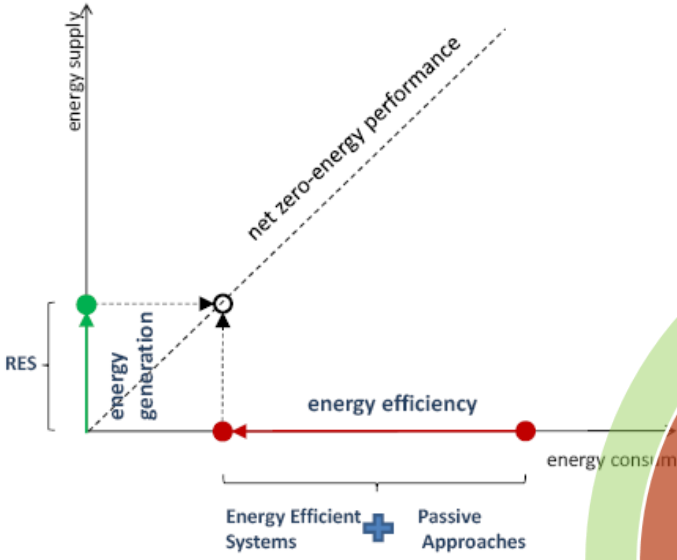


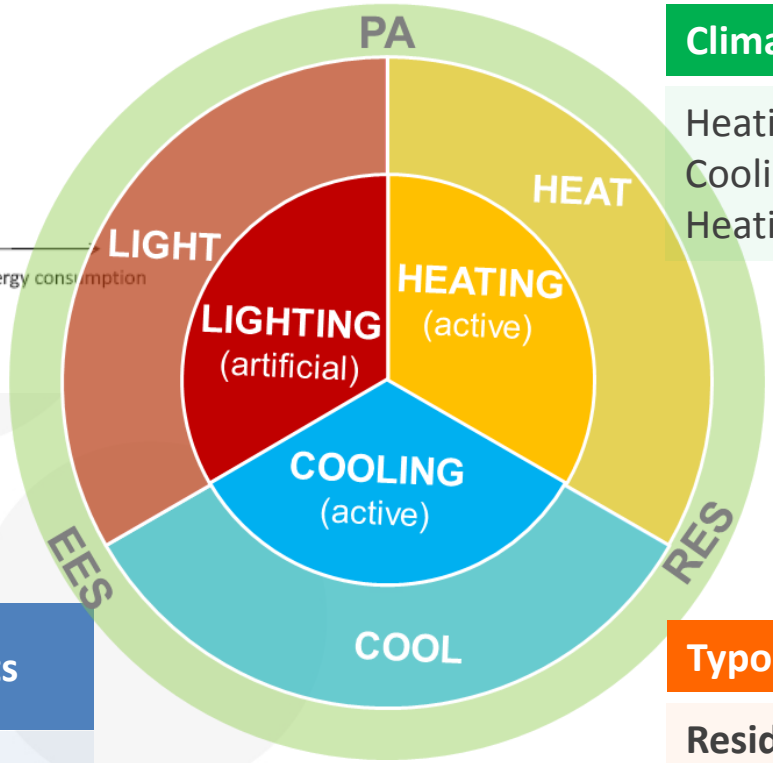


Eike Musall, Eurosun 2010

design issues for NZEB

Net Zero Energy Design





Climate

Heating dominated
Cooling dominated
Heating & Cooling dominated

NZEB Methodology Components

Efficiency:
Passive approaches (PA)
Energy Efficient Systems (EES)

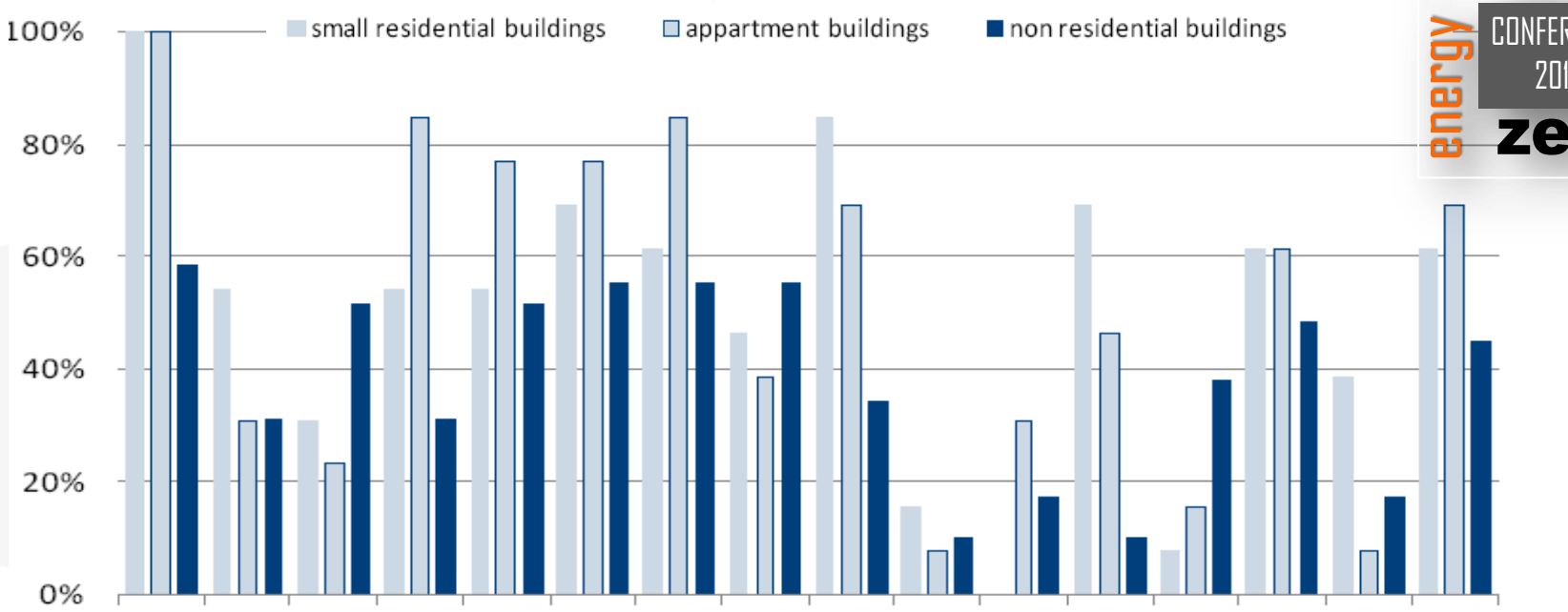
Supply: RES

Typology

Residential Buildings
small, multyfamily, group

Non-residential
office, schools, …

design issues for NZEB



Eike Musall, Eurosun 2010

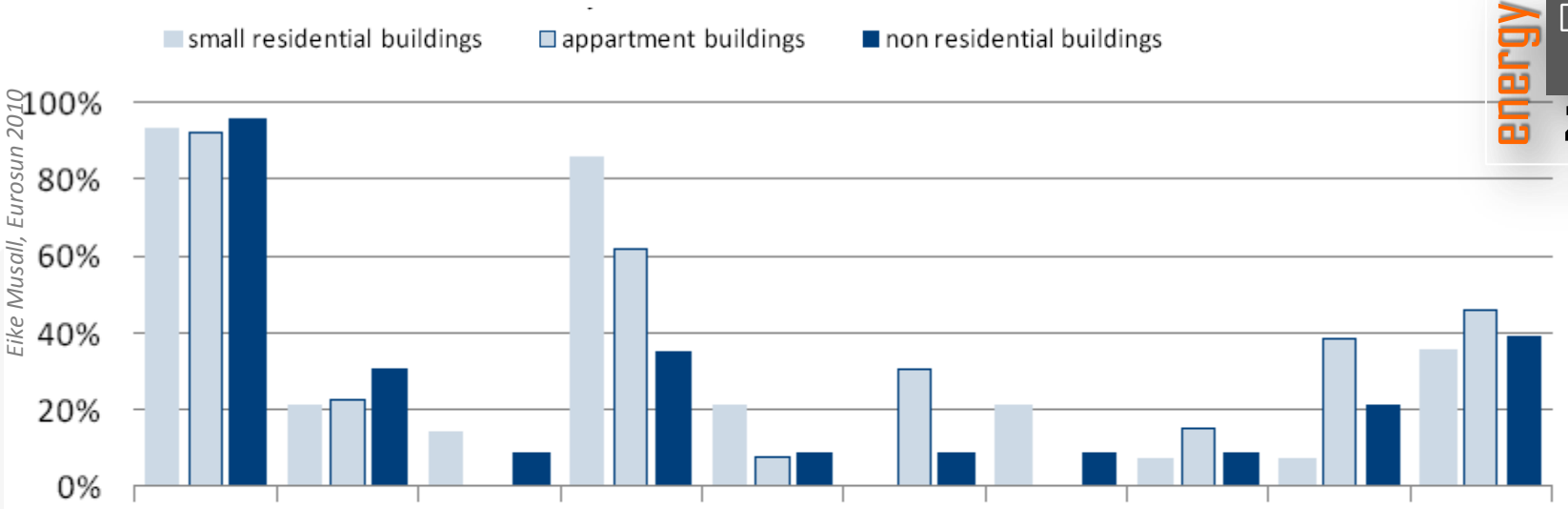
Passive approaches

- ✓ Improved insulation
- ✓ High thermal mass
- ✓ Compactness
- ✓ Passive solar gain
- ✓ Sunshading
- ✓ Heat recovery
- ✓ Energy storage
- ✓ Mechanical ventilation
- ✓ Natural ventilation
- ✓ Cross ventilation
- ✓ Night cooling
- ✓ Green roof/façade
- ✓ Earth tube exchanger

Energy Efficient Systems

- ✓ Efficient appliances
- ✓ Efficient office equipment
- ✓ Efficient HVAC
- ✓ LED lighting

design issues for NZEB



Eike Musall, Eurosun 2010

Renewable Energy Systems

- ✓ PV: roof top, façade, on site
- ✓ Solar Thermal DHW
- ✓ Solar Thermal Heating
- ✓ Wind power off-site
- ✓ Biomass Boiler
- ✓ CHP (Fossil/Biomass)
- ✓ Geothermal Heat Pump

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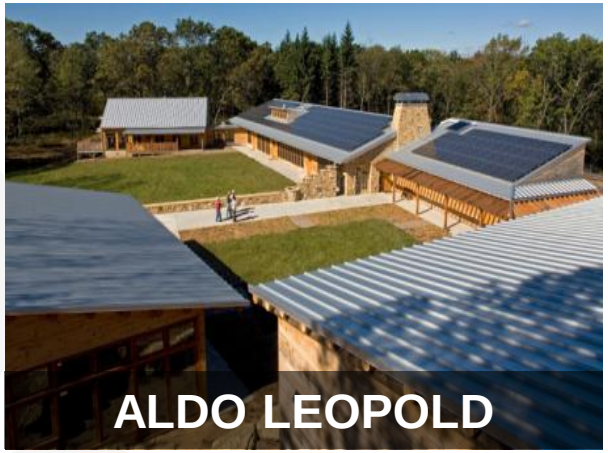
Architectural integration



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Architectural integration

SOLAR XXI

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design issues for NZEB

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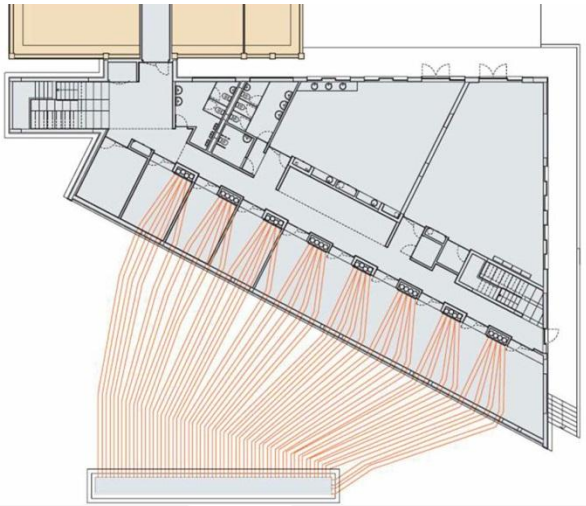

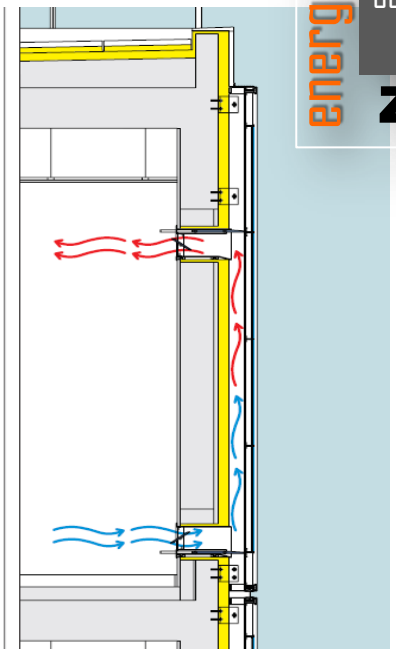

ENERGY EFFICIENCY

High thermal mass
Passive solar heat gains
Improved insulation
BIPV-T
Natural ventilation, cross ventilation, night cooling
Sunshading
Ground cooling system
Natural lighting

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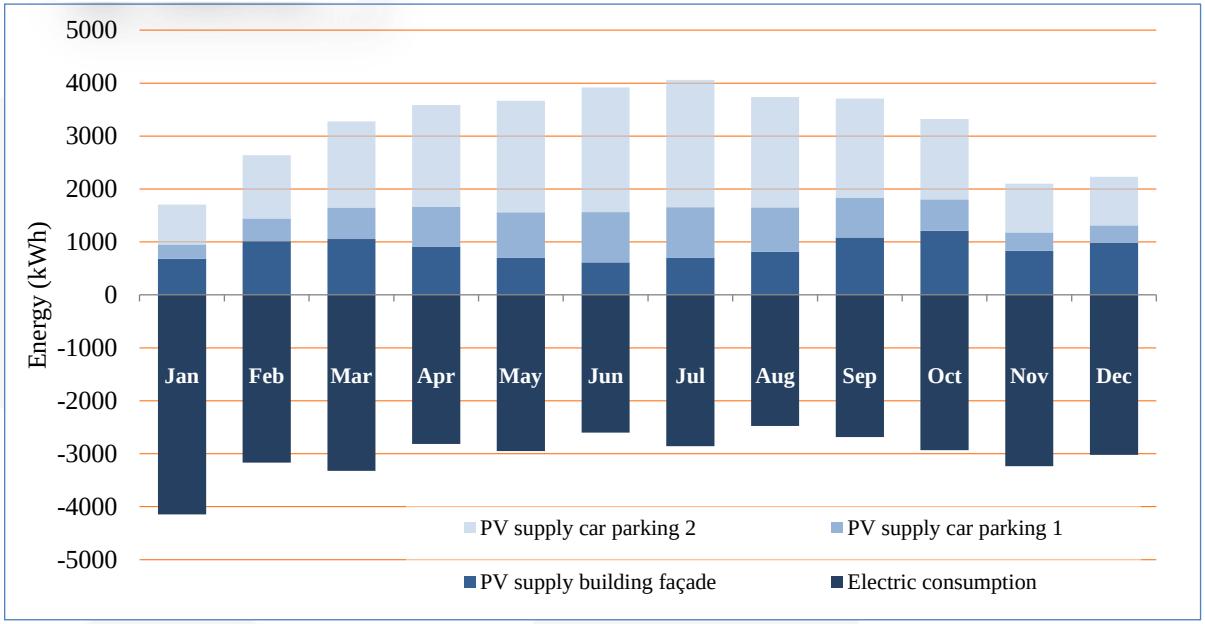
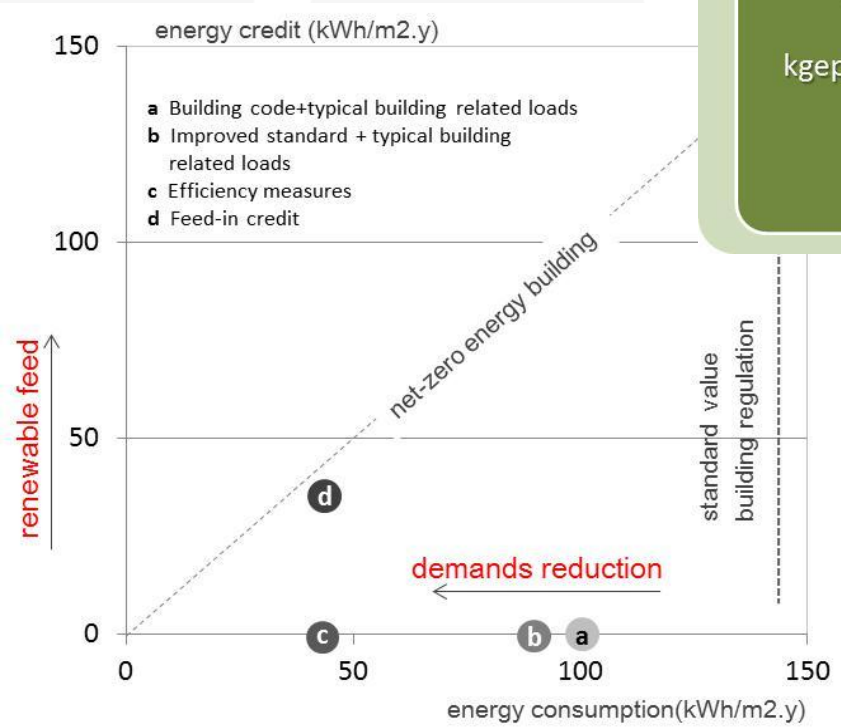
design issues for NZEB



RES	Integration	Area (m^2)	Installed Peak power (kW)	Productivity (kWh/kW)
76 PV multicristalline silicon modules	Building façade	96	12	1004
100 PV amorphous silicon	Car parking 1	95	6	1401
150 PV CIS thin-film modules	Car parking 2	110	12	1401
CPC Thermal Solar Collectors	Building roof	16	11 MWh, from which 5MWh being used	

NZEB performance



IEE SOLAR XXI (real)	IEE SOLAR XXI (typical user related loads)	IEE Standard value office building
2.8 kgep/(m2.year)	16 kgep/(m2.year)	30 kgep/(m2.year)

Energy performance for office buildings
IEE (Energy Eficiency Indicator)

Thank you

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