Zero-Energy Buildings – An overview of terminology and policies in leading world regions

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Aim

review the international definitions and supporting policies of ZEB, to provide implications for developing regions (e.g., China) that are considering in adopting ZEB goals.

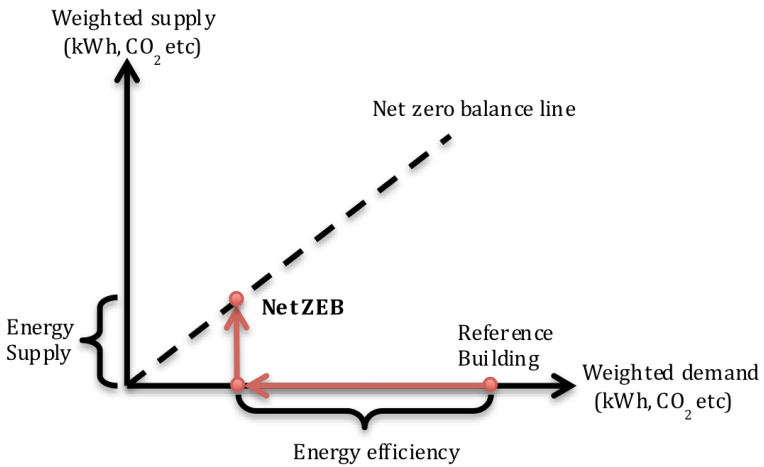
Outline

- ZEB terminology in leading world regions
- General targets and policies in EU and the US, specific policy (BEE and PV) examples of Denmark and California
- ZEB activities and policies in China
- Terminology and Policy implications

Understanding ZEB

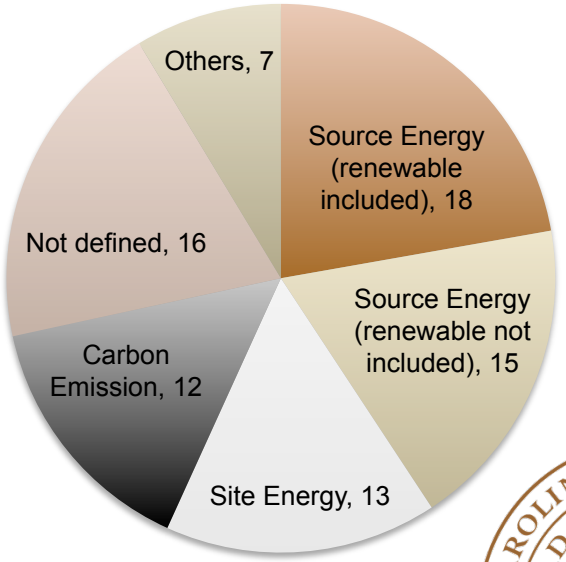
- Inconsistent definitions (most cited ones): Site Energy, Source Energy, Energy Costs, and Energy Emission
- In each country, definitions both from the official and voluntary backgrounds
- Extensive discussions based on existing definitions, research projects, ZEB case studies, EU template reporting

Common balance approach



ZEB balance concept (Sartori I., etc, 2012)

Variety of applied approach



Overview on chosen metrics of the known 75 international bal methodologies (Ecofys, 2013)

The ZEB definitions in world leading regions

Country	Definition/ label	Metric			System boundary		End Uses and Life-Cycle Stages Included					Minimum requirements		Single building types	
		Primary (Source) energy	Final (Site) energy	Carbon emissions	On-site	Off-site	HVAC*	DHW*	Lighting	Plug load /Appliance	Embodied energy	EE*	RE* share	New	Existing
EU	EPBD*	✓			✓	✓	✓	✓	✓			✓	✓	✓	✓
DE*	EffizienzhausPlus	✓			✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
DK*	Danish Building regulation 2010 (BR10)	✓			✓	✓	✓	✓	✓			✓		✓	
CH*	Minergie-A	✓			✓		✓	✓	✓	✓	✓	✓		✓	
NO*	Zero-emission building			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
UK*	Zero-carbon standard			✓	✓	✓	✓	✓	✓			✓	✓	✓	
US**	Zero-Net- Energy Building		✓		✓	✓	✓	✓	✓	✓		✓		✓	

** California: time-dependent valuation (TDV) metric was proposed.

Notes to table: mostly by public authorities, new buildings, single buildings, generally without electro mobility, operational year, indoor/comfort included

---EU and US: source/site energy, Plug load, EE/RE goal, embodied energy, prescriptive-performance-outcome

---Definitions affected by existing official/voluntary building codes, relevant laws and regulations, designer/user side feasibility, existing grid conditions, economic viability, as well as different stakeholder interests

ZEB targets in Europe

(selected leading EU member states and non-EU countries)

Region	Intermediate and future target
EU	New commercial buildings meet ZEB by 2018; all new buildings meet ZEB by 2020.
DE	Energy-efficiency requirements gradually tighten 25% by 2016. Renewable energy for heating in new buildings is compulsory since 2009 (according to the German Renewable Energy Heat Act).
DK	Expected share of renewable energy in building sector is 44-51% in 2015 and 51-56% in 2020. Energy consumed for heating, cooling, ventilation, and hot water limited to 20 kilowatt hours per square meter per year (kwh/m^2/year) by 2020. Additional lighting requirements for non-residential buildings (25 kwh/m^2/year).
CH	Similar to Minergie-A ecological standard by 2020; consider embedded energy below 50 kwh/m^2/year.
NO	Passivhaus standards by 2017; zero emissions for all new buildings by 2020.
UK	New homes to be “zero-carbon homes” by 2016. Public buildings should be zero carbon by 2019.

ZEB targets in the United States (selected regions)

Regions	Targets
California	All new residential construction will be net zero energy by 2020; all new commercial buildings will be net zero energy by 2030.
Massachusetts	All new buildings will reach net zero energy by 2030 (Massachusetts zero-net-energy-building task force).
City of Austin, Texas	Net-zero-energy-capable (designed and built so that PV will be added when it becomes more cost-effective) homes achieved by 2015; citywide net-zero impact on climate change by 2050.
Oregon	The Energy Trust of Oregon has created a "Path to Net Zero" pilot program. (Oregon Army National Guard, under U.S. Army Net Zero Initiative).
The District of Columbia	By 2032, 100 percent of all existing commercial and multi-family buildings should achieve net-zero energy standards. All new development should achieve net-zero energy performance standards ("Sustainable DC").
Washington State	All new buildings incrementally move toward achieving a 70% reduction in annual net energy consumption by 2031, compared to consumption in 2013. The city of Seattle has a citywide goal of carbon neutrality by the year 2030.
Vermont	Incremental improvements to achieve net-zero goal before 2030.
Minnesota	Meeting the Architecture 2030 goal to achieve net- zero-energy buildings.

ZEB policy example of Denmark

Policy Instruments	Denmark (EU)
Targets and building codes	Mandate ZEB target, three performance levels. *fossil-fuel-free country* by 2050. Danish appliance standard depends on EU regulations
Certificate	Energy Performance Label is mandatory and verified by third party
Economic instruments	High energy-use/carbon taxes. *public service obligation* levied by state-owned enterprises, tax rebate for EE, and subsidies to replace oil /coal/natural gas heat boilers. For solar PV: net-metering rules and feed-in-tariffs were adopted
Supervision	Through a mandatory "Energy Performance scheme" (EPC) initiated in 1997, an energy audit is performed and an energy label issued. Violation fine
Information tools	Campaign by The Danish Energy Agency. Utilities obligation. and a "knowledge center for energy savings in buildings" for building professionals
Demonstration	The first ZEB was built in the late 1970s. These demonstrations are seen as *mainstream practices* rather than futuristic experiments
Education and training	ZEB education is conducted by major Danish universities and the "knowledge center for energy savings in buildings."
R&D	The "strategic research center for zero-energy buildings" was established in 2009 through joint collaboration of two Danish universities. Private sector: develop most of the practical and technical solutions.
Overall approach	*Balanced policy package* combining top-down and bottom-up approaches. General energy policies are influenced by neoclassical economic and "innovative democratic" approaches

ZEB policy example of California in the US

Policy Instruments	California (US)
Targets and building codes	Zero-net-energy (ZNE) goals are *proposed* (not yet mandatory) by 2020 (residential) and 2030 (commercial). Appliance standard subject to federal pre-emption. Renewable portfolio standard 33% by 2020
Certificate	Home Energy and Commercial Building Energy Asset Rating Systems (0), Building Challenge Certification Program
Economic instruments	*Market-based approach.* Substantial federal and state financial support for both building energy efficiency and solar PV (e.g., tax credits, rebates, grants, and low-interest mortgages, net-metering rules)
Supervision	ZEB targets are not legally binding. Title 24 compliance. Ensure code compliance: simplifying the regulatory process and training. Living Building Challenge
Information tools	*Informational tools* are a current focus of the ZNE action plan. All ZEB market actors participate. Early adopter networks were established.
Demonstration	Increasing ZEB demonstration is a current focus of the ZNE action plan. In 2014, about 47 ZEB projects had been built in California
Education and training	current focus of the ZNE action plan and take a variety of forms
R&D	Federal: key technologies. CA: technical, economic and policy completed
Overall approach	*Bottom-up market-driven* strategy to create awareness among builders and homeowners. Neo-liberal principles at the core of economic policy.

ZEB activities in China

- 30%, 50%, 65% (75%) energy savings (1980s baseline)
- ZEB roadmap by 2030?
- Net-zero-energy building (Jing Ling Neng Hao), site/emission
- Definition discussion in academics
- ZEB networks

ZEB policy in China

Policy Instruments	China
Targets and building codes	Building energy policies focus solely on building codes: 30%, 50%, 65% (baseline 1980s). Next step unclear. *Code updates are not institutionalized, A ZEB roadmap by 2030 is under consideration*
Certificate	*Existing Chinese green building certificate and passive house standard*.
Economic instruments	Insufficient funding. Financial support for PV recently begun to receive attention. *Shifting PV policy.* Net-metering rules are currently simplified
Supervision	Compliance is mainly verified through the "building energy conservation inspection and supervision" program
Information tools	Information-sharing is limited to professionals.. The ZEB technology innovation association was established in 2014
Demonstration	only a handful of ZEB projects have been completed
Education and training	Domestic education is highly regional. At the national level, Tsinghua University and CABR
R&D	only a few studies have been done on ZEB definitions and empirical lesson from demonstration projects
Overall approach	*Mainly top-down approach* complemented by local experiments (namely "Regionally Decentralized Authoritarianism"). Policy focuses solely on building regulations.

ZEB terminology in the Chinese context

- ZEB individual building using site energy metric. 8-10 story (commercial), 9-11 story (residential)
- A consistent definition across the country?
- Base on existing codes? Green Building (water and others)
- Prescriptive—performance—outcome?
- Take into account of local culture, norms and occupant behavior

Policy implications for China and other emerging economies

Policies aimed specifically at a ZEB target

- Specifying multiple performance levels in the building code
- Defining ZEB concept at the district level, allowing renewable-energy credits to offset energy usage in urban areas
- Experiment with different contract mechanisms (design-build)
- Defining ZEBs to suit regional conditions
- Defining ZEBs in relation to broad societal benefits
- Considering legislative barriers
- Addressing appliance standards

Energy policy environment for ZEBs

- Evolving ZEB policies
- Establishing stable, long-term targets
- Mandating and incentivizing utilities and others to participate

Political and economic factors

- Relying on different factors from political economics
- Combining bottom-up and top-down approaches
- Implementing policy in the context of social principles and economic development

Conclusion

- ZEB definitions: outcome-based and consider the diversity among local regions. Broad and long-term societal benefits. Base on existing voluntary codes.

- Policy implications: a phased approach, district level ZEB or others, evolving ZEB policies, combined top-down and bottom-up

- Structural challenges: ZEB issues are beyond building sector (BEE, RE, Plug loads, grid integration)---coordination between inter-ministries, implementation gap between central and local governments

Thank you for your attention!

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