A Integração de Energias Renováveis nos Edifícios
“*Conceito de NZEB e Smart Cities*”

Helder Gonçalves e Laura Aelenei

26 de Março de 2012

Tópicos a abordar...

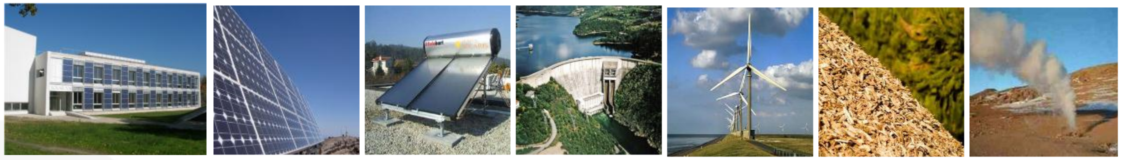
1. *Energias Renováveis no Contexto de Produção Centralizada*

2. *Energias Renováveis no Contexto de Integração nos Edifícios e Espaço Urbano*

   - *NZEB (Net Zero Energy Buildings)*

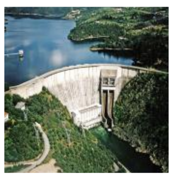
   - *Smart Cities*

Energias Renováveis no Contexto de Produção Centralizada



solar fotovoltaica

solar térmica



hidrica

eolica

bioenergia

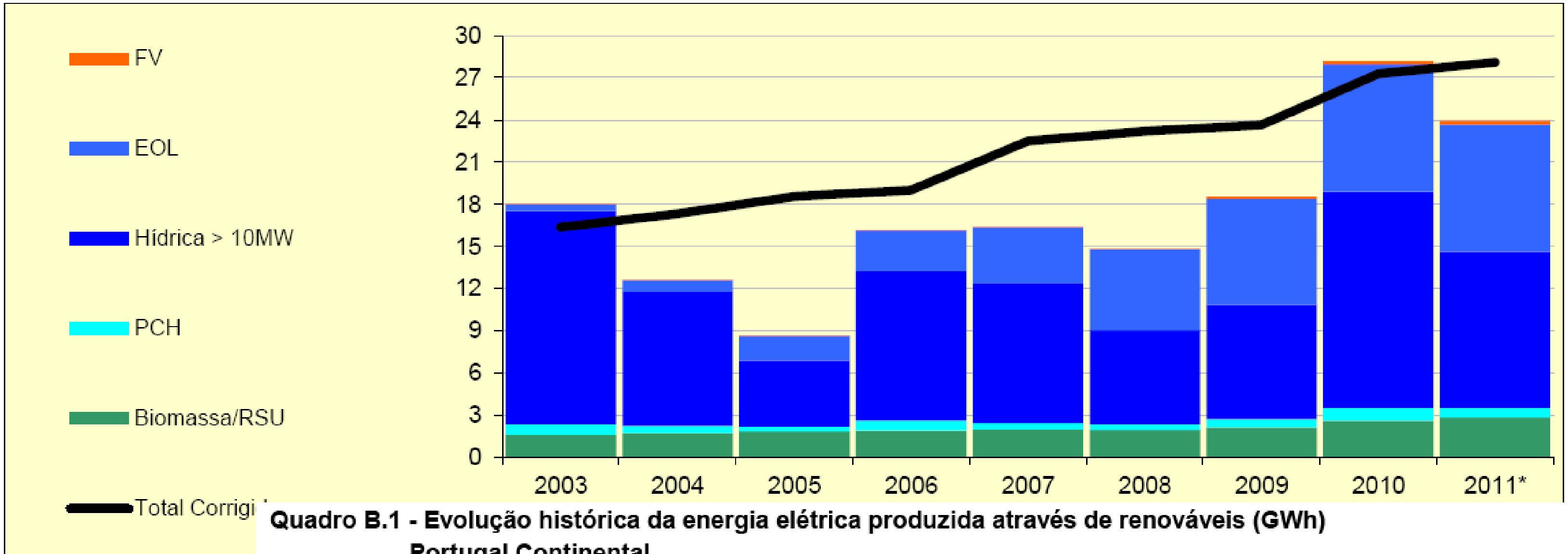
geotermia

Energias Renováveis no Contexto de Produção Centralizada

- ✓ O total da potência instalada renovável atingiu 10 323 MW, no final de 2011
- ✓ A incorporação de FER no consumo bruto de energia elétrica, para efeitos da Diretiva, foi de **50%** em 2011
- ✓ Portugal foi, em 2009, o terceiro país da União Europeia (UE15) com maior incorporação de energias renováveis

Fonte: DGEG
Estatísticas rápidas dezembro 2011

Gráfico B.1 - Evolução da energia produzida a partir de fontes renováveis (TWh)



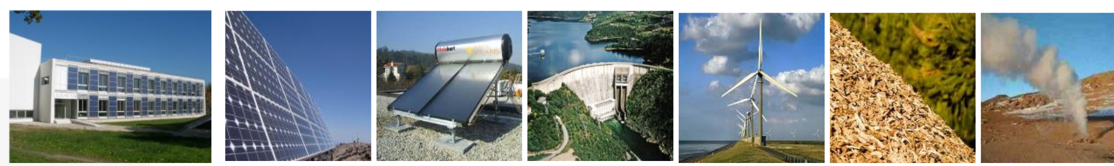
Quadro B.1 - Evolução histórica da energia elétrica produzida através de renováveis (GWh)
Portugal Continental

	2003	2004	2005	2006	2007	2008	2009	2010	2011*
Hídrica Total	15 894	10 053	5 000	11 323	10 351	7 102	8 717	16 249	11 827
Grande Hídrica (>30MW)	14 303	9 065	4 454	9 897	9 406	6 190	7 547	14 306	10 495
em bombagem	331	278	387	465	357	498	725	399	575
PCH (>10 e <=30 MW)	822	487	265	702	504	478	618	1 045	646
PCH (<= 10 MW)	769	501	281	724	441	434	552	898	686
Eólica	468	787	1 741	2 892	4 007	5 720	7 506	9 078	9 003
Biomassa (c/ cogeração)	1 069	1 206	1 286	1 302	1 361	1 381	1 390	1 579	1 669
Biomassa (s/ cogeração)	43	52	64	78	149	146	311	612	688
Resíduos Sólidos Urbanos	523	475	545	532	498	441	458	455	486
Biogás	2	14	31	33	55	67	80	97	151
Fotovoltaica	3	3	4	4	24	41	160	213	265
microprodução								*41*	*78*
Total	18 002	12 590	8 671	16 164	16 445	14 898	18 622	28 283	24 089
IPH (ano base da Diretiva - 1997)	*1,115*	*0,680*	*0,336*	*0,800*	*0,631*	*0,461*	*0,634*	*1,070*	*0,750*
Hídrica Total Corrigida (IPH da Diretiva)	14 255	14 784	14 881	14 154	16 404	15 406	13 749	15 186	15 769
Total Corrigido	16 363	17 321	18 552	18 995	22 498	23 202	23 654	27 261	28 109
Produção Bruta + Saldo Imp. (GWh)	48 220	50 017	51 729	52 749	52 952	53 558	53 134	54 865	53 219
% de renováveis (Real)	37,3%	25,2%	16,8%	30,6%	31,1%	27,8%	35,0%	51,6%	45,3%
% de renováveis (Directiva)	**33,9%**	**34,6%**	**35,9%**	**36,0%**	**42,5%**	**43,3%**	**44,5%**	**49,7%**	**52,8%**

Em 2011, o valor da da Produção Bruta + Saldo Importador é provisório

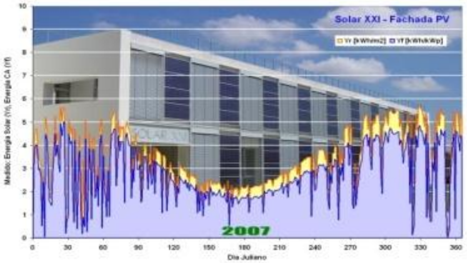
Fonte: DGEG
Estatísticas rápidas dezembro 2011

Investigação e Desenvolvimento e Inovação das Energias Renováveis



Eficiência Energética: Gestão da procura; Consumo Sustentável; Combustão mais limpa; Cidades inteligentes; Edifícios de balanço energ

- Solar Térmico
- Solar Fotovoltaico
- Energia Eólica
- Energia dos Oceanos
- Bioenergia



Solar Térmico

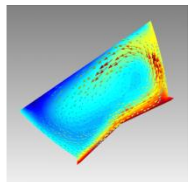
Competências desenvolvidas desde o início dos anos 80 no desenvolvimento de tecnologias de conversão térmica da radiação solar a baixa, média e alta temperatura

100ºC | 400ºC | >1000ºC

secagem solar

aquecimento de água

cozinhas solares



arrefecimento solar

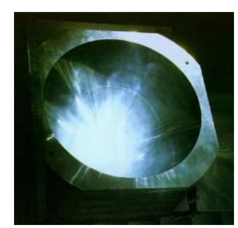
produção de vapor industrial

power (Organic Rankine)

power (Steam Rankine)

materials' fusion/sublimation

hydrogen production



Solar Fotovoltaico

A produção centralizada em grandes centrais

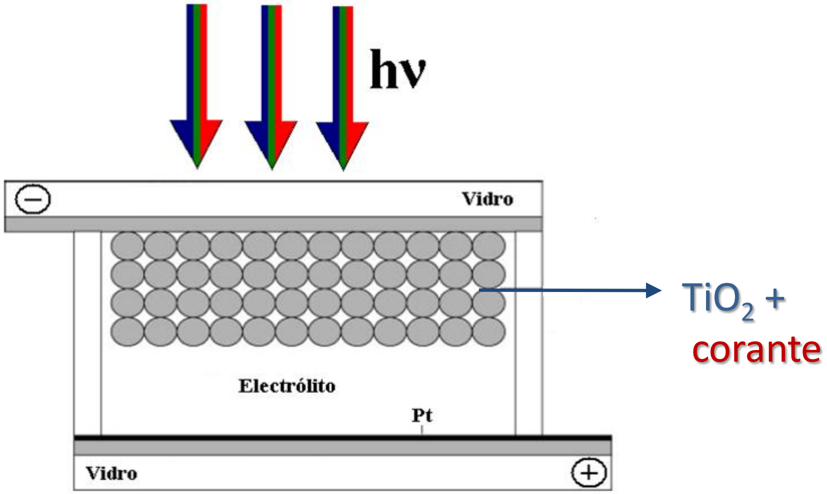
O Fotovoltaico com concentração – CPV

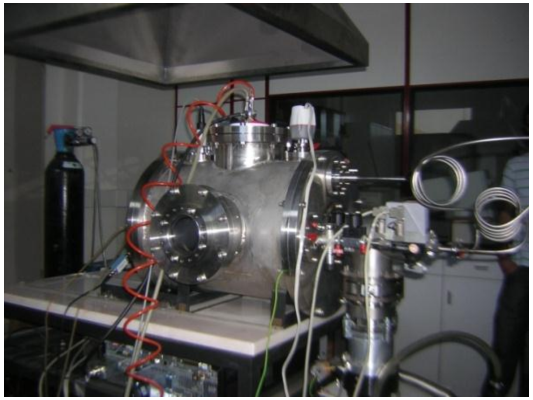
Microgeração

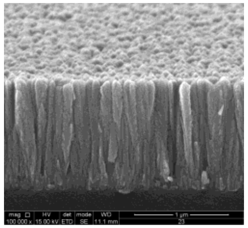
Integração em edifícios e mobiliário urbano

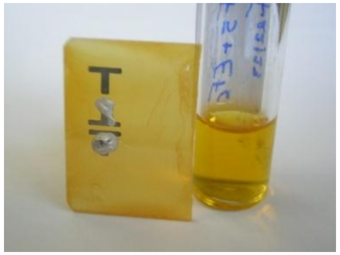
Células Solares com base em novos corantes orgânicos conjugados

• Preparação de células solares orgânicas com diferentes electrólitos (líquidos e de estado sólido) e sua caracterização.



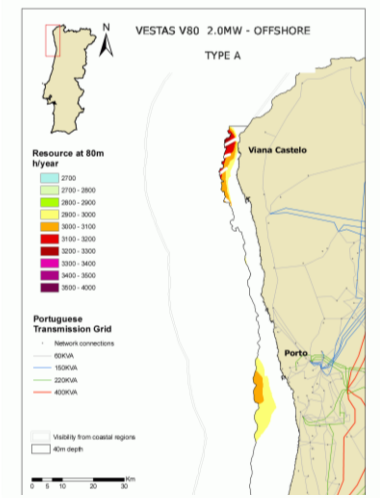


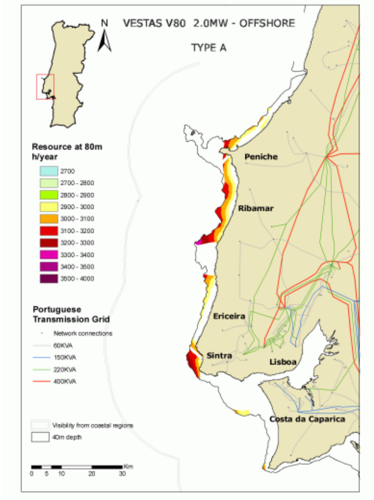


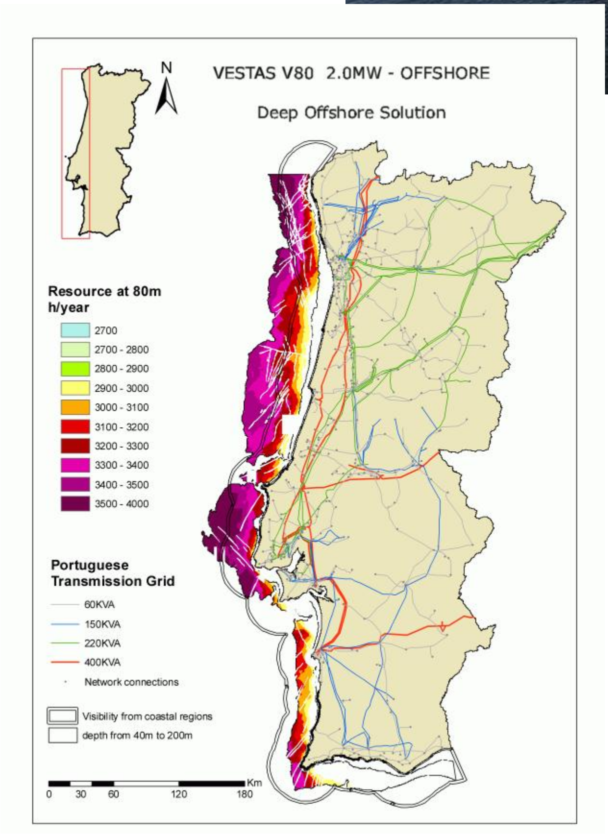


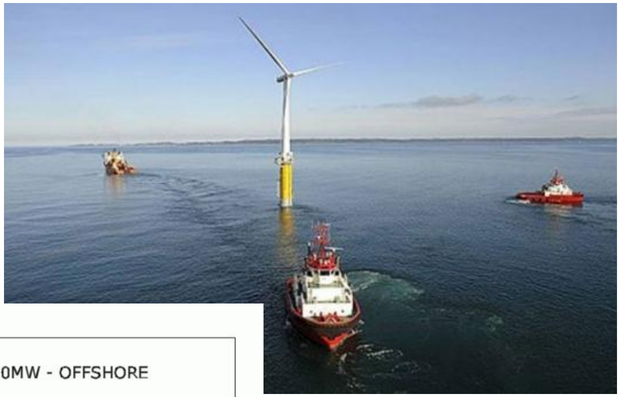
A. Energia Eólica *nearshore* e *deep offshore*

Projecto Beatrice









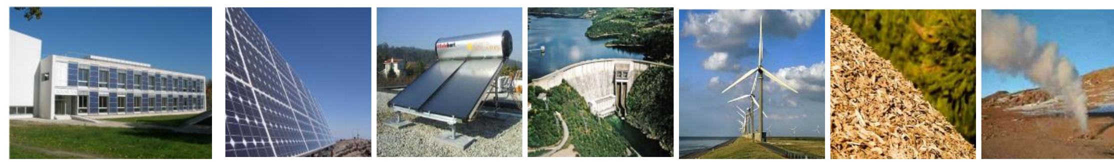
Projecto Hywind

Microgeração e microturbinas: T.Urban

- Programa de financiamento nacional;DEMTEC, ADI;
- Dois protótipos construídos com tecnologia nacional;
- HAWT e VAWT
  - HAWT: Construida e em fase de industrialização;
  - VAWT: construida e em fase de testes

Parceiros: IDMEC, LNEC, INESC-Inov, UMinho, INEGI, Iberomoldes, DA, ...

Energias Renováveis no Contexto de Integração nos Edifícios e Espaço Urbano



Net Zero-Energy Buildings (NZEB)

LNEG

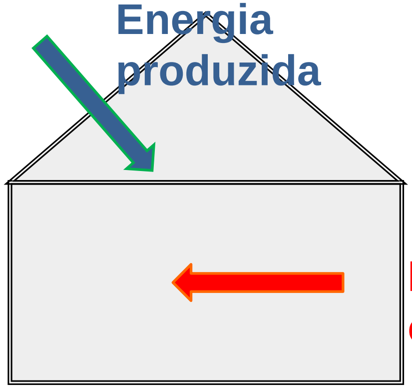
NZEB - definição

Energy Supply

- Electricity
  (PV, wind, geothermal)
- Thermal
  (Solar, Geothermal)

y Kwh

Necessidades = Produção

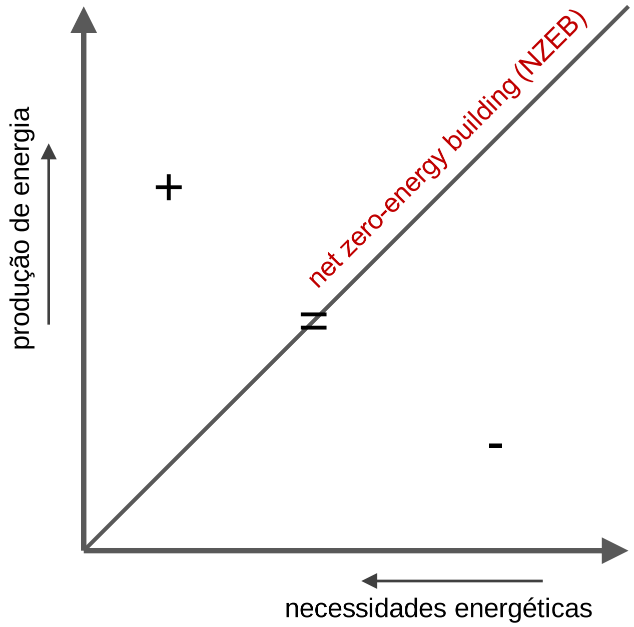


Energy Demand

- Heating
- Cooling
- Lighting
- Hot Water
- Appliances

x Kwh

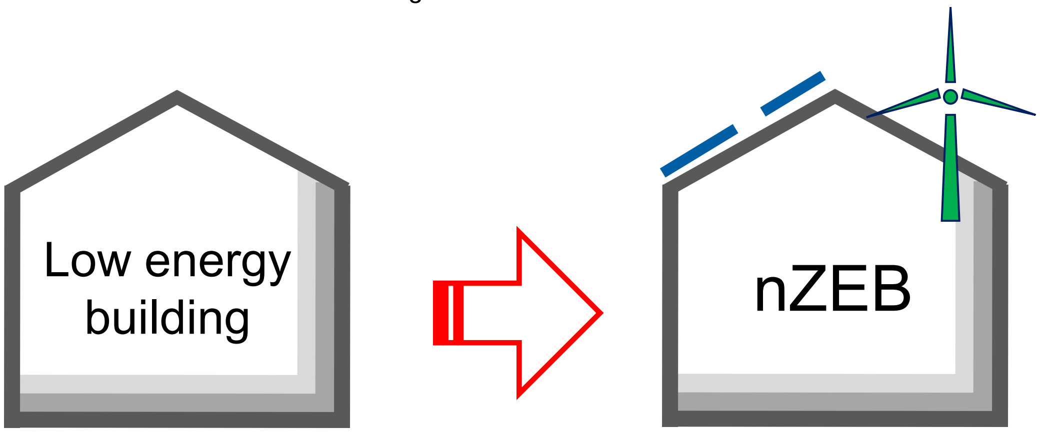
1. Definição



EPBD recast

Article 2
Definitions

'nearly zero-energy building' means a building that has a very high energy performance, as determined in accordance with Annex I. 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;



International Energy Policy

USA: "The building technologies program outlines the technology portofolio and activities that are necessary to **achieve our strategic goal of net zer-energy buildings** (NZEB) at low increment cost by 2025."

[www1.eere.energy.gov/buildings/about/,01/2007]

UK: "The objective of the proposal is to set a timetable for movinf towards **zero carbon development** as a contribution to meeting the UK target to reduce carbon emission by 60% by 2050."

[Department for Communities and Local Government, 13th of December 2006 press release]

Austria: "Vision 2050 on energy in buildings: The building stock of the year 2050 should be in total over the entire life cycle (involves the production and operation of the building**) free of any carbon emissions**."

[www.e2050.at/pdf/energie_gebauede.pdf]

Netherlands: "In the Netherland, the government and the construction sector aim at achieving **energy neutral new construction in 2020**."

[Chiel Boomstra, Trecodome]

Germany: " From current point of view future capable buildings are building architectural demanding with high user comfort, minimal energy demand, optimized technological equipment, meaningful integration into large energy supply systems as well as together economical energy demand cover. **Zero emission houses** are the long-term objective."

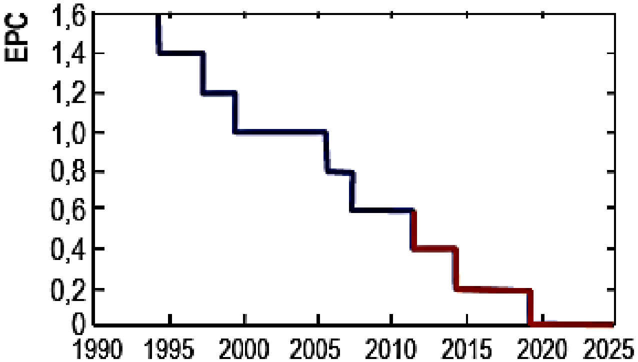
LNEG

["Das 5.Energgieforschungsprogramm der Bundesregierung", BMWA, 07/2005

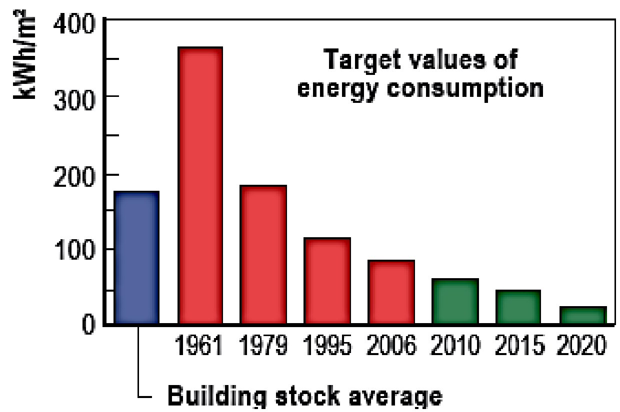
Towards NZEB – examples of national requirements and roadmaps

Ref: REHVA 03/2011

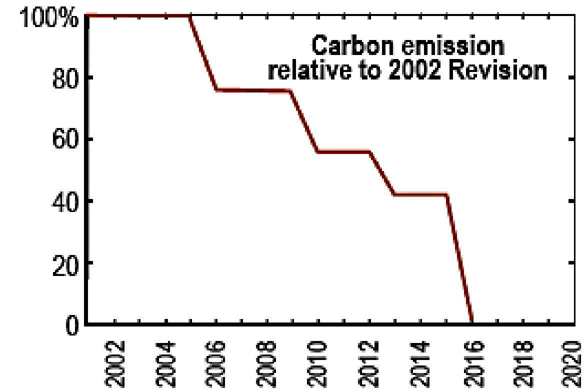
The Netherlands



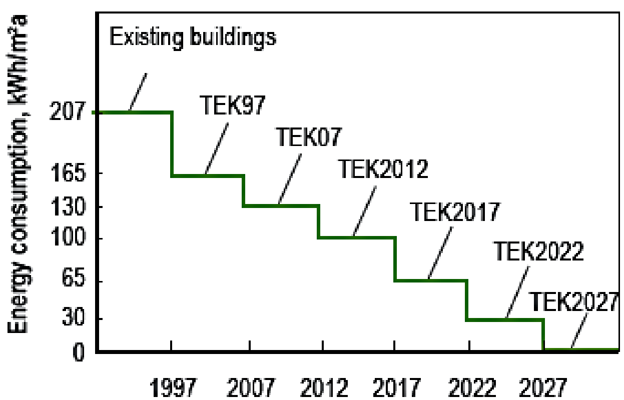
Denmark



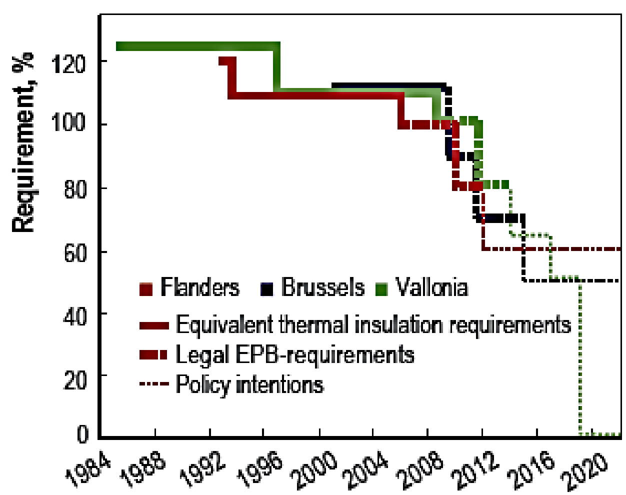
United Kingdom



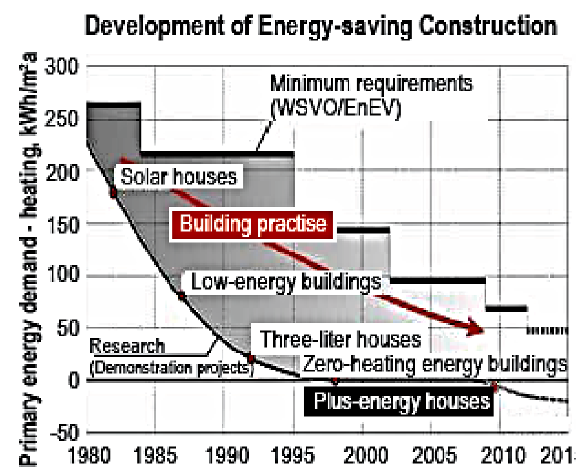
Norway



Belgium



Germany



RECAST EPBD

DIRECTIVE 2010/31/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

of 19 May 2010

on the energy performance of buildings

(recast)

Article 9

Nearly zero-energy buildings

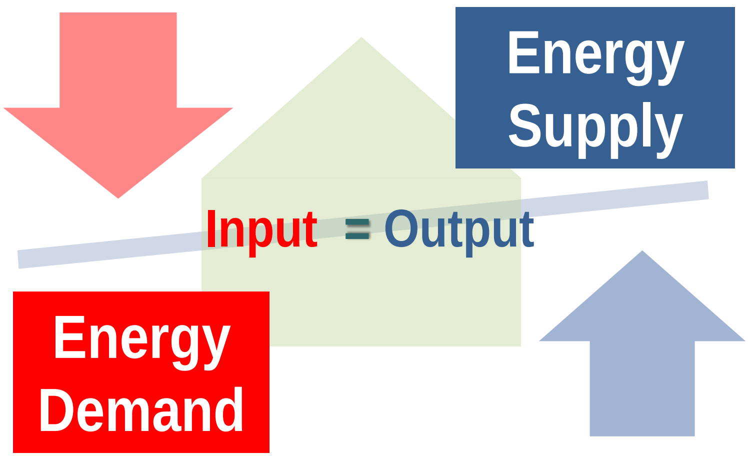
1. Member States shall ensure that:

(a) by 31 December 2020, all new buildings are nearly zero- energy buildings; and

(b) after 31 December 2018, new buildings occupied and owned by public authorities are nearly zero-energy buildings.

Member States shall draw up national plans for increasing the number of nearly zero-energy buildings. These national plans may include targets differentiated according to the category of building.

LNEG



Specific balance items

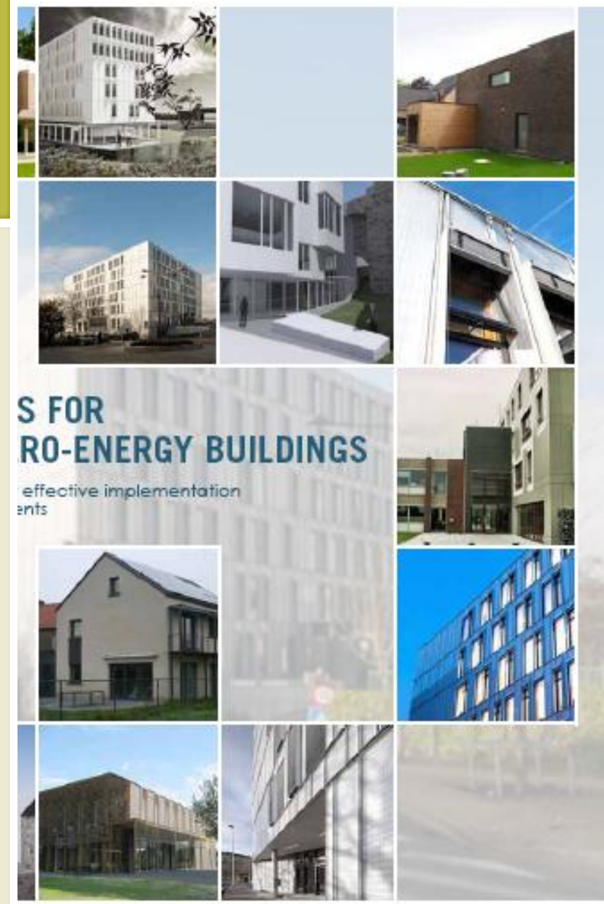
- Metric (Primary energy, carbon emission, cost)
- Balance boundary
- Balance items (heating, cooling, DHW)
- Balance period

Challenges

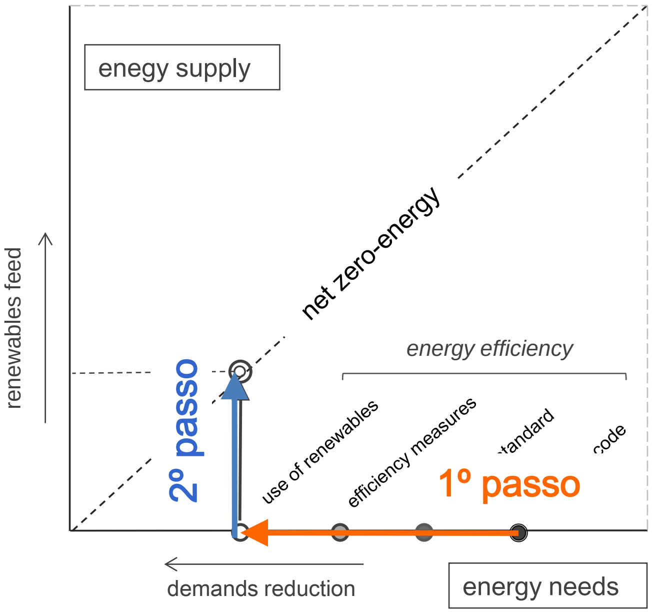
- Common Definition Framework
- Net ZEB Performance Indicators
- Building Code Relevance
- Architectural Integration
- Monitoring /Measured data

Definições/Metodologias/Desafios

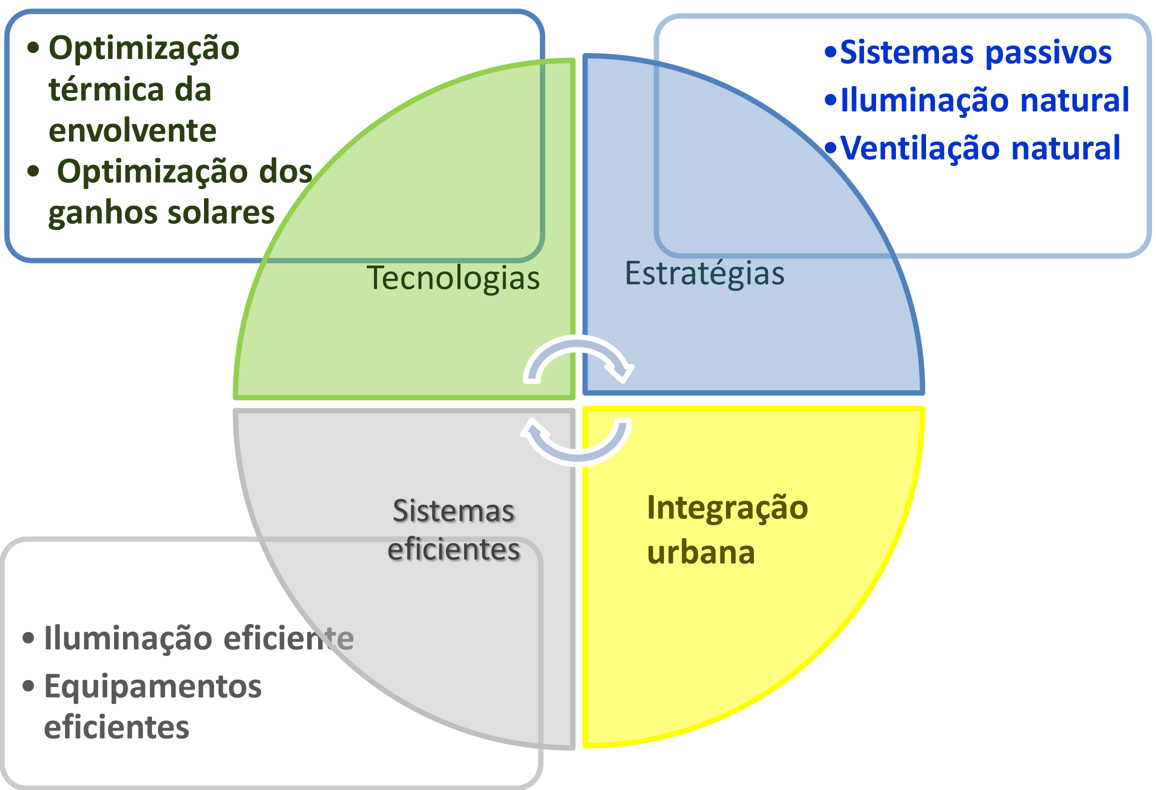
Corollary of First nZEB Principle: **Threshold on energy demand**	Corollary of Second nZEB Principle: **Threshold on renewable energy share**	Corollary of Third nZEB Principle: **Threshold on CO_2 emissions in primary energy**
A threshold for the maximum allowable energy need should be defined.	A threshold for the minimum share of renewable energy demand should be defined.	A threshold for the overarching primary energy demand and CO_2 emissions should be defined.
Implementation approach: For the definition of such a threshold, it could be recommended to give the Member States the freedom to move in a certain corridor, which could be defined in the following way: • The upper limit (least ambitious, maximum allowed energy demand) can be defined by the energy demand that develops for different building types from applying the principle of cost optimality according to Article 5 of the EPBD recast. • The lower limit (most ambitious) of the corridor is set by the best available technology that is freely available and well introduced on the market. Member States might determine their individual position within that corridor based on specific relevant national conditions.	**Implementation approach:** The share of energy from renewable sources which is considered to be "very significant" should be increased step-by-step between 2021 and 2050. The starting point should be determined based on best practice, nearly Zero-Energy Buildings serving as a benchmark as to what can be achieved at reasonable life-cycle cost. A reasonable corridor seems to be between 50% and 90% (or 100%).	**Implementation approach:** For meeting the EU long term climate targets, the buildings CO_2 emissions related to the energy demand is recommended to be below 3 kg $CO_2/(m^2\,yr)$. The EPBD clearly promotes primary energy as indicator for the energy performance of buildings. However, the buildings should follow also the EU's long-term goals by 2050 and definitively the CO_2 reduction is in close relation to the reduction of energy consumption and energy decarbonisation. Consequently, introducing an indicator on the CO_2 emissions of buildings (linked to the primary energy indicator for the energy demand) is the single way to ensure coherence and consistence between the long-term energy and environmental goals of the EU.



Como alcançar NZEB

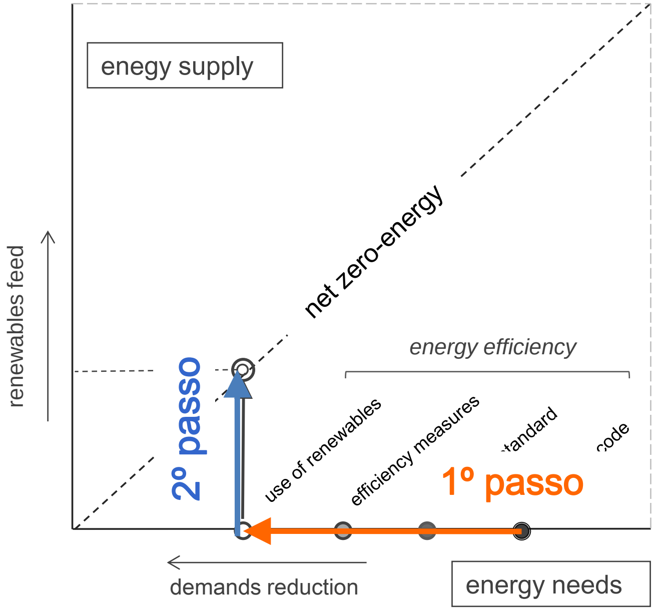


1º passo: reduzir as necessidades energéticas do edifício



2º passo: produção de energia

Como alcançar NZEB



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 Buildings

SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

International Energy Agency
Energy Conservation in Buildings and Community Systems Programme

SHC TASK 40 - ECBCS ANNEX 52

TASK 40 /ANNEX 52

Towards Net Zero Energy solar Buildings

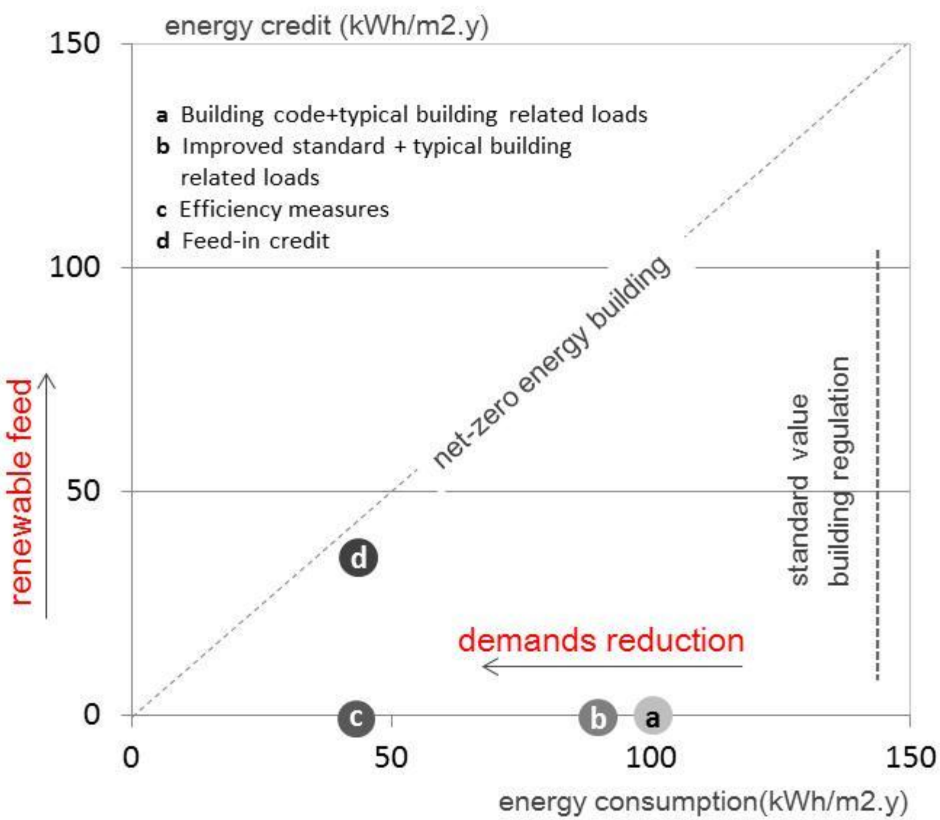
(October 2008 – September 2013)

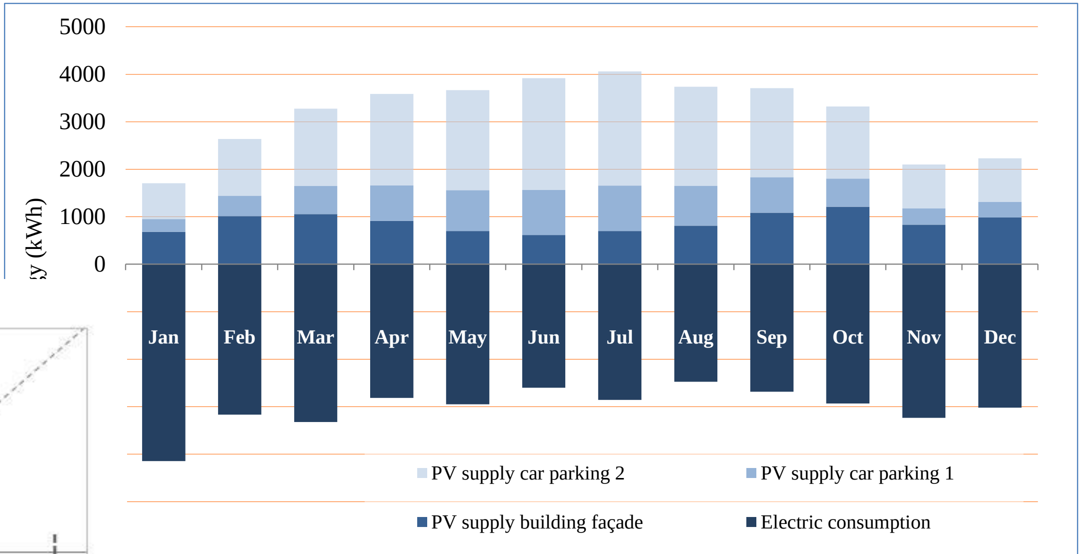
PORTUGAL

Net Zero Energy Buildings - worldwide

8	SUNDAYS - Offices and Rowhouses in Gleisdorf, Austria		solar low energy house (primary energy)	space heating, ventilation, domestic hot water, appliances, office equipment, lighting	main facade oriented south				0,23		0,01		
20	Sunny woods in Zürich, Switzerland		zero heating energy building (electricity)	space heating, DHW, ventilation	south-nord	heated part is established in timber-frame construction. The rest are made out of concrete	0,49	45,67	0,03	1,33	0,16	7,31	
58	Forum Chriesbach, Dübendorf, Switzerland		zero heating energy building, 2000-Watt Society, Minergie-P (primary energy)	space heating, DHW, cooling, ventilation, lighting, services, equipment like appliances, and office equipment	south-east to north-west	massive constructional elements, use of concrete and brick-earthwalls, inside wood and steel		50,77	0,004	0,20	0,04	2,03	
59	Support Office Marché International in Kemptthal, Switzerland		net zero energy office building, Minergie-P Eco (electricity)	space heating, DHW, ventilation, lighting, service equipment, office equipment	south oriented main facade	prefabricated timber frame construction combined with concrete staircases	0,34	25,34			0,38	9,63	

SOLAR XXI
NZEB Performance





Solar XXI - monthly electric energy consumption/PV energy supply

Project Name: SOLAR XXI

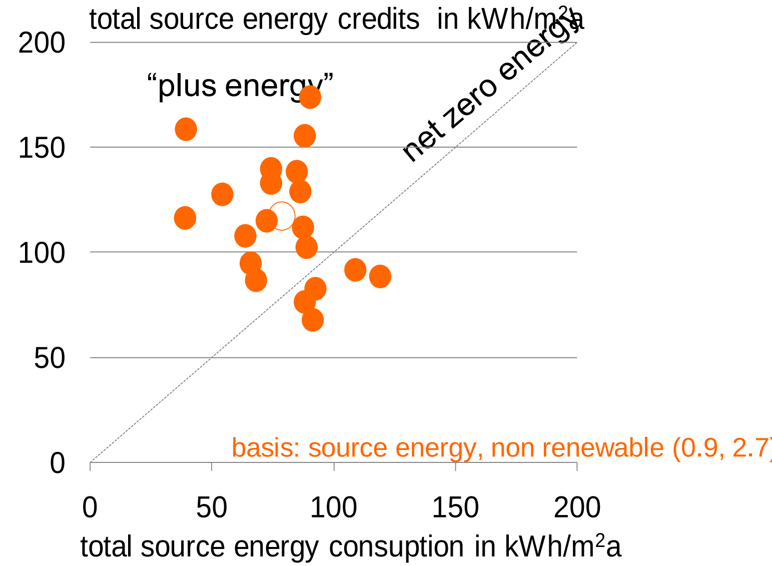
Contact Person: Helder Gonçalves/Laura Aelenei
email: helder.goncalves@lneg.pt / laura.aelenei@lneg.pt

Building Information:

- Building Status: Construction completed August 2006
- Location: Paço do Lumiar, 22 Lisbon 0 Portugal
- Latitude: North 38°46'20.27" N
- Longitude: West 9°10'39.83" W
- Climate Challenge: Heating & Cooling Dominated
- Building Type: Non-residential_Office
- Site Context: Village, Urban Edge - 2-5 storey buildings with at most narrow lanes between adjacent bu
- Engineer Civil: Obrecol SA
  - Address 0
  - email 0
  - Web Addres 0
- Engineer MEP: Lomarisco Lda / Aquadomos Lda
  - Address 0
  - email 0

Residential buildings

Solar Settlement, Freiburg
Architecture and concept: Rolf Disch

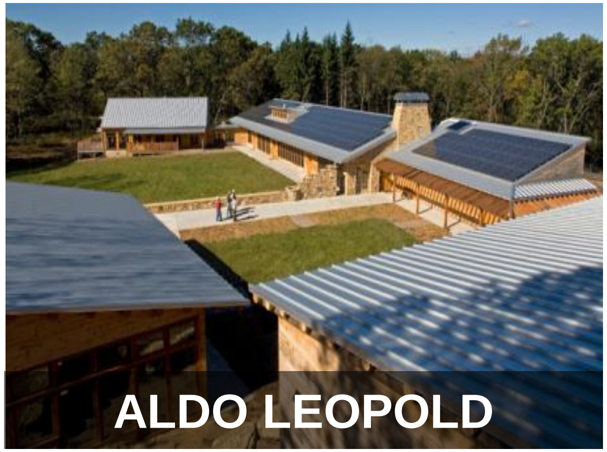


note: 100 kWh/m²y = 32 kBTU/ft" y

Residential buildings

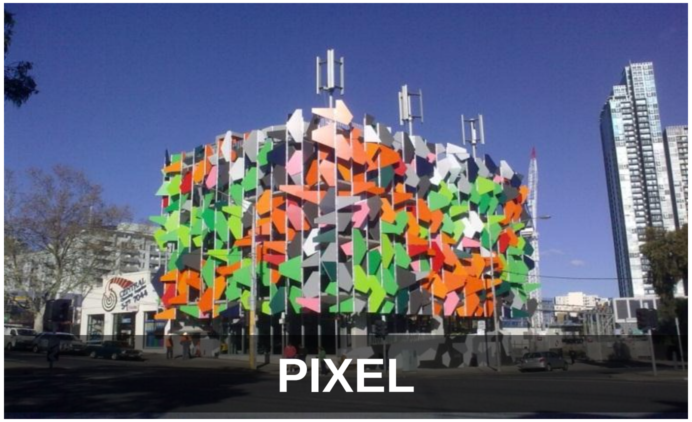
Non-residential buildings


ENERPOS


ALDO LEOPOLD

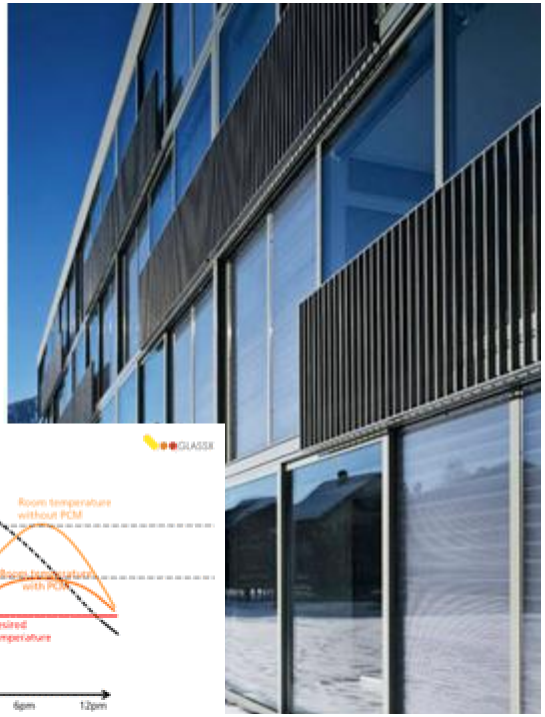

NREL RSF

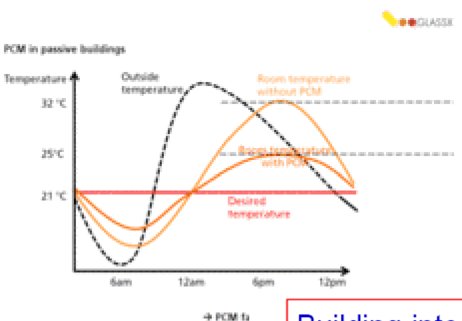

MERIDIAN


PIXEL

Towards Innovation - Towards NZEB

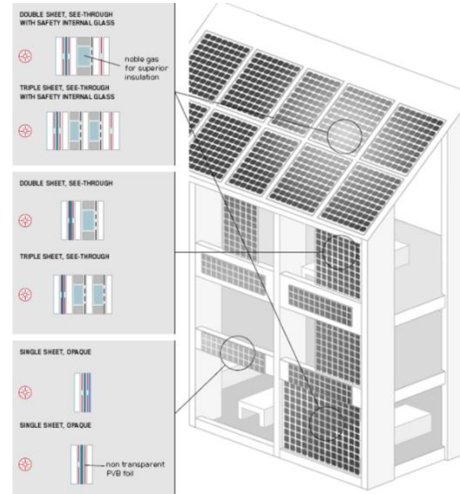
PCM



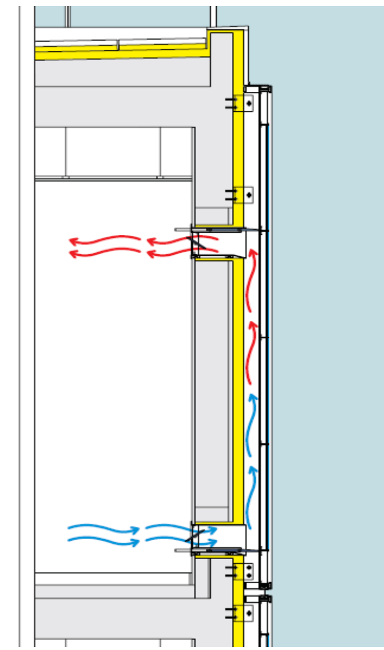


www.glassx.ch

BIPV

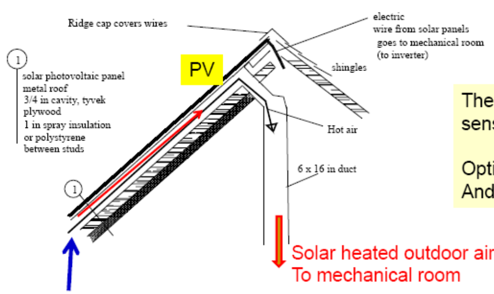


sapa-solar



Building-integrated photovoltaic/thermal system principle and design (Theme 1 of SBRN)

Open loop
Air system



Thermal performance sensitive to slope

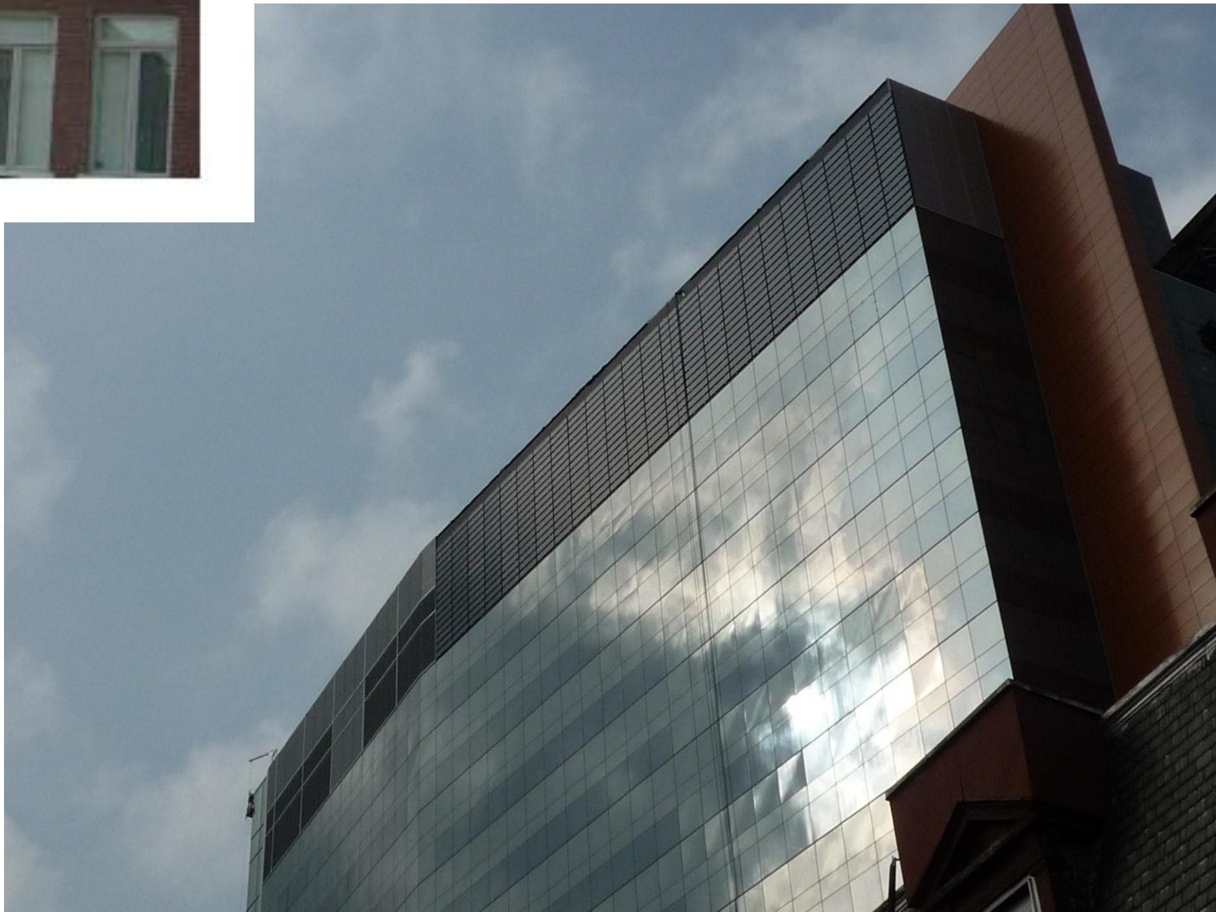
Optimal slope for thermal
And to get rid of snow 45deg

BIPV-T

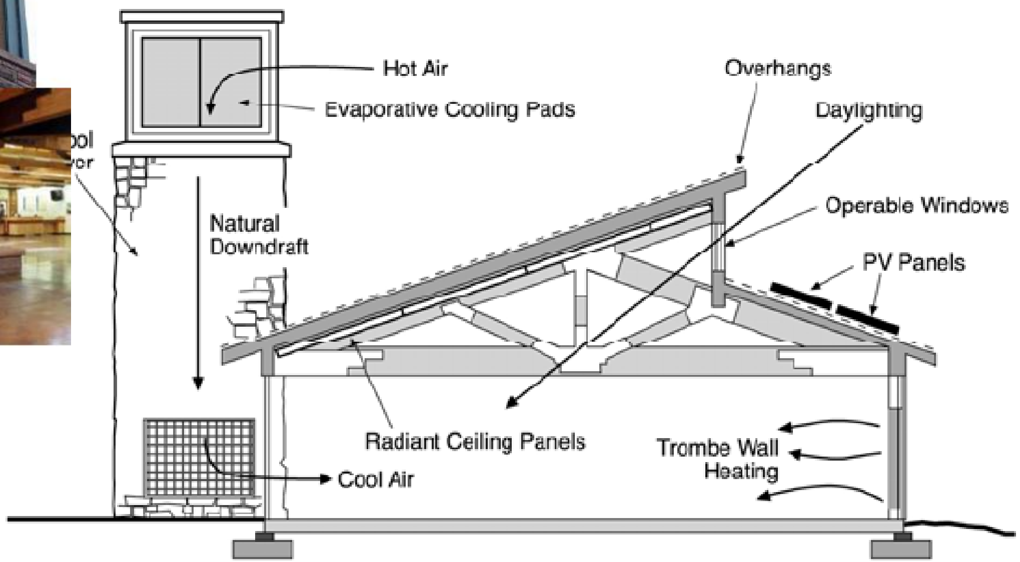
Heat recovery from PV roof raises combined solar efficiency by a factor of >= 3

LNEG

ex. Canada

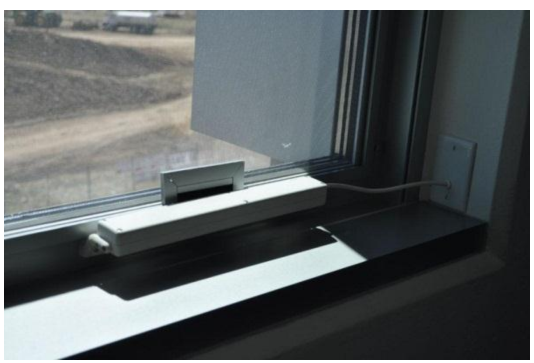


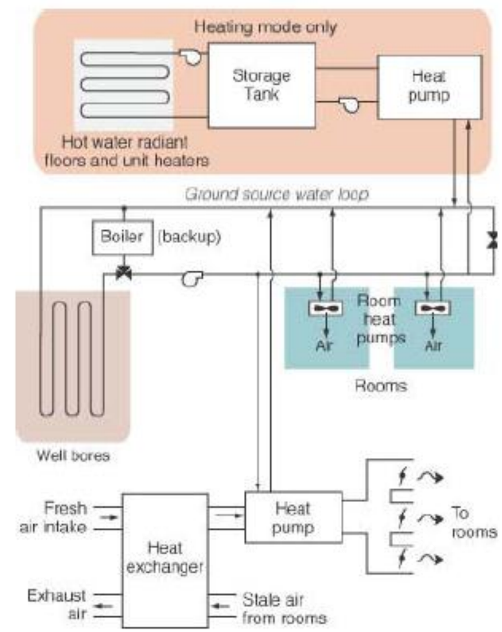
Towards Innovation - Towards NZEB



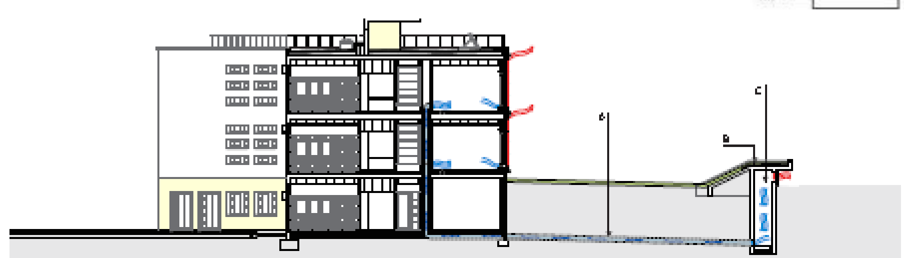
cooltower

P. Torcellini NREL





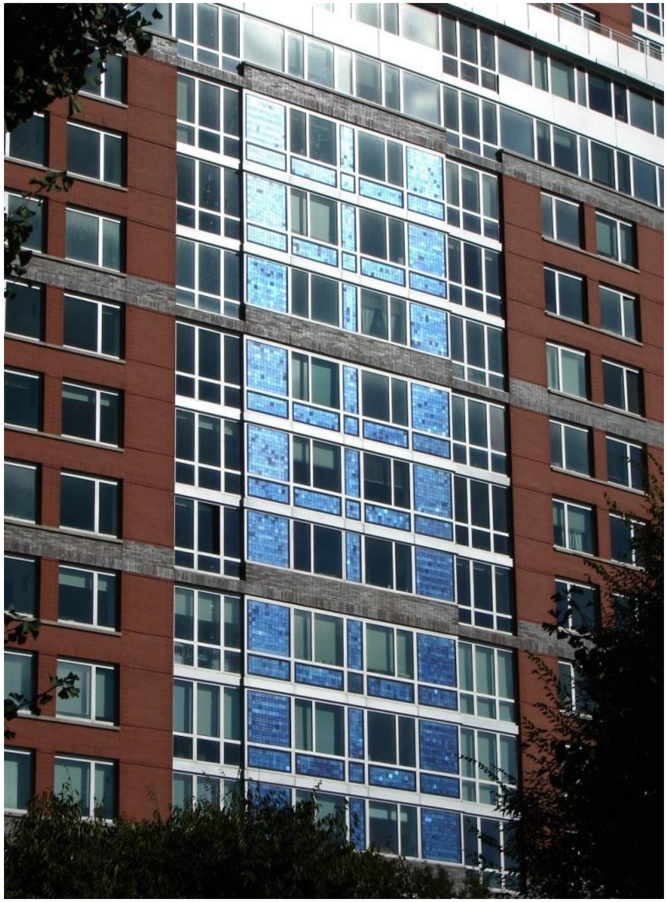
Ground source heat pump
Heat recovery ventilators
Radiant slab



ARCHITECTURAL INTEGRATION CHALLENGE

Solaire – Battery Park City, NY: 33 kWp   USGBC LEED – Gold

Architect: Cesar Pelli



Cortesy

altPOWER®

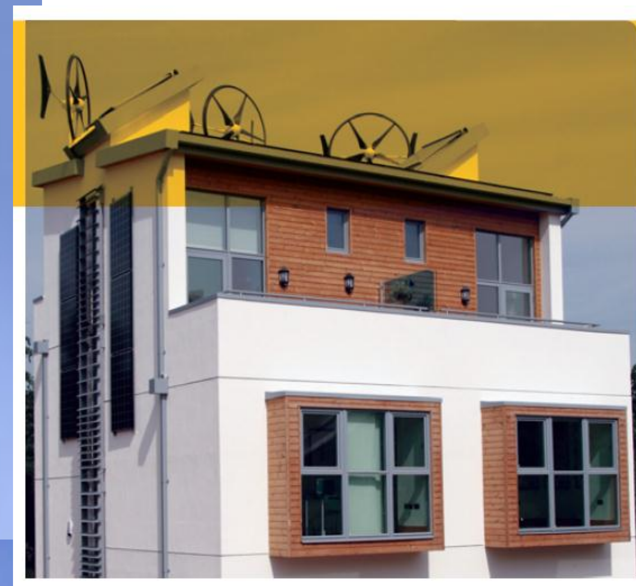
RELAB

RENEWABLE ENERGY LABORATORY

ARCHITECTURAL INTEGRATION CHALLENGE

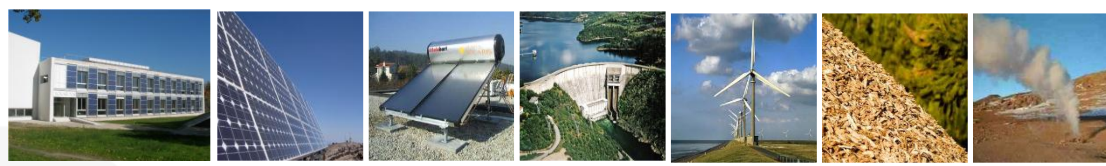
Bahrain World Trade Center

Sigma House
BRE Innovation Park



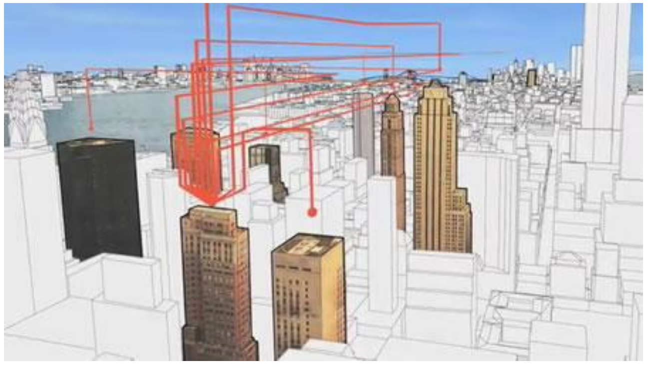
Innovation_Park/InnovParkBrochure2012.pdf

Smart Cities



SMART CITIES

SMART CITIES - WHAT ARE?



SMART CITIES - WHY FOR?

SMART CITIES - EXIST A MODEL?

SMART CITIES - KEY ACTIONS?

WHY FOR?

Region	Share of city primary energy demand in regional total	Ratio of city per-capita primary energy demand to regional average	Urbanisation rate
United States	80%	0.99	81%
European Union	69%	0.94	73%
Australasia	78%	0.88	88%
China	75%	1.82	41%

Overview of city energy use and urbanization rate by regions and countries (World Energy Outlook, IEA,2008)

WHAT ARE?

SMART CITIES:

- innovative design
- intelligent operation of an entire energy system at city level
- Information and Communication Technologies (ICTs)
- social and environmental capital in profiling the competitiveness of cities

EXIST A MODEL?

European Energy Research Alliance

SMART CITIES - KEY ACTIONS/AREAS?

ENERGY IN CITY	ENERGY NETWORK	BUILDINGS	SUPPLY TECH	TRANSPORT
city energy flows	smart grids	NZEB?	integration of RES in building and grids	electric mobility
urban morphology	shift bewteen thermal and electrical loads	interaction between building and grid	hybrid supply systems	public transport
…	…	…		Walking/cicling

Laboratório Nacional de Energia e Geologia, I. P.

www.lneg.pt

MINISTÉRIO DA ECONOMIA E DO EMPREGO