PRINCIPLES FOR NEARLY ZERO ENERGY BUILDING IN BELGIUM

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ABSTRACT

The recast of the European Performance of Buildings Directive (EPBD) requires all new buildings to be "nearly zero energy' buildings (nZEB) by 2020, including existing buildings undergoing major renovations. Belgium was first to set a definition for a 'net zero energy house' (NZEB) in 2009. Every year the definition is revised for consistency with shortcomings and emerging issues. However, to reach the nZEB objective many questions are raised in the Belgian context. Many uncertainties exist among local governments and municipalities to achieve that objective. Therefore, the paper presents a review on the current Belgian definition and its market status in comparison with the international context. The paper builds on existing experience with the implementation of the EPB calculation method and the Passive House initiative. The aim of the paper is to review current definition discussions and pave the way to a more consistent definition. Finally, four principles are suggested to reach the nZEB objectives in Belgium.

1. INTRODUCTION

The definitions of NZEBs are discussed and proposed at the international level. The International Energy Agency (IEA) is compiling and discussing the definitions within Task 40: Towards Net Zero Energy Buildings comprising almost 20 countries [1]. The USA is discussing the definitions within the Energy Independence and Security Act of 2007 and the European Union is discussing the definitions within the recast of the Directive on Energy Performance of Buildings (EPBD) adopted in May 2010 [2-4]. The recast of the EPBD requires the uptake of a definition of so called 'nearly zero energy' buildings (nZEB) [5]. All Member States, including Belgium, have to engage in a more widespread deployment of such buildings by 2020. In addition, the Member States shall draw up national plans for increasing the number of nZEBs. These national plans can include differentiated targets according to the category of building. Currently procedures are being developed in the energy administrations of the Belgian regions to respond to the European requirements. In 2009, Belgian definitions for the low-energy house, the passive house and the zero-energy house have been introduced in federal income tax legislation [6], thus providing first guidance in the residential sector. For dwelling owners and leaseholders only, an income tax reduction[1] can be obtained during 10 years. In 2010, the Royal Decree [7] defined the renewable energy types and their calculation method for net zero energy buildings (NZEBs). However, the view on this federal definition and the expected means to achieve defined targets in the regions show considerable differences. Also, there is no cross-national understanding and agreement on the definition. There exists a conflict between the Passive House Concept with calculation procedures developed during the implementation of the Energy Performance of Buildings Directive (EPBD) before its recast [8]. Therefore, this paper reviews the existing market and political definition landscape in order to provide an overview of the state-of-the-art of Belgian federal and regional status versus the international status. Also the paper analyses and lists the problems of the existing Belgian definition and suggests a set of principles to achieve the EPBD objective before 2020. This work can be a basis for proposing a more consistent and practical definition of nZEBs, which allows for inclusion of national conditions. The paper thus provides

[1] For 2011 the fiscal advantage during 10 years is 420 EUR for low energy houses, 850 Euro for passive houses and 1700 EUR for zero energy houses.

information and analysis that can be useful for policy makers, NGOs, municipalities, governments, industry associations, project developers, building experts and researchers.

2. ANALYSIS OF BUILDING STOCK IN BELGIUM

Before introducing the Belgian energy performance market status it is very important to identify the characteristics of the Belgian building stock. In fact this step is essential to put the 2020 objective in perspective. In fact over the last 60 years the growth rate of Belgian building stock has been around 1 percent. As shown in Figure 1a, the post Second World War building boom has been increasing from approximately 1 percent to 1.5 percent. However, since the 1980 the growth rate has been almost stable ranging around 0.6 percent annually. According to Figure 1b, if we project the same growth rate until 2050, the share of the newly constructed buildings will not exceed 20 percent of the current building stock. Even if we assume a strong growth rate of the Belgian building stock during the coming years, assuming a growth rate of 1 percent, which contradict with the demographic forecasts, the newly built stock will not exceed 50%. In fact, in 2050 it is expected that Belgium (currently 10.3 million) will reach 9.3 million. This confirms that by 2050, almost three quarter of the building stock currently exists. On the other hand, the renovation rate of existing buildings in Belgium is very low and almost negligible.

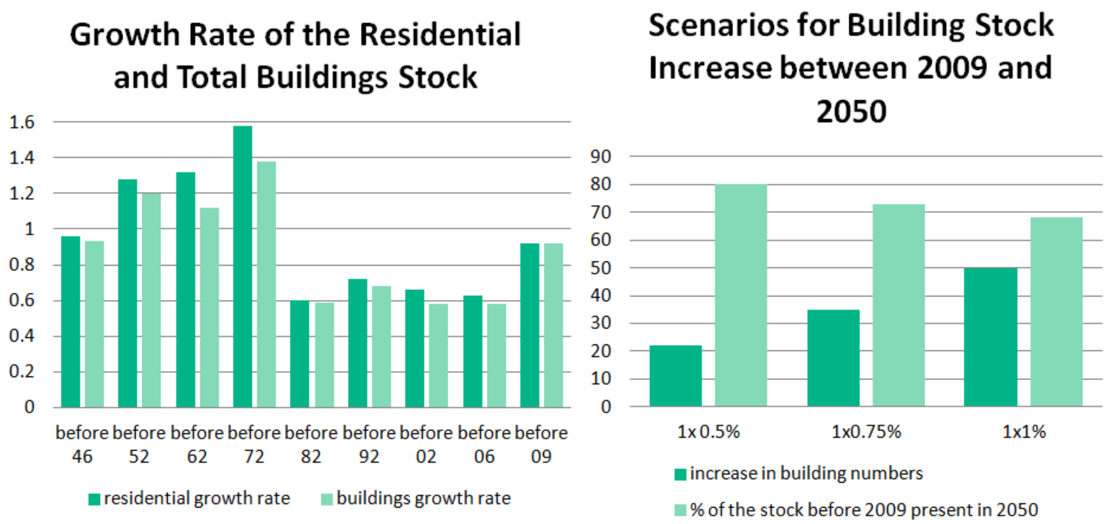

Figure 1a, Growth rate of Belgian building stock, 1b, future scenarios (adapted from INS Documentation patrimonial, Influence du territoire sur le bati existant, Teller, UL, LEMA)

3. EVOLUTION OF ENERGY PERFROMANCE REGULATION IN BELGIUM

Since January 2006, Belgium installed the EPBD regulation in its three regional administrations (Flanders, Wallonia and Brussels Region). The E-Level is required as part of the construction permit for any new residence, office or school. The requirements became more stringent (from E100 to E80) in all three regions in 2010. Prior to the introduction of the EPBD, the voluntary passive house requirements and PHPP software were introduced in 2003 by the nonprofit organization Passiefhuis-Platform. PHPP is currently not accepted as an EPBD calculation and both calculations have to be performed. This situation created a partially conflicting situation [9]. Further, in 2009 Belgium introduced three definitions on the federal level: the low-energy house, the passive house and the zero-energy house.

Regional Market Definitions

Like in many countries definitions are also subject to different market interpretations. ‘Zero energy’ is generally interpreted as ‘net zero energy’: i.e. balance between the consumed and produced energy on site. Due to the lack of policy definition for (very) low energy buildings, initially different definitions were introduced by business networks and mixed business/ policy networks. Table I summarizes the definitions introduced for market creation in Belgium. It highlights the multitude of definitions that exist, which all have an impact on the construction market. Table I show that there is no consensus in the market, especially considering low-energy definitions. Further, there are large differences according to the Region. In the Flemish Region these definitions can differ according to the initiating body (NGO's or government). In the Walloon Region, there are only very limited energy restrictions. Most advances towards the passive house definition appear to be in the Brussels Capital Region with its implementation of limitations for space heating demand and primary energy use.

Legal Belgian Definitions

Next to the previous definitions listed in Table I, in Belgium definitions for dwellings (for the low-energy house, the passive house and the zero-energy house) have been introduced in federal income tax legislation [6] as shown in Table II. For dwelling owners and leaseholders only, an income tax reduction[2] can be obtained during 10 years.

A recent Royal Decree [7] defines that the renewable energy should be produced by:

1° a system of water heating using solar energy[3]

2° solar panels for the conversion of solar energy into electrical energy

3° heat pumps that use energy stored in the form of heat: (- in the surrounding air, - under the soil surface, - in surface water)

According to the Royal Decree, the number of kWh generated renewable energy has to be calculated with the regional energy performance calculation method in the framework of the Directive CE/2006/32 applicable on the building, unless this method does not provide an evaluation of the production between input and output of the systems and equipment for renewable energy has to be valued by means of a European/International procedure[4].

TABLE I: MARKETING DEFINITIONS FOR LOW ENERGY HOUSES IN BELGIUM.

Category[5]	Energy criteria for homes	Reference
Low-energy house	under no specified calculation model: The total energy demand for space heating should be limited to 60 kWh/m^2 gross floor area.	Flemish charter 2003 [10]
(Low-energy house)	under the conditions in the Flemish EPB calculation model: The E-level should be limited to 60.	Label for Flemish architects [11]
(Low-energy house)	under the conditions in the Flemish EPB calculation model: The E-level should be limited to 60.	Flemish grants from energy providers [12]
Low-energy house	under the conditions in the Walloon EPB calculation model: $E_w \leq 80$.	Baseline for subsidies[6] in the Walloon Region [13]
Low-energy house	under the conditions in the Walloon EPB calculation model: $E_w \leq 70$; $E_{spec} \leq 120$kWh/m².a.	Label for construction companies & architects [14]
Low-energy renovation	under the conditions in the PHPP 2007 calculation model: The total energy demand for space heating is limited to 60 kWh/m² of conditioned floor area.	Project listing for Brussels Capital Region [15]
(Very low-energy house)	under the conditions in the Flemish EPB calculation model: The E-level should be limited to 40.	Flemish grants from energy providers [12]
Very low-energy renovation	under the conditions in the PHPP 2007 calculation model: The total energy demand for space heating is limited to 30 kWh/m² of conditioned floor area.	Project listing for Brussels Capital Region [15]
Passive house	under the conditions in the PHPP 2007 calculation model: - The total energy demand for space heating is limited to 15 kWh/m² of conditioned floor area. - The total primary energy use is limited to 45 kWh/m²year for heating, domestic hot water and auxiliary equipment (fans, pumps), excluding lighting and appliances	Exemplary projects Brussels Capital Region [15-16]
Passive house (also non-residential)	under the conditions in the PHPP calculation model: - The total energy demand for space heating and cooling is limited to 15 kWh/m² of conditioned floor area; - The total primary energy use for all appliances, domestic hot water, and space heating and cooling is limited to a compactness formula: {90 – 2.5 x Compactness kWh/m²} where the compactness [compactness=V/A] is a ratio between the building volume (V) and the envelope surface area (A)	Definition promoted by Belgian business and research networks: PHP, PMP, BBRI,..

2 For 2011 the fiscal advantage during 10 years is 420 EUR for low energy houses, 850 Euro for passive houses and 1700 EUR for zero energy houses.

3 Pellets boilers have not been considered: the argument was that the origin of the wood is not on site.

4 This is not very clear in the Royal Decree.

5 The brackets indicate that the term is not specifically used in reference documents.

6 The baseline for construction permits under the conditions in the Walloon EPB calculation model is Ew ≤ 100; K= 45; for Ew ≤ 80 for every reduction credit Ew-1 subsidies are granted.

In Belgium, the legal “zero energy” definition is thus defined on the federal level requiring compliance with the passive house requirements and the compensation of heating and cooling demand on site by renewable energy. Biomass was rejected as an option because on site production could not be guaranteed. However, the application and calculation is different on the regional level. For example, in the case of Wallonia, the calculation method is based only on the PHPP calculation method and is communicated in kWh/m^2. The general policy trend among the local governments is to reduce the demand as low as possible before considering renewable systems.

TABLE II: Definitions of highly energy-efficient dwellings in Belgium [6]

Category	Definition for homes situated in the European Economic Area according to ***Belgisch Staatsblad*, 2009**
Low-energy house	The total energy demand for space heating and cooling should be limited to 30 kWh/m^2 conditioned floor area;
Passive house	1° The total energy demand for space heating and cooling should be limited to 15 kWh/m^2 conditioned floor area; 2° During a pressurisation test (according to the NBN EN 13829 norm) with a pressure difference of 50 Pascal between inside and outside, the air loss should not be more than 60% of the volume of the house per hour ($n_{50} \le 0.6$/h).
Zero-energy house	1° Comply with the conditions for a passive house; 2° The residual energy demand for space heating and cooling can be fully compensated by renewable energy produced on site. (The monarch decides how the production of renewable energy is taken into account for the compensation.)
Comfort	**Belgian Passive House Platforms**
Residential	Indicator of Comfort with 5% maximum of hours exceeding 25°C Excessive temperature frequency ≤ 5% (> 25°C)
Tertiary Commercial	EN15251 with a dynamic simulation proof

Certification proposed by Passiefhuis-Platform

Passiefhuis-Platform vzw (PHP) has launched a Belgian ‘passive house’ label in 2005 with the support of a Federal Minister [17]. The first building certification was achieved in 2005, based on verification of calculations of the German PHPP software as a basis. Since the launch of the label and the developed quality assurance procedure, several communities and an energy provider have used the passive house definition for defining associated grants. With the launch of the federal income tax reduction for passive houses in 2007 the tax administration relied on PHP and its French speaking counter-part Plate-forme Maison Passive (PMP) as ‘institutes’, and on the already developed passive house label as a format for a certificate[7]. Certification based on PHPP calculation is currently performed by PHP in Flanders and in the Brussels Region and alternatively by PMP in Wallonia and in the Brussels Region on a voluntary basis [18-19]. Since the adoption of zero-energy houses in the Royal Decree PHP and PMP are now also expected to provide a procedure for evaluating the applications for grants and income tax reduction for zero energy houses.

A discussion is ongoing whether performance criteria for indoor climate installations should be made obligatory for passive house certification. It is recommended to adapt PHP certification procedures to include at least a basic quality assurance of the proper working of installed indoor climate systems [20]. Due to the introduction of the zero and low energy categories in the Royal Decree, the certification was adapted to include zero energy certification. The cost of the zero energy certificates is dependent on the fact if a house already has a passive house certificate[8].For the moment the control of energy needs for heating and cooling to be compensated with renewable energy is based on net energy needs. A final control procedure will be developed in a future update of the current vademecum for certification[9].

4. PROBLEM DESCRIPTION

In Belgium, the problem is not so much a (legal) definition, which has been installed, but rather the need for a constant[10] and practical definition accepted on different regional levels and coupled with the EPBD. Already the definition of passive house in Belgium is not the same as in other countries [21]. For example, because of limited know-how about primary energy use of Belgian dwellings during the introduction of the criteria, the introduction of the total primary energy use limitation of 120 kWh/m²

[7] The certificate is an obligation for obtaining federal income tax reduction.

[8] When available: 300 EUR + VAT, if not: 900 EUR + VAT (rates January 2011)

[9] During this time remarks can be submitted to Stefan.vanloon@passiefhuisplatform.be.

[10] The tax legislation was adapted every year since 2007.

was delayed. In the Belgian context, there are several shortcomings of the current procedures to certify a NZEB [22-23]. The following list is a summary of an analysis of the existing definition:

(1) In the Belgian definition the term “net zero” is not truly achieved because only the heating and cooling demands are net balanced.

(2) The application and calculation method is different on the regional level, which creates definition discrepancies on the national level.

(3) The Belgian passive house standard excludes the total primary energy use rule of 120 kWh/m² for all appliances (plug loads) and lighting in residential. However, in Brussels the total primary energy use should not exceed 45 kWh/m^2 for dwellings and (90-2.5*Compactness (volume/exterior surface area)) kWh/m^2.

(4) To be bound to the passive house standard has implications on the comfort criterion used. For example, a summer comfort criterion on cooling demand is included in the Belgian Passive house certification, but this does not allow the adoption of other comfort models e.g. the European adaptive comfort model EN15251 or direct results from building physical simulations which is requested for non-residential buildings [24-26].

(5) The fuel specific conversion factors for use in performing primary energy calculation can dramatically influence the building assessment and carbon dioxide emissions calculation. For example, the Brussels Capital Region assumes the conversion factor of biomass by fp=0.32 which encourages the use of wood pellet combustion.

(6) The current definition is only focused on dwellings and does not address other building typologies (commercial, institutional, and so on) and neglects the refurbishment and renovation of patrimonial and historical buildings [27-28]

(7) The renewable energy sources compensated for the energy balance are restricted to on-site heat pumps, solar thermal and electric systems

(8) The definition does not address the energy matching and storage (annual, monthly, and daily), on-site versus off-site generation and grid connectivity-interaction. It is an important issue to develop in parallel the Belgian smart grid energy storage and exchange market.

(9) The definition does not address the urban-scale zero energy communities or districts and synergies that can occur from implementing district heating/cooling systems. Additionally, the Passive House Standard benefits from solar gains, which implies urban morphologies that allow solar access [29]. This issue is a challenge in Belgian cities and urban policy.

(10) The definition does not address reliable quality assurance system and monitoring procedure to guarantee the physical quality of construction realization and in the same time performance of the nZEB.

5. INTERNATIONAL COMPARISON

Internationally, there are many unanswered questions and conflicting definitions for NZEBs [30-31]. There is no standardized way of making zero energy calculations either on the Belgian or the European level [32]. It is not obvious which analysis and representation methodologies should be used. More importantly, which comfort criteria should the NZEB definitions comply with [33]? As evaluations of zero-energy projects are usually based on calculations, decisions need to be taken on which energy (or environmental) metrics to use (final energy, primary energy, non-renewable share of primary energy, CO_2, CO_2 equivalent, and so on) [32, 34-35][11].

The different countries participating in IEA Task 40 show a different definition formulation and interpretation of NZEBs. To date, no national, standardized methodology for balancing energy of NZEBs exists except in Belgium. There are several proposals in Denmark, Norway and Switzerland (MINERGIE-A) to define NZEBs as well as the calculation methodology. However, there is a gap between the proposed definitions and most existing national building codes [36]. The first problem is that the metric used in the building codes is final energy whereas the proposed methodologies would like to include the final energy, primary energy and emissions. Secondly, no national regulations currently exist to regulate the onsite generation including the electricity feed-in tariffs.

Similar to Belgium, Central European Countries are already developing initiatives to include the passive house standard as a legal instrument and/or obligation for new constructions. However, the problem of harmonization with national building codes and EPBD is significant. Also the passive house criteria have limited application to other building types (offices, schools etc.) and cooling dominated climates. Possible problems of indoor quality and summer overheating can be an obstacle in adopting a passive house standard as a low energy baseline.

[11] It could be investigated if the EPBD recast provides a framework for certain choices.

In this context, it is important to revise the Belgian definition in the perspective of the IEA Task 40. The recent work of Subtask A, concerned with the definitions of NZEBs, states five major principles that any definition of NZEB should take into consideration [30, 31, 34]. Firstly, the (1) boundary conditions, which addresses (a) physical boundaries, (b) functionality, (c) effectiveness, (d) climate and (e) comfort. Secondly the (2) weighting system, which addresses (a) metrics, (b) accounting method and (c) asymmetric weighting. Thirdly, the net zero balance which addresses the (a) Items of the balance, (b) balancing period, (c) energy efficiency and (d) supply options. Fourthly, the temporal energy match regarding the (a) load match, (b) grids interaction and (c) carrier switching. Finally, the monitoring procedure and post occupancy protocol. A definition that does not take into account those five principals will be hardly comparable and consistent on the long term. The five principles can be implemented on different levels and can include even detailed metrics such as embodied energy and the environmental impact [37-38].

6. SUGGESTED PRINCIPLES OF nZEBs IN BELGIUM

To overcome the previously mentioned problems and achieve the nZEB objective in Belgium we suggest tangible measure that can be adapted before 2020.

- First, fixing a maximum value of energy demand of 30 kWh/m^2 per year for all newly constructed buildings. This value is for the sum of the demands of buildings, space heating, space cooling, DHW, auxiliary energy, ventilation, lighting and appliances.

- Secondly, fixing an overarching value for primary consumption kWh/m^2 per year of 45 kWh/m^2 per year for residential buildings and 80 kWh/m^2 per year for commercial buildings.

- Thirdly, fixing a comfort criterion that allows maximum 5 percent of hours exceeding 25^{o}C for residential buildings and complies with EN15251 with a dynamic simulation proof for commercial buildings.

- Fourthly, fixing a percentage of renewable energy demand to be covered by renewable energy annual balance. At least a minimum share of 50 percent might be generated and used on site.

Despite that the four suggested principles are aggressive, already Brussels Capital Region decided to adapt the first three principles starting from 2015. Regarding the fourth principle no European country including Switzerland has enforced any threshold for onsite renewable energy generation. However, in the near future it might be important to amend additional measures to address energy matching and storage issues, mobility and materials' embodied energy issues. By reflecting back on the introduction section we finally should not forget that how much our definition of nZEB strict is, by 2020 the newly constructed nZEB will form only less than 10 percent f the existing building stock.

7. CONCLUSION

In Belgium, a zero energy definition has been introduced for dwellings in the legal framework of income tax reduction. The emerging market of zero-energy certification has been developed by independent non-profit organizations by means of additions to passive house labels. However, the existing definition requires more refinement and detail to address issues such as energy metric, minimum efficiency requirements, comfort, building typologies, urban scale, renewable energies, construction quality assurance, monitoring, energy matching and storage. Also, there is a conflict between the EPBD and the passive house standard approach. The question arises if there should be synchronization so one definition of nZEB for Belgium is a goal, or local definitions encapsulating regional situation of adoption history and specific policy programmes. As part of this study we suggested four tangible principals that could contribute to achieve the nZEB objective by 2020. Already Brussels Capital Region decided to adapt three of those principles by 2015. This could be a starting point to explore other serious issues including mobility and embedded energy. More importantly we should expand our nZEB objective to include the existing building stock.

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9. REFERENCES

1. IEA SHC Task 40, 2010. Towards Net Zero Energy Solar Buildings. http://www.iea-shc.org/task40
2. D. Crawley, S. Pless, P. Torcellini, Getting to net zero, ASHRAE Journal 51 (9) (2009) 18–25
3. EPBD, 2002. Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 on the energy performance of buildings. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32002L0091:EN:NOT, consulted: 30/03/2009.
4. EPBD, 2010. Directive of the European Parliament and of the Council on the energy performance of buildings (recast), Inter-institutional File: 2008/0223 (COD), http://www.europarl.europa.eu/meetdocs/2009_2014/documents/cls/cons_cons(2010)05386(rev3)_/cons_cons(2010)05386(rev3)_en.pdf, consulted: 14th June 2010.
5. European Parliament, 2009. European Parliament legislative resolution of 23 April 2009 on the proposal for a directive of the European Parliament and of the Council on the energy performance of buildings (recast) (COM(2008)0780 – C6-0413/2008 – 2008/0223(COD)), http://www.europarl.europa.eu/sides/getDoc.do?type=TA&language=EN&reference=P6-TA-2009-0278; consulted: June 15, 2009; last update May 15, 2009.
6. Belgisch Staatsblad – Moniteur Belge, 2009. 30.12.2009, Art. 121, pp. 82334.
7. Belgisch Staatsblad – Moniteur Belge, 2010. 22.09.2010, Art. 145, pp. 58666.
8. Visscher H. et al., 2009, The impact of energy performance regulations on systems of building control , RICS, COBRA Research Conference, University of Cape Town, 10-11, pp 1356-1367.
9. Feist, W., Baffia, E., Schnieders, J., Pfluger, R., Kah, O., 2002. Passivhaus Projektierungs Paket 2002, Anforderungen an qualitätsgeprüfte Passivhäuser, Fachinformation PHI-2002/1, Darmstadt, Passivhaus Institut.
10. BBLV, 2010. Energiecharter voor de bouwsector, information (in Dutch) on http://www.bondbeterleefmilieu.be/campaign.php/13, consulted September 14, 2010.
11. EA, 2010. Energiebewuste architect. Available on-line: http://www.energiebewustarchitect.be/pages/interesse-in-het-label.php, consulted September 14, 2010.Energie Wallonie, http://energie.wallonie.be/fr/index.html?IDC=6018, consulted: 11th January 2011
12. VEA, 2010. Premies voor energiebesparing in Vlaanderen [Premiums for Energy-Saving in Flanders], Flemish Energy Agency (VEA), Brussels, 2010.
13. Energie Wallonie, 2011, Online: http://energie.wallonie.be/fr/primes-energie.html?IDC=7015, 01/04/2011.
14. CALE, 2010. Construire avec l'énergie (in French), available on http://energie.wallonie.be/fr/action-construire-avec-l-energie.html?IDC=6143, consulted September 14, 2010.
15. Leefmilieu Brussel, 2010. Energiepremies voor de individuele woningen [Grants for Individual Dwellings] http://www.leefmilieubrussel.be/uploadedFiles/Contenu_du_site/Particuliers/01_Gestes/09_Mes_primes/Primes_Energie_2010/NL_PRETS_R.pdf?langtype=2067, consulted April 27, 2010.
16. PMP, 2011. Vademecum, [Online]: http://www.maisonpassive.be/?Vademecum. Consulted: 03/03/2011.
17. Cobbaert B., 2005. Certificatie-systeem voor passiefhuizen, in Proceedings of PHH, Brussels, p. 33-51.
18. PHP, 2010. Passiefhuis-Platform vzw, http://www.passiefhuisplatform.be.
19. PHP, 2011. Certificatiecriteria en toe te passen randvoorwaarden, [Online], Available: http://www.passiefhuisplatform.be/index.php?col=-diensten&lng=nl&doc=certification. 6 January 2011.
20. Mlecnik, E., Van Loon, S., 2010. Certification of Passive Houses: new criteria = better quality?, in the proceedings of Passive House 2010, Brussels, Belgium.
21. Mlecnik E., 2009. Certification of passive houses: what can we learn from interviews and measurements? in the Proceedings of Passive House 2009, Brussels, PHP, Berchem, 102-113.
22. Mlecnik, E., Visscher, H., van Hal, A., 2010. Barriers and Opportunities for Labels for Highly Energy-Efficient Housing Concepts. Energy Policy, Volume 38, Issue 8, August 2010, 4592-4603.
23. Van Loon S.and Poppe, J. 2010, EPB en PHPP: Impact van randvoorwaarden and rekenmethodiek op de berekeningsresultaten voor passieve woningen, in the proceedings of Passive House 2010, Brussels, Belgium.

24. EN 15251, 2007, Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics.
25. ASHRAE, (2004) ASHRAE Standard 55 2004 -Thermal Environmental Conditions for Human Occupancy, American Society of Heating Ventilating and Air-conditioning Engineers,, Atlanta, USA.
26. Attia, S., De Herde, A., (2011) Defining Zero Energy Buildings from a Cradle to Cradle Approach, In Proceedings of the Passive and Low Energy Architecture Conference, July, Louvain-la-Neuve, Belgium.
27. Attia, S., De Herde, A., 2010. Towards a Definition for Zero Impact Buildings, In the Proceedings of Sustainable Buildings CIB 2010, Maastricht, the Netherlands.
28. Klein, R., et al. 2010. A Belgian pilot project for zero energy office buildings. In Proceedings of EuroSun.
29. Attia, S., De Herde, A., 2010. Aiming Zero Impact Buildings: Mondo Solar-2002, A case study in Belgium, In the Proceedings of Sustainable Buildings CIB 2010, Maastricht, the Netherlands.
30. Marszal, A., Heiselber, P. et al., 2011. Zero Energy Building – A review of definitions and calculation methodologies, Energy and Buildings, accepted and in press.
31. Sartori, et al., 2010. Criteria for Definition of Net Zero Energy Buildings, In the Proceedings of EuroSun, Austria. Buildings, In the Proceedings of EuroSun 2010, Graz, Austria.
32. Voss, K., 2008. What is Really New about Zero-Energy Homes? In the proceedings of the International Passive House Conference, Nuremberg, Germany, pp. 187-192.
33. Sartori, et al., 2010. Comfort and Energy Performance Recommendations for NZEB, In the Proceedings of EuroSun 2010, Gratz, AT.
34. Torcellini, P., et al. M., 2006. Zero Energy Buildings: A Critical Look at the Definition, ACEEE, California.
35. PEGO, 2009. Stevige ambities, klare taal! Definiëring van doelstellingen en middelen bij energieneutrale, CO2—neutrale of klimaatneutrale projecten in de gebouwde omgeving [Strong Ambitions, Ready Language! Defining aims and means in energy-neutral, CO2-neutral or climate-neutral projects in the built environment], Platform Energietransitie Gebouwde Omgeving, Utrecht, The Netherlands, October 2009.
36. Marszal, A., Bourrelle, J. et al., 2010. Net Zero Energy Buildings - Calculation Methodologies versus National Building Codes, In the Proceedings of EuroSun 2010, Graz, Austria.
37. Hernandez, P. and P.Kenny, 2010. From net energy to zero energy buildings: Defining life cycle zero energy buildings (LC-ZEB), Energy and Buildings 42 815–821.
38. Trachte, S. and Massart, C., 2011 Reducing the environmental impact of new dwellings: Analyse of the balance between heating energy savings and environmental assessment of the building materials, PLEA 2011 Conference, Louvain-la-Neuve.