Il futuro dell'efficienza energetica nelle costruzioni: Zero Energy Building

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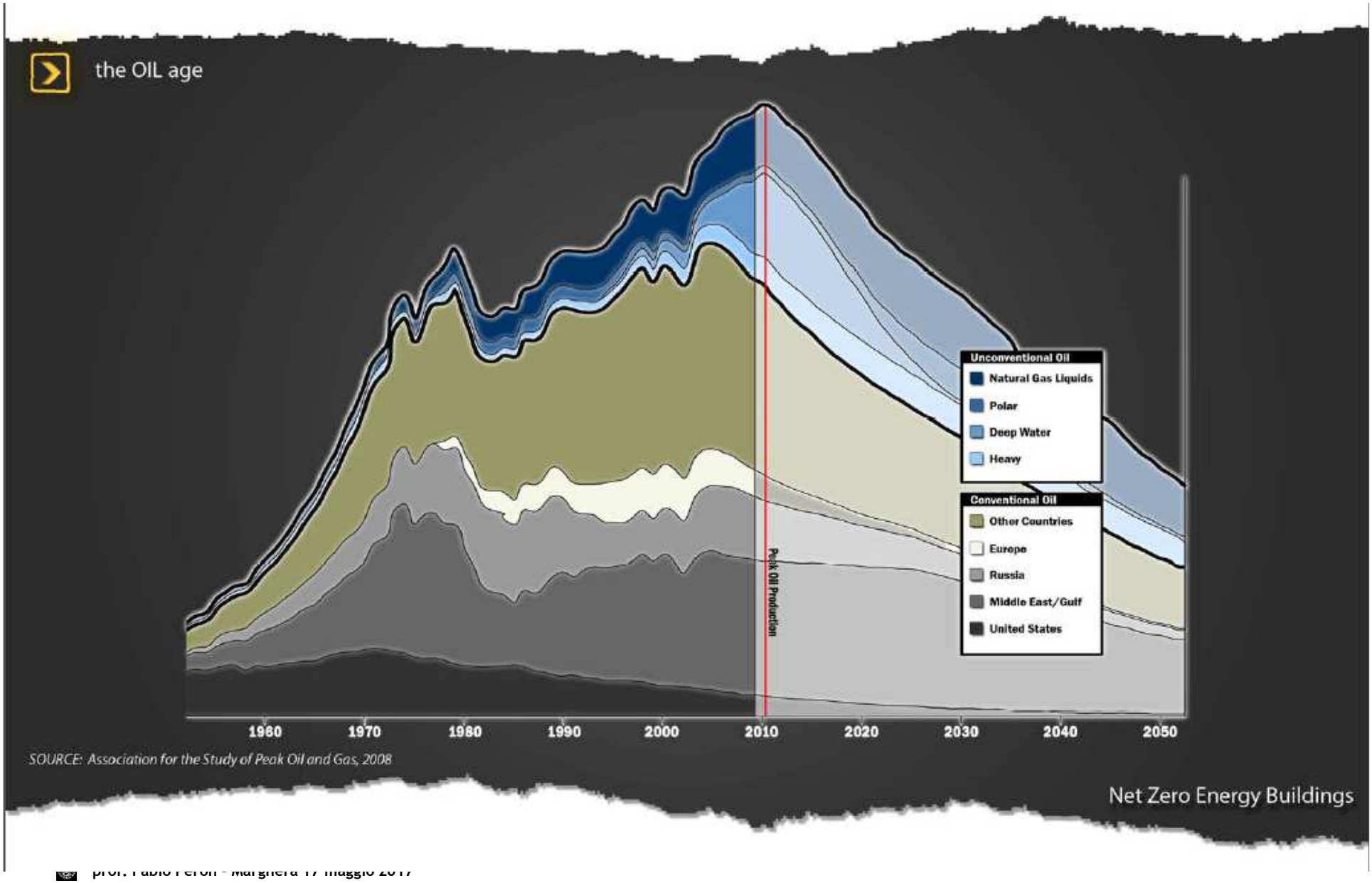
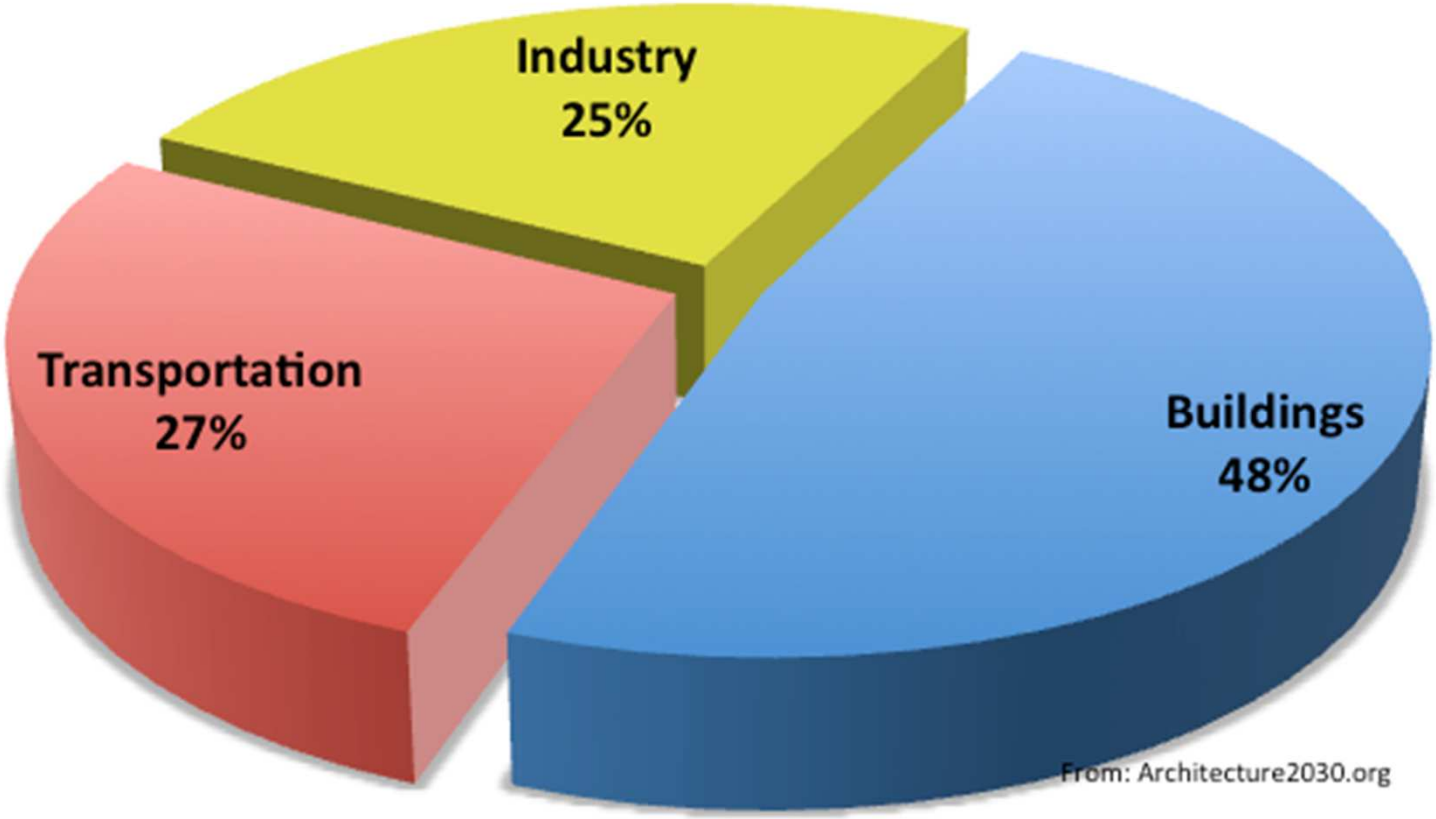
Perché Zero Energy Building?

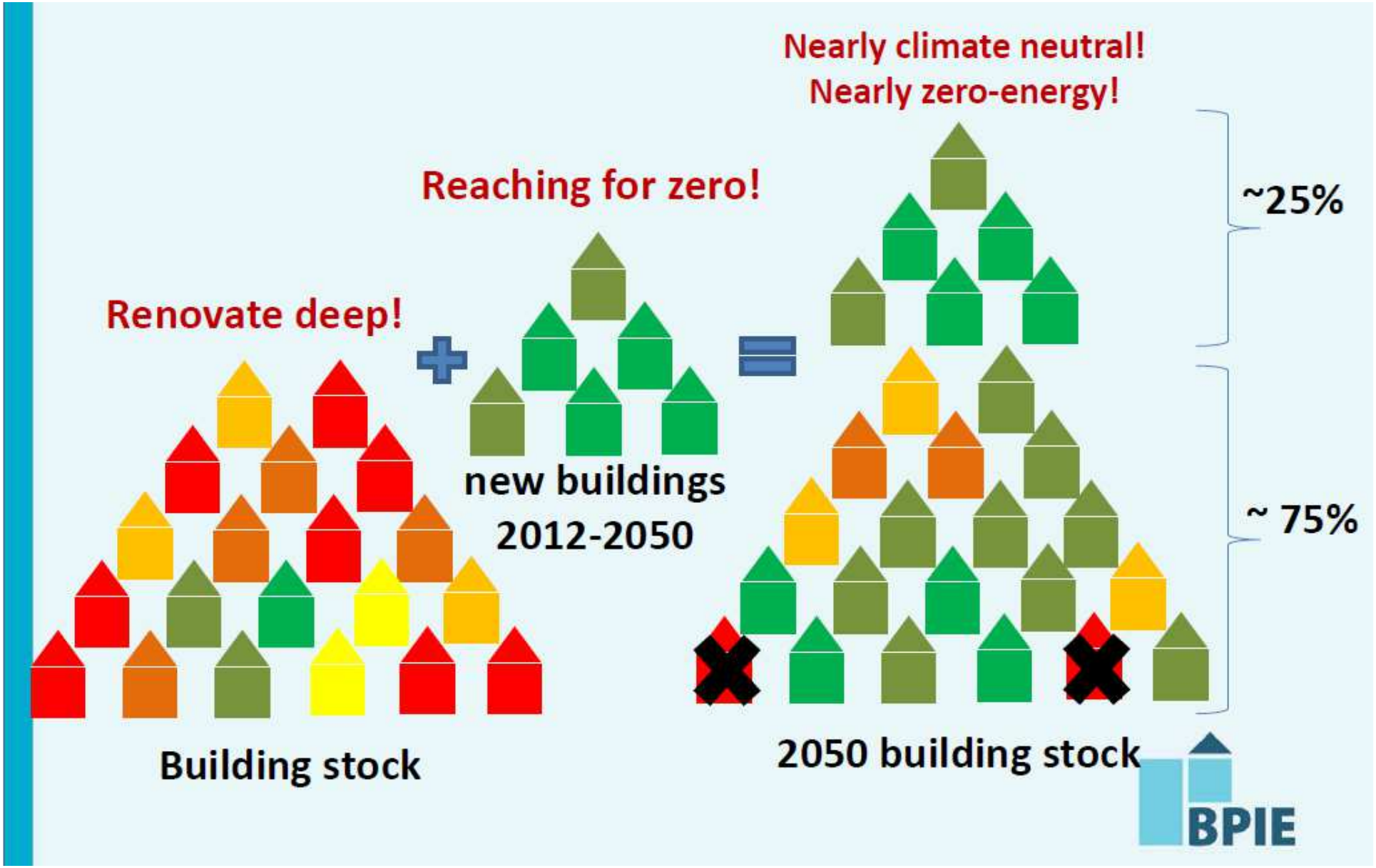


Perchè Zero Energy Building?

Il settore delle costruzioni è un grande consumatore di energia e fonte di emissione di Gas Climalteranti



L’azione dell’Europa per il 2050: due grandi sfide

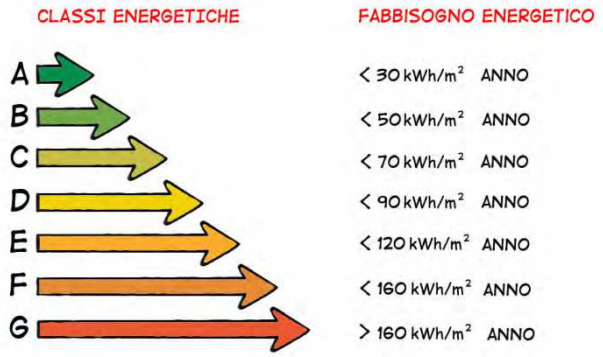


L'azione dell'Europa negli ultimi venti anni

Low energy building (LEB)

Building that use lower levels of energy than regular buildings.

- **Determined by heating needs in kWh/m^2 /year**
- **Existing buildings: 80 - 300 kWh/m^2/year**
- **Low-energy building: 30 - 70 kWh/m^2/year**
- **Three-litre-building: 16 - 30 kWh/m^2/year**

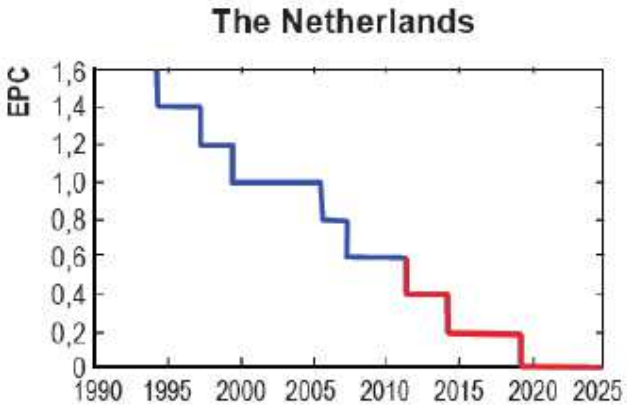


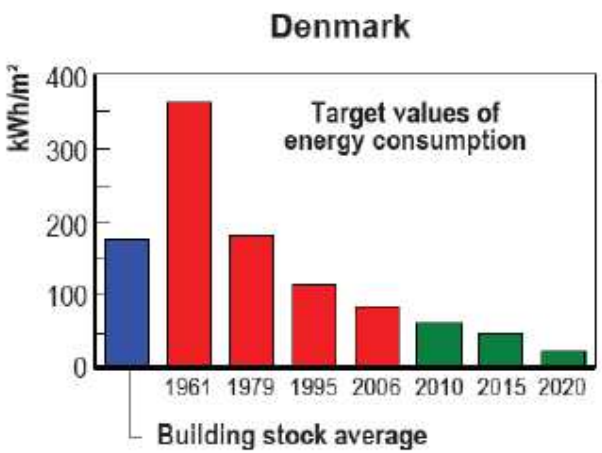
Passive house

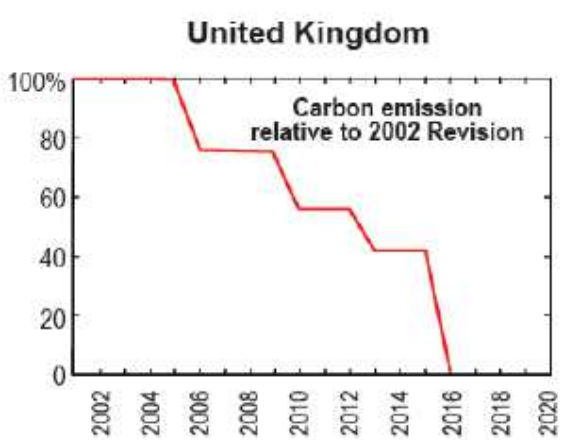
focuses on reducing energy demand, it doesn't include active systems e.g. photovoltaics:

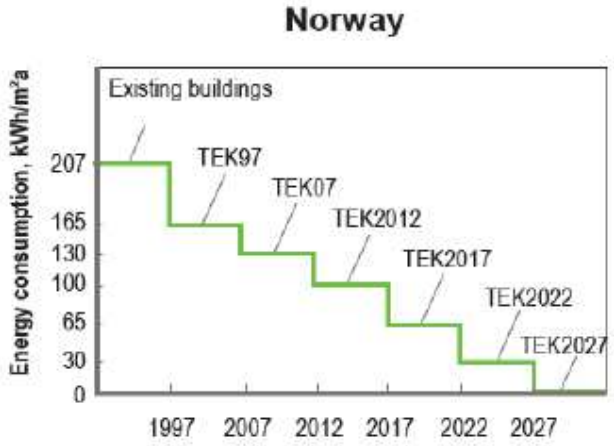
- **very high levels of insulation (wall U-values less than 0.15 W/m^{2}K);**
- **high-quality building construction (thermal bridge free, air-tightness)**
- **high-performance glazing (U-value less than 0.85 W/m2K**
- **high efficiency ventilation system with heat recovery (MVHR);**
- **high efficiency appliances and lighting.**
- **max. 15 kWh/m2/year**

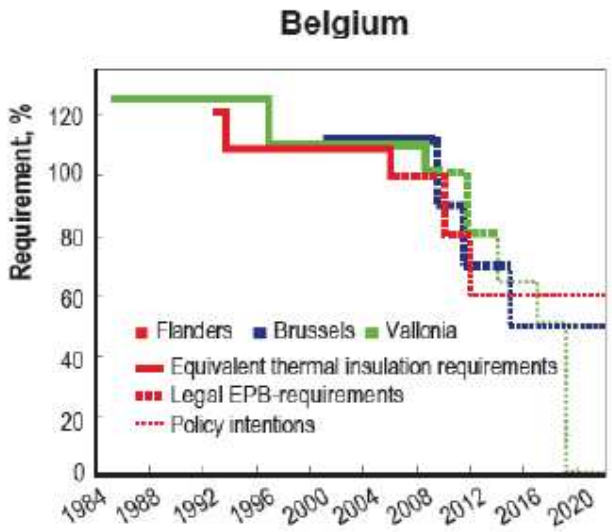
Le roadmap europee per la riduzione dei consumi

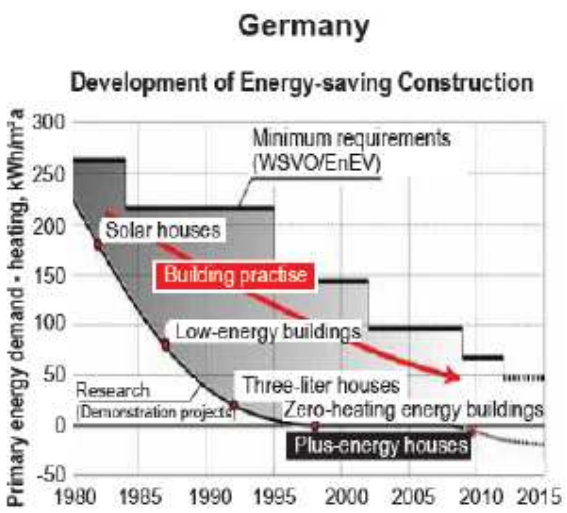




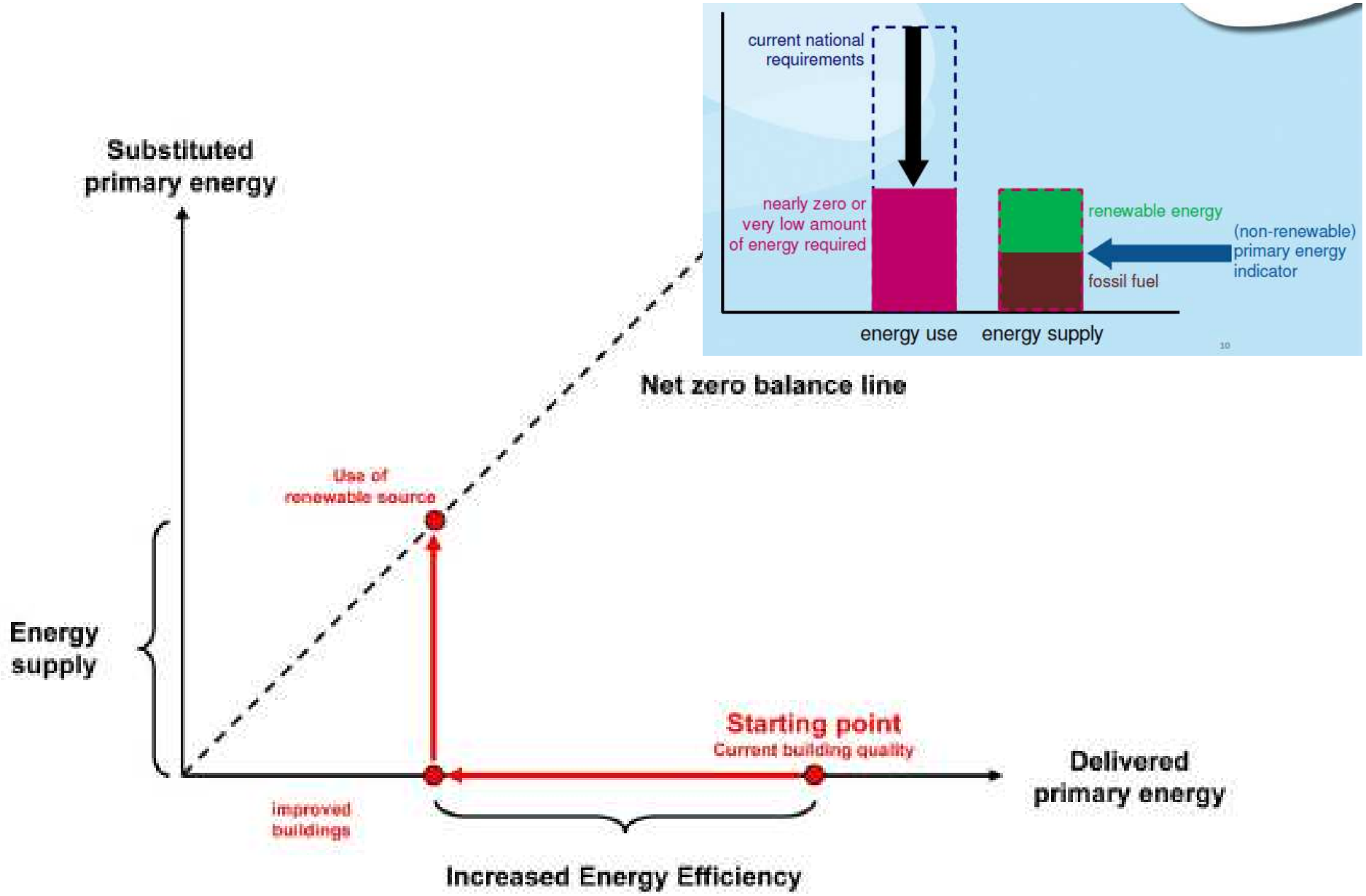








L’efficienza degli edifici di domani



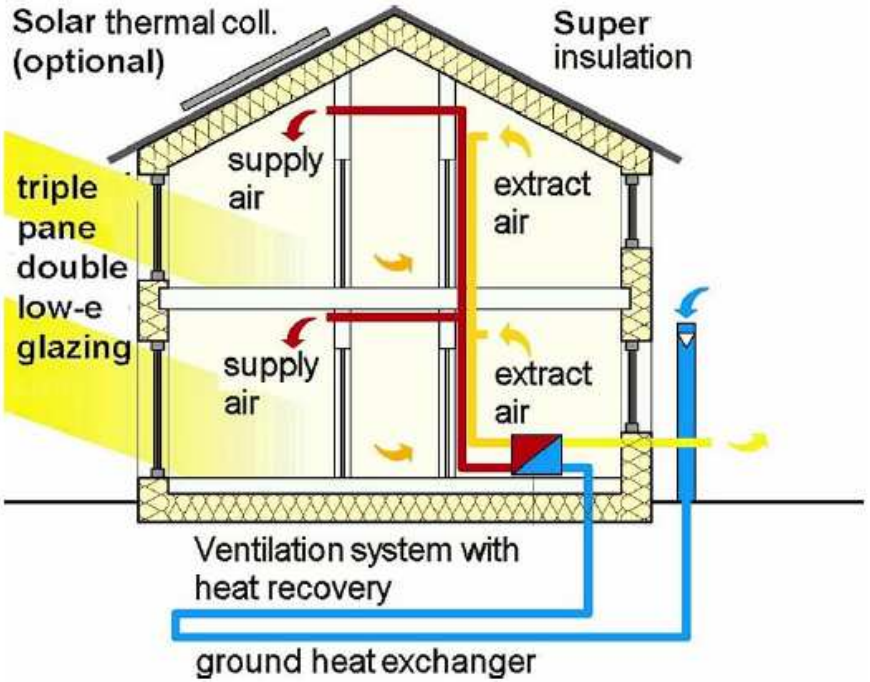
Zero Energy Building issues

ZEB is not a single product or technology, but rather a combination of closely-integrated evolving technologies.

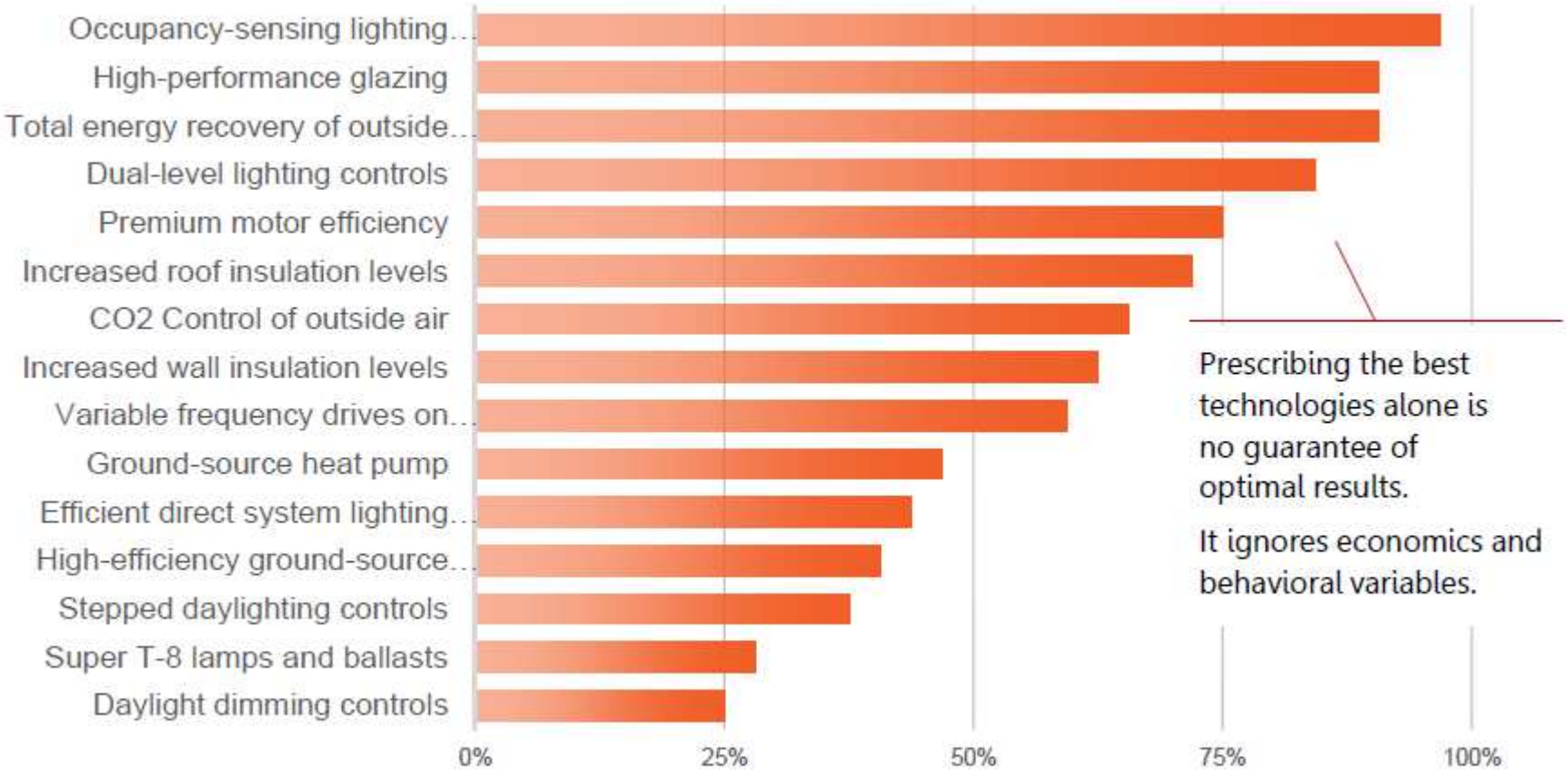
Whole-building energy-consumption system integration requires careful planning and computer modelling to make all the subcomponent parts work together cost effectively.

Common energy efficiency (EE) features:

- Daylighting
- EE lighting
- EE electric equipment
- EE ventilation, DCV,
- Controls & Sensors
- Passive solar
- Insulation
- Energy management

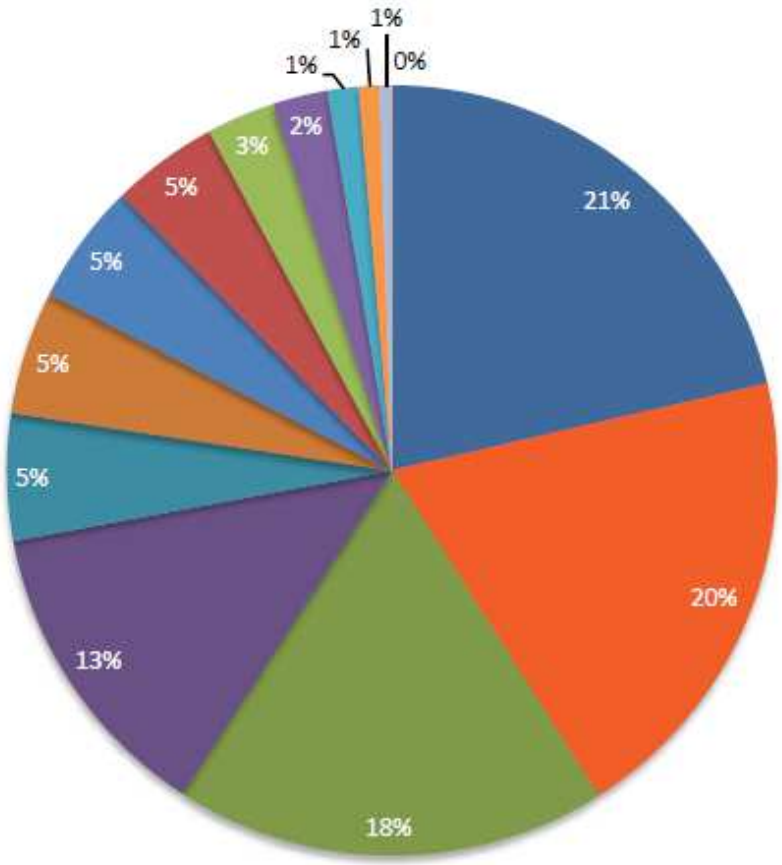


Zero Energy Building issues



General Frequency of Occurrence Projects that Saved 60%+ or NZE ready

Zero Energy Building issues



- Low Ambient Light with Task Lights High Efficiency Lighting Fixtures
- Photovoltaic electrical
- Radiant heating and cooling with Dedicated Outdoor Air System (DOAS),
- Daylighting and Occupancy Controls
- High Insulation Walls (40) and Roof (50)
- Wood Frame/Triple Glazed Windows
- Reduce equipment load allowance
- Solar thermal system
- Total heat recovery system
- Operable windows / ceiling fans
- Higher cooling temperature set points
- CO_2 controls
- Fixed shading
- High interior thermal mass

Particular Strategies in Example,

Tons of CO_2 Savings come from many choices

Zero Energy Building: la definizione

Zero Energy Building (ZEB)

A building that produce as much energy as it consumes (yearly basis)

- Consumes grid power when it needs it
- Feed power to grid when it has extra
- All energy considered
- Not Zero Carbon or Zero GHG
- Not off-grid
- does not consider Embodied energy

Benefit of ZEB

- Reduce energy consumption and cost
- Reduce carbon emissions
- Reduce dependence on fossil fuels
- Higher asset value
- Comfortable and productive environments

Zero Energy Building: la definizione

near Zero Energy Building (nZEB)

A building approaching zero energy is called “Near-zero energy building or “ultra low energy building”.

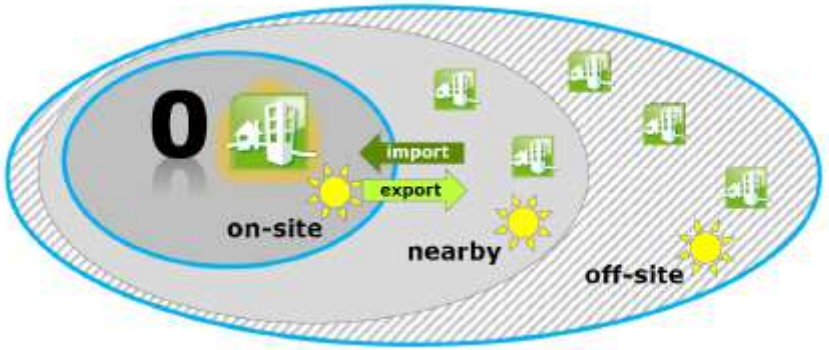
Net Zero site Energy Building (siteZEB)

Amount of energy provided by on-site renewable energy sources is equal to the amount of energy used by the building. Self-sufficient stand-alone ZEB that is not connected to an offsite energy utility facility. It requires distributed renewable energy sources and energy storage capability.

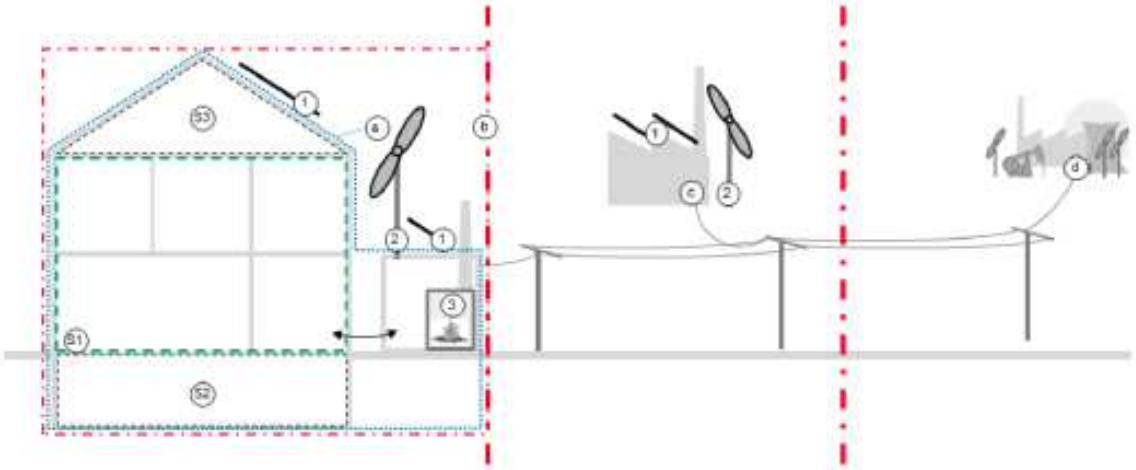
Energy-plus/-positive building (E+B)

produces a surplus of energy during a year.

Zero Energy Building: i confini del sistema



- On-site, off-site, nearby, distant? (pr-EN 15603-2013)



Key

a	Assessment boundary (use energy balance)	S1	Conditioned space (needs energy certificate)	1	PV
b	On-site	S2, S3	Unheated space	2	Wind
c	Nearby				
d	Distant				

Il primo esempio di nZEB

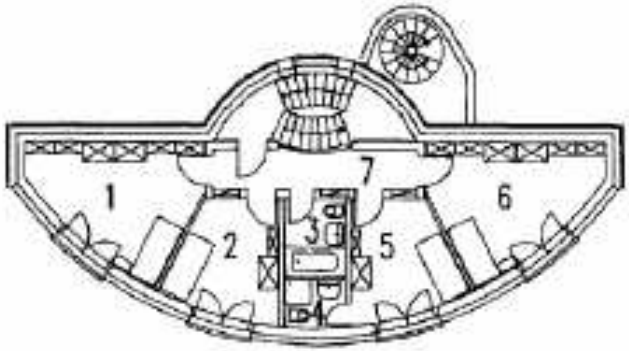
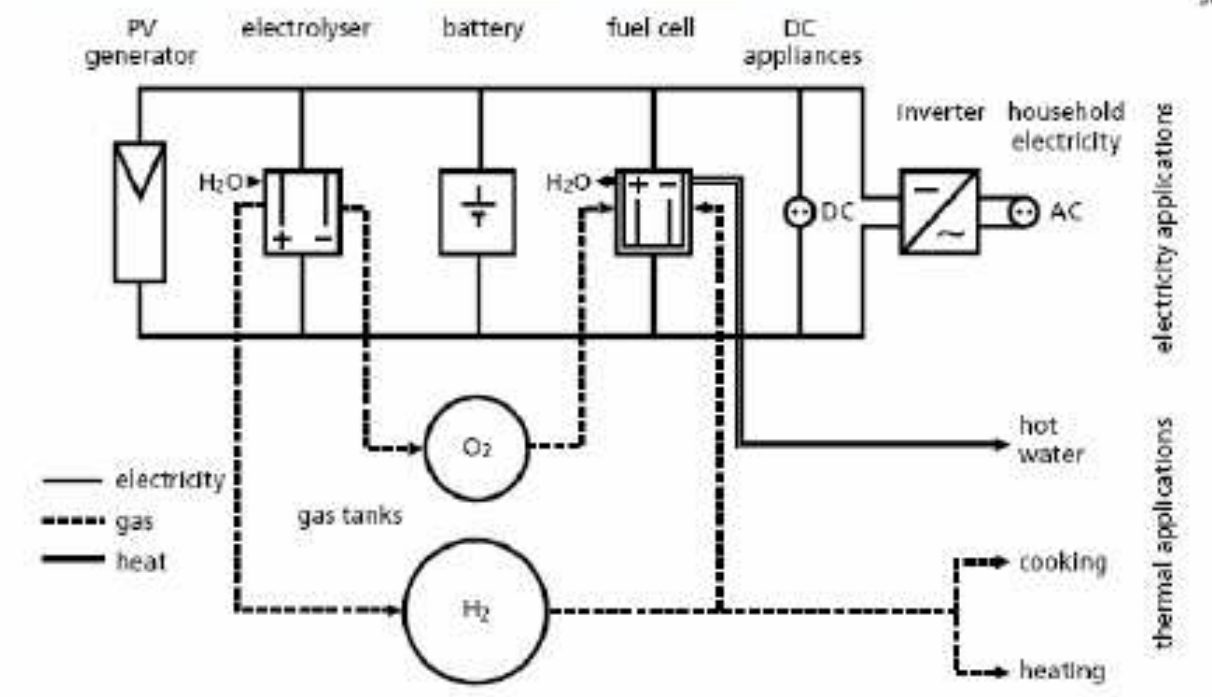


Fig. 3. The first floor of the SSSH

1: room 1, 2: room 2, 3: bath/toilet, 4: shower/toilet, 5: room 3, 6: room 4, 7: hor.



Self-sufficient Solar House
Freiburg - Germany
Fraunhofer Institute

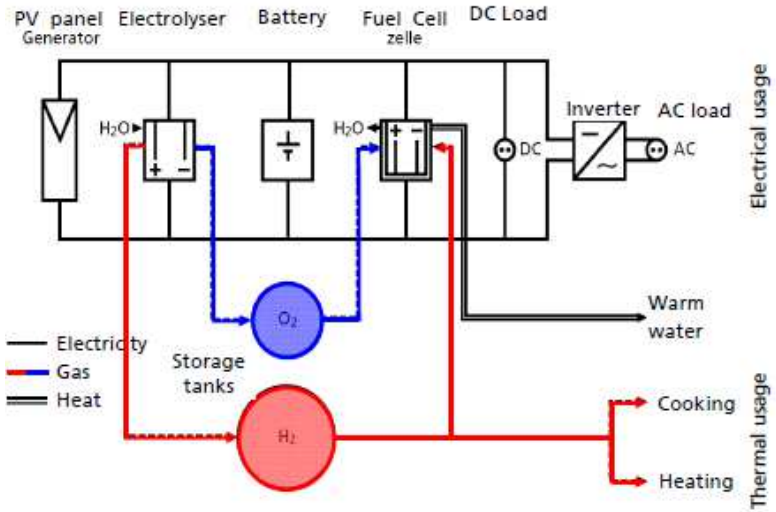
(Source: www.ise.fhg.de)

Il primo esempio di nZEB

Self-sufficient Solar House
Freiburg - Germany
Fraunhofer Institute

Regenerative fuel cell:

- PEM electrolysis unit
- (30 bar / 2 kWel)
- H2/O2 storage tanks
- PEM fuel cell
- No mech. compressor!



BedZED, UK - 2002

Consisted of 99 **super-insulated dwellings** of various sizes, workspaces and community facilities. **Triple glazed windows**.

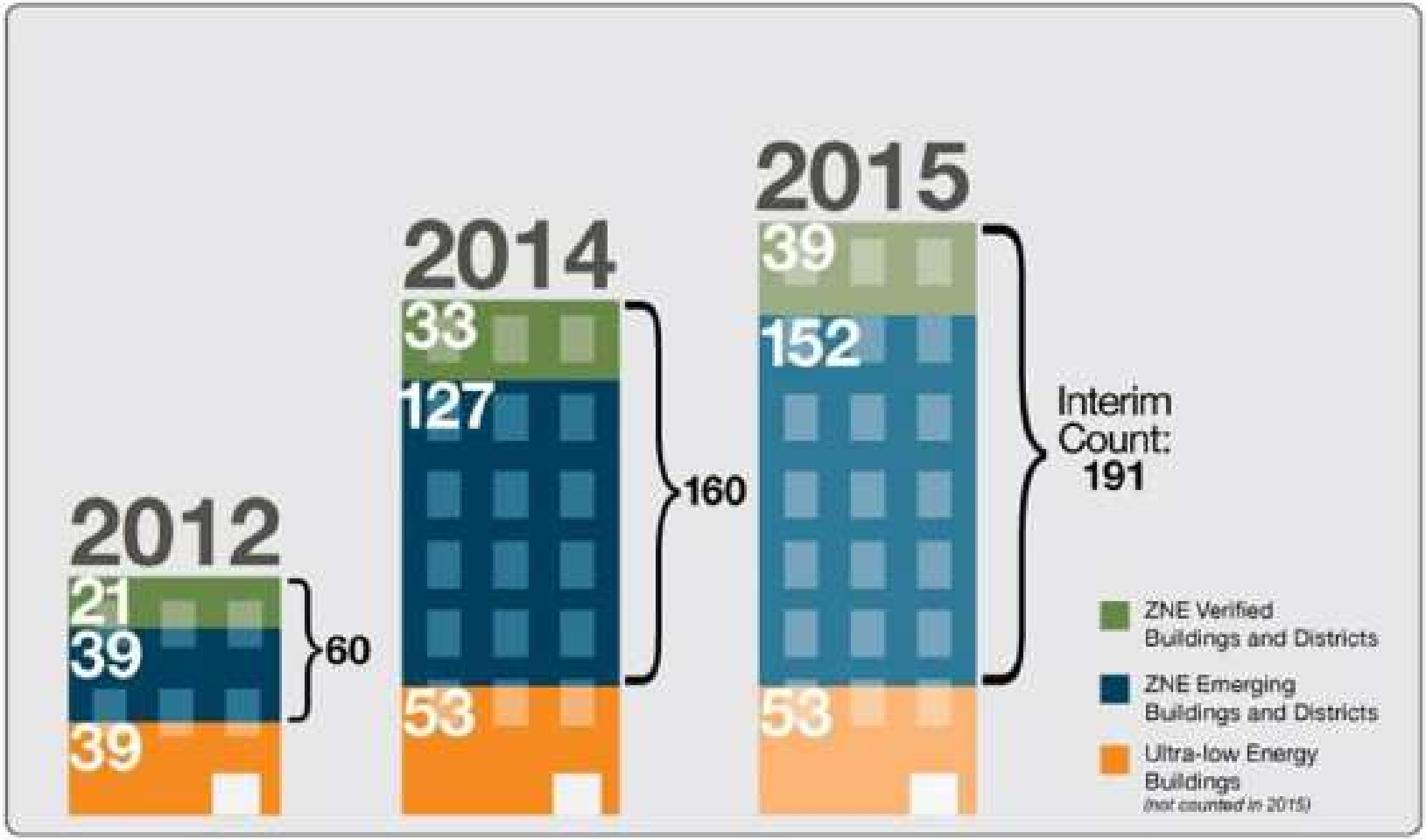
on-site zero-carbon generation provided by a **prototype 120kWe wood-waste fuelled combined heat and power (CHP)** system with **777m^2 of photovoltaic panels**

designed to meet all of the energy demands of the residents and potential to power up to 40 electric vehicles.

- Monitoring indicated:
  - that space **heating demand was 90% lower** than the UK average
  - **electrical power consumption** was **33% lower** than average, **due to residents using back-up electrical water heating**

- The development did ***not*** **achieve zero-carbon** operation, primarily due to the fact that the prototype biomass CHP system was unreliable and never operated effectively (it was shut down in 2005)
- The remaining **PV system only offset around 20% of the total energy demands** of the community with the remainder being drawn from external supplies

Zero Energy Building in USA



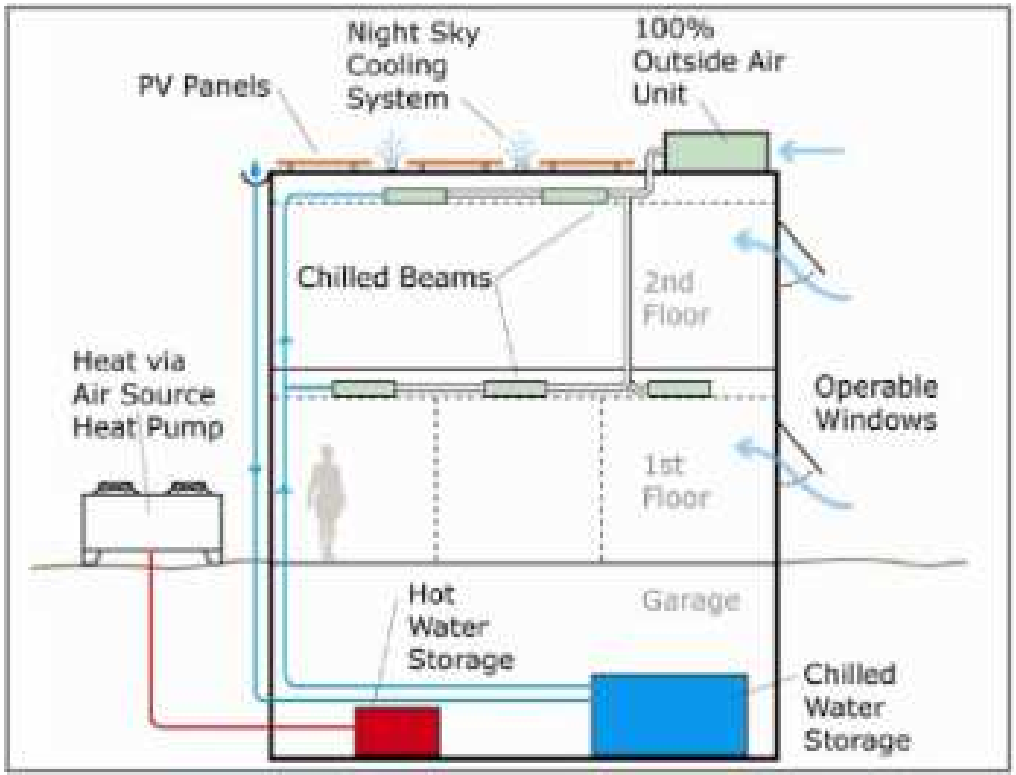
Zero Energy Building in the USA

Zero Energy Building data-base

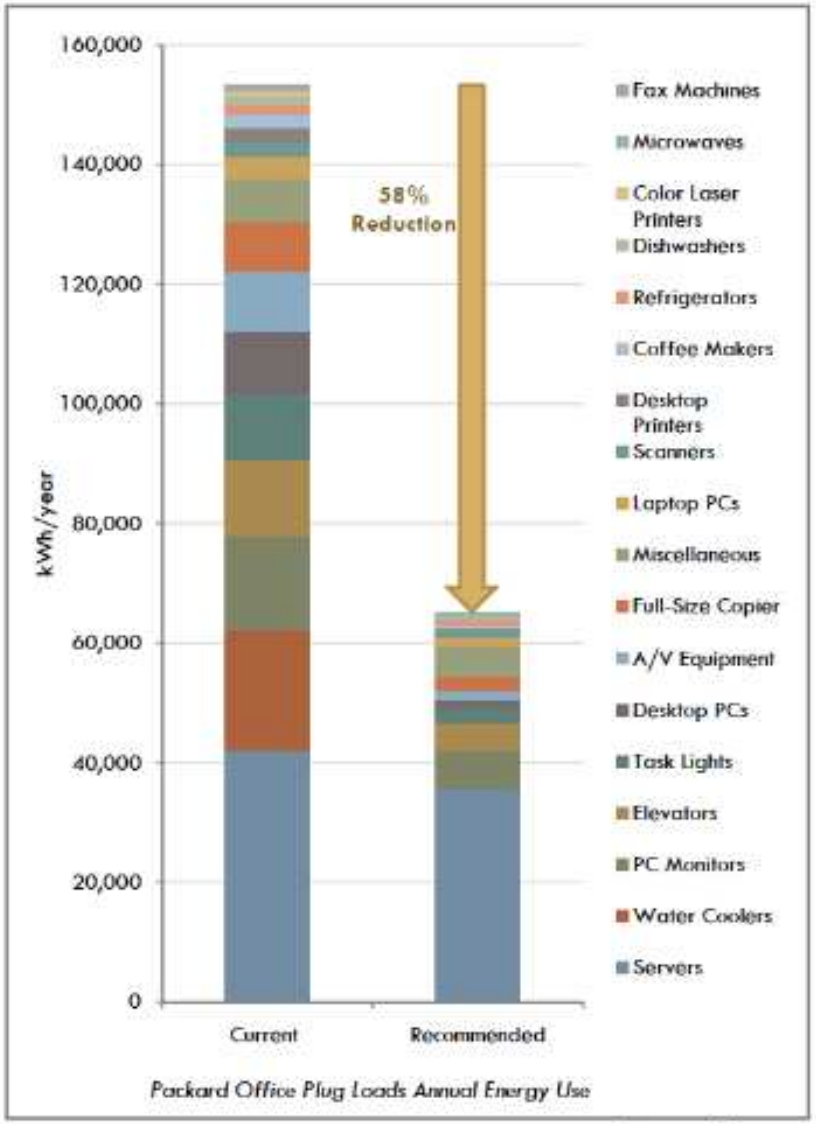
The largest database on ZNE buildings in North America and the only database searchable by ZNE Status & Energy Performance
http://newbuildings.org/getting-to-zero-buildings-database

David & Lucile Packard Foundation

David & Lucile Packard Foundation



Integral Group



Integral Group

David & Lucile Packard Foundation

The Packard Foundation describes its headquarters project as "a conscious decision to live the values we support," which it articulates for this project as a threesome:

> *a physical manifestation of our long-term commitment to conserving the Earth's natural resources; a comfortable, healthful space for our employees to work collaboratively; support for a vital downtown in the community which has been the Foundation's home for over 45 years.*[1]

La lezione appresa dagli esempi di ZEB

- **From the evidence of the case studies achieving zero-carbon operation is not straightforward!**
- **A building *designed* to be zero-carbon does not necessarily *perform* as zero carbon**
- **Most fail to achieve this due to 1) under-prediction of demands at the design stage 2) over-prediction of energy yields from renewables or 3) poorly performing equipment in-situ**
- **PV seems to be the ubiquitous option for electricity generation**
- **Most achieve significant reductions in thermal demand … less success with curbing electrical and demands**
- **usually grid connection is allowed and necessary. Excess production used to offset later energy use.**

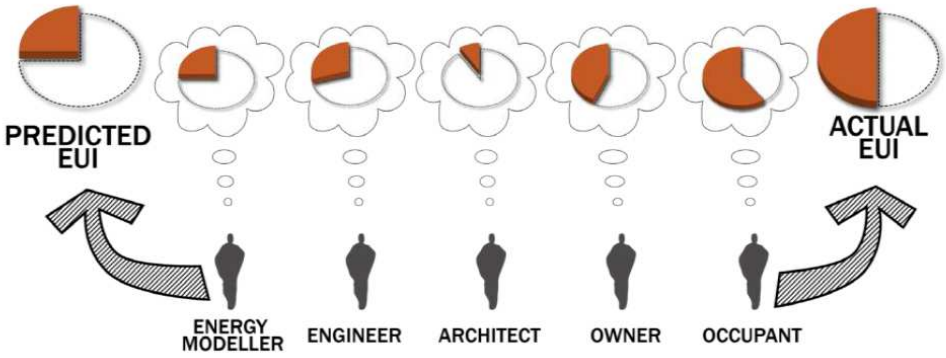
Zero Energy Building: takeaway lessons

- Production is usually MUCH more expensive than reducing waste (efficiency/conservation)
- Energy demanded by building should always be reduced, before adding production. Check cost of reducing demand vs cost if supplying energy
- Conservation measures first! Good design/orientation, good enclosure (shell), good mechanicals, then add renewable energy.
- Electrical energy becomes the predominant demand; in the dwelling - currently over 80% of demand is thermal energy.
- Zero-carbon buildings will have radically different energy demand characteristics compared to existing housing: space heating demand is minimal electricity for appliances and lighting becomes the major energy demand.
- Monitoring of actual performance indicates that most do not actually achieve zero-carbon operation.
- Renewables can be more cost-effective than insulation after a point!
- Net zero energy: good & noble target, but out beyond “neutral cost”.

La lezione appresa dagli esempi di ZEB

ENERGY USE

PREDICTED vs. ACTUAL



Zero Energy Building in Europe

Energy Performance of Buildings Directive - EPBD 2002, revised in May 2010, EPBD Recast 2010.

Renewable Energies Directive (RES) - April 2009

- Increase the use of renewables up to 20%, biofuels up to 10% in EU
- require energy consumers (also buildings) to include a given proportion of energy from renewable sources in their consumption

Energy Efficiency Directive Recast (EEDR) - November 2012

- District heating, Combined Heat and Power generation CHP, renovation 3% each year, public procurement, public buildings as exemplary model

Zero Energy Building in Europe

EPBD Recast

- By 31 Dec 2020, all new buildings are nearly zero energy buildings
- After 31 Dec 2018, public authorities that occupy and own a new building shall ensure that the building is a nearly zero energy building
- Minimum energy performance requirements based on calculation of cost-optimal levels, with the methodology developed by the Commission
- Primary energy target values have to be set in kWh/m2
- Different target values for new and existing buildings
- Specific regulations for building envelope and HVAC systems for renovated buildings

Zero Energy Building in Europe

In the directive 'nearly zero-energy building' means: "*a building that has a very high energy 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 energy from renewable sources produced on-site or nearby*".

Since the Commission does not give minimum or maximum harmonized requirements, it will be up to the Member States to define what for them exactly constitutes a "very high energy performance" on the base of the cost optimal performance level.

EPBD recast instructs Member States on how to set energy performance requirements: "with a view to achieving cost optimal levels"

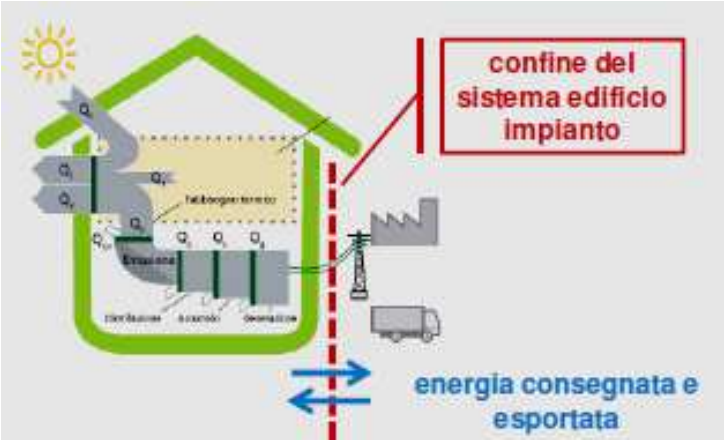
Cost optimal = "the energy performance that leads to the lowest cost during the estimated economic lifecycle" (the latter determined by Member States)

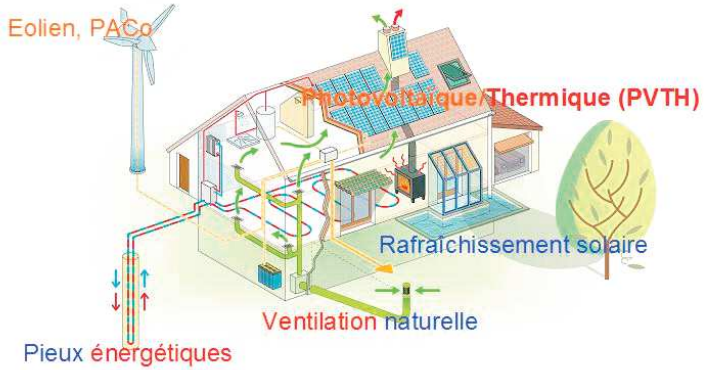
Edifici n-ZEB: DL 90/2013

Art. 2.

"edificio a energia quasi zero":
edificio ad altissima prestazione energetica, calcolata conformemente alle disposizioni del presente decreto, che rispetta i requisiti definiti al D.Lgs. 192 di cui all'articolo 4, comma 1.

Il fabbisogno energetico molto basso o quasi nullo è coperto in misura significativa da energia da fonti rinnovabili, prodotta all'interno del confine del sistema (in situ).



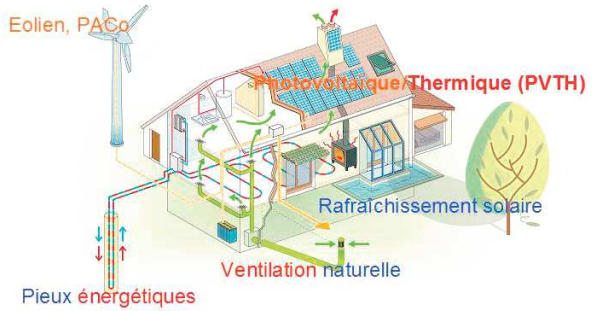


Edifici n-ZEB DM 26/6/2015

Nel **DM 26/6/2015** sono "**edifici a energia quasi zero**" tutti gli edifici, siano essi di nuova *costruzione o esistenti, per cui sono* ***contemporaneamente rispettati***:

a) **tutti i requisiti previsti** *dalla lettera b), del comma 2, del paragrafo 3.3* determinati con i valori vigenti **dal 1 gennaio 2019 per gli edifici pubblici** e **dal 1 gennaio 2021 per tutti gli altri edifici**;

b) **gli obblighi di integrazione delle fonti rinnovabili** nel rispetto dei **principi minimi di cui all'Allegato 3**, paragrafo 1, lettera c), del **Decreto Legislativo 3 marzo 2011**, n. 28 (*ricorso di energia prodotta da rinnovabili per coprire il 50% del consumo di acqua calda sanitaria e il 50% dei consumi globali per riscaldamento, condizionamento e acqua calda sanitaria*).



Edifici n-ZEB DM 26/6/2015

EDIFICIO AD ENERGIA QUASI ZERO "NZEB"

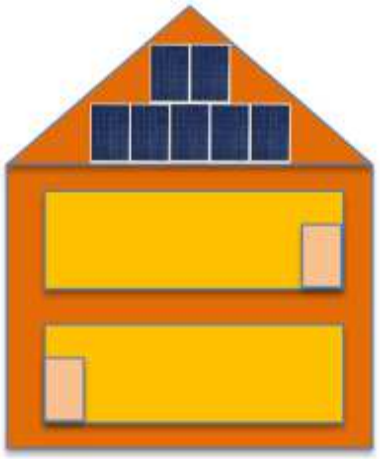
Direttiva 2010/31/UE

Art.2 Definizioni

«edificio a energia quasi zero»:

Edificio **con fabbisogno energetico molto basso** e coperto in misura **molto significativa** da energia **da fonti rinnovabili**

Edificio di riferimento con parametri al 2019/21 + FER



DM Requisiti - Allegato 1

Edificio che rispetta **tutti i requisiti** previsti al 2019/21 e gli **obblighi di integrazione delle fonti rinnovabili**

Edifici n-ZEB DM 26/6/2015

-Parametri termofisici ed impiantistici al 2019/21
- 50% ACS da FER
- 50% (ACS+Risc+Raffr) da FER

Zona climatica	U (W/m²K)	
	2015(1)	2019/2021(2)
A e B	0,45	0,43
C	0,38	0,34
D	0,34	0,29
E	0,30	0,26
F	0,28	0,24

0,34
0,33

OPACHE VERTICALI

Zona climatica	U (W/m²K)	
	2015(1)	2019/2021(2)
A e B	0,38	0,35
C	0,36	0,33
D	0,30	0,26
E	0,25	0,22
F	0,23	0,20

0,30
0,29

COPERTURE OPACHE

Zona climatica	U (W/m²K)	
	2015(1)	2019/2021(2)
A e B	0,46	0,44
C	0,40	0,38
D	0,32	0,29
E	0,30	0,26
F	0,28	0,24

0,33
0,32

PAVIMENTI OPACHI

Zona climatica	U (W/m²K)	
	2015(1)	2019/2021(2)
A e B	3,20	3,00
C	2,40	2,20
D	2,00	1,80
E	1,80	1,40
F	1,50	1,10

2,2
2,0

CHIUSURE TECNICHE TRASPARENTI E OPACHE

Zona climatica	U (W/m²K)	
	2015(1)	2019/2021(2)
Tutte le zone	0,8	0,8

0,8

OPACHE DI SEPARAZIONE TRA EDIFICI O U.I.

Zona climatica	g_{gl+sh}	
	2015(1)	2019/2021(2)
Tutte le zone	0,35	0,35

FATTORE TRASMISSIONE SOLARE PER FINESTRE S/E/O

Edifici n-ZEB e NZEB

nZEB = nearly zero energy building
NZEB = net zero energy building

Il primo può includere il secondo
Il secondo può non soddisfare i requisiti del primo

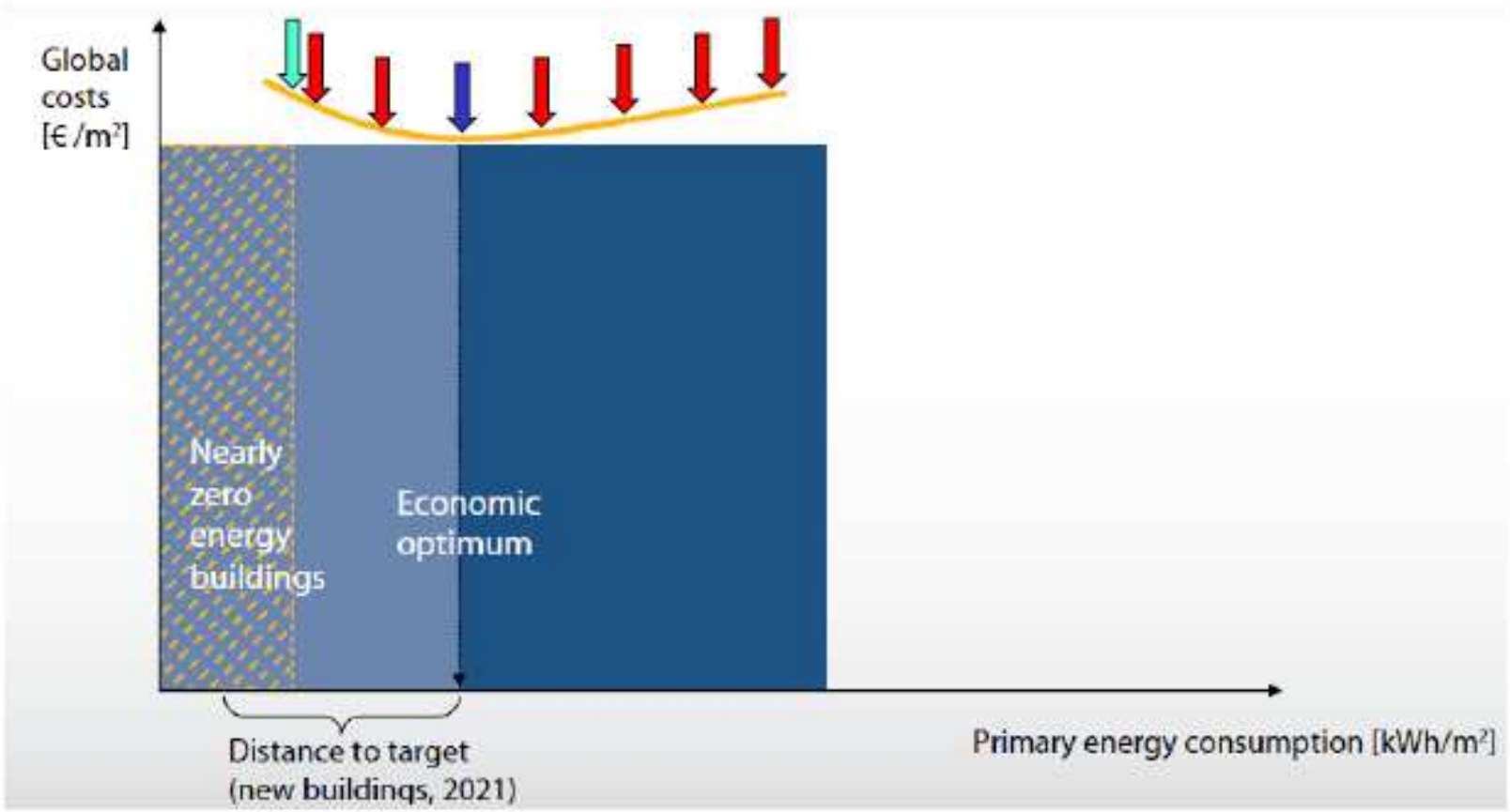
Posso definire l'edificio nZEB (nearly zero) tramite la relazione

$$0 < E_{p,x} < E_{p,x}\Big|_{\text{lim}}$$

Fissando $E_{p,x}\Big|_{\text{lim}}$ mediante la procedura di cost optimality

(x = generico servizio)

Zero Energy Building: cost optimal calculation



Source: The Buildings Performance Institute Europe (BPIE):
http://dl.dropbox.com/u/4399528/BPIE/BPIE_costoptimality_publication2010.pdf