



CONCERTED ACTION ENERGY PERFORMANCE OF BUILDINGS

EPBD implementation in Luxembourg

Status in December 2016

AUTHORS

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NATIONAL WEBSITES

www.gouvernement.lu/4067443/energie

1. Introduction

In Luxembourg, the implementation of the EPBD is the overall responsibility of the Ministry of Economy, with the General Directorate of Energy as the managing body. The EPBD was implemented by regulations based on the "*Loi modifiée du 5 août 1993 concernant l'utilisation rationnelle de l'énergie*" (Law 1993)¹. This law is the legal basis for setting up the requirements for the energy performance of buildings. In 1995, Luxembourg implemented the first mandatory requirements for residential and non-residential buildings.

In 2008, the requirements for residential buildings were modified in order to transpose the EPBD into national law, "*Règlement grand-ducal modifié du 30 novembre 2007 concernant la performance énergétique des bâtiments d'habitation*"² (RGD 2007), and the EPC became mandatory for residential buildings.

The implementation of the EPBD, including the mandatory issue of EPCs for non-residential buildings, came into force in 2011, "*Règlement grand-ducal modifié du 31 août 2010 concernant la performance énergétique des bâtiments fonctionnels*"³ (RGD 2010).

Over the years, many regulatory changes entered into force. The major changes are:

- a strengthening of the overall energy performance of buildings on a defined timeline and the definition of NZEB;
- the introduction of the "as-built" EPC;
- the obligation to indicate the energy performance of buildings in advertisements;
- the obligation to control a representative percentage of EPCs.

In 2016, some major changes (detailed in chapter 2) concerning residential buildings have been published and entered into force.

2. Current Status of Implementation of the EPBD

In Luxembourg, a distinction is made between residential and non-residential buildings, but not between public and private buildings, with regard to energy performance requirements. Nevertheless, the public sector has a leading role and has to act as an example. Minimum requirements for technical building elements and building envelope elements apply in the same way for new and existing buildings. New buildings have to comply with overall energy performance requirements (heat energy demand and primary energy needs).

2.1. Energy performance requirements: NEW BUILDINGS

2.1.i. Progress and current status of new buildings

A timetable to reinforce energy performance requirements for residential buildings and a first step to reinforce energy performance requirements for non-residential buildings have been defined in 2012 and 2014, respectively.

In 2017, the last step of the reinforcement for new residential buildings entered into force. This last step introduced the residential NZEB as a standard.

For non-residential buildings, a new step for reinforcing the energy performance entered into force in 2015 on the path towards the non-residential NZEB.

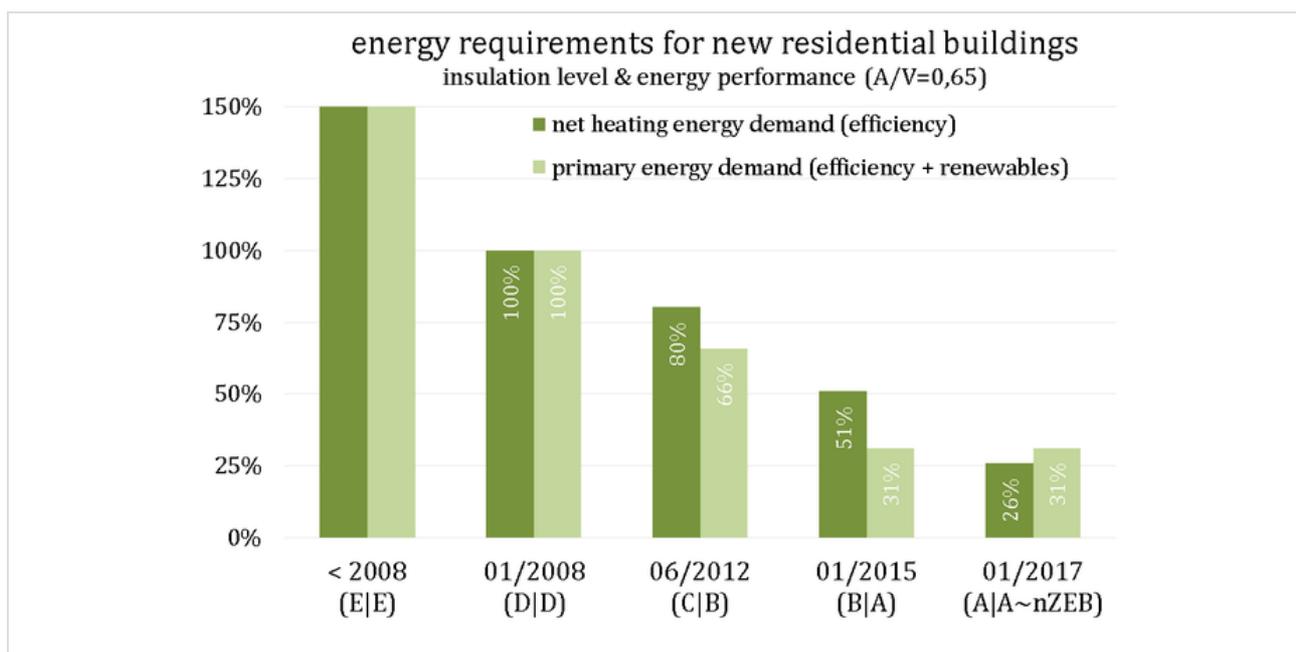


Figure 1. Reduction of energy needs over time for residential buildings. Source : Dr. Markus Lichtmess, Goblet Lavandier & Associés Ingénieurs-Conseils S.A.

In 2016, Luxembourg has implemented the following important aspects for residential buildings:

- the definition of the NZEB standard as the new standard from 1 January 2017 onwards;
- changes to the requirements and calculation methods for thermal protection in the summer, with the aim of limiting summertime overheating;
- the ability to take photovoltaic production into account at least partly;
- a change in the calculation methodology of global requirements (primary energy needs and heating energy needs) towards implementing the reference building procedure;
- the adjustment of calculated energy needs in the EPC to more adequately reflect the real energy consumption;
- the introduction of an interface in the EPC calculating tool for measured airtightness values.

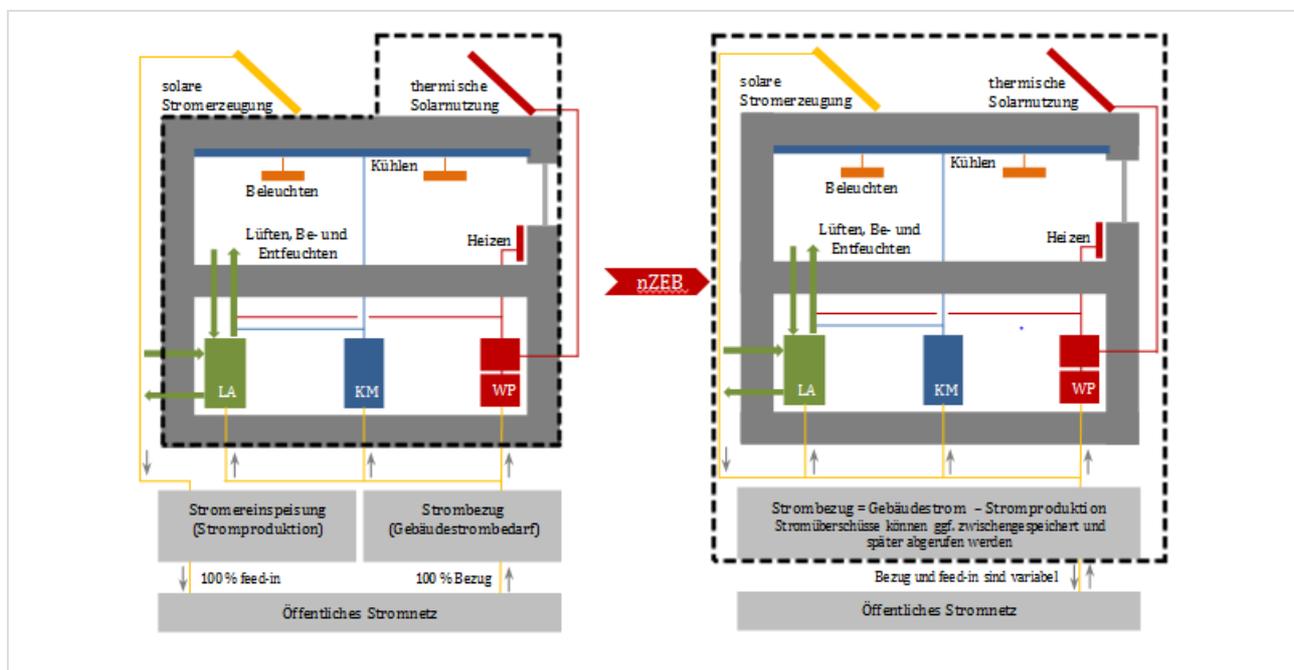


Figure 2. Integration of photovoltaic production. SOURCE: Dr. Markus Lichtmess, Goblet Lavandier & Associés Ingénieurs-Conseils S.A.

Concerning financial incentives, Luxembourg introduced a subsidy scheme for more sustainable residential buildings from 1 January 2017 onwards. This scheme is based on 46 criteria covering social, environmental and financial aspects. In each category 60% of the maximum points have to be reached in order to qualify for financial aid. The maximum aid for a sustainable house is fixed at 24,000 €.

The Luxembourgish Sustainability Certification ("**L**ëtzebuerg**e**r **N**ohalte**g**keets **Z**ertifiz**e**ierung", LENOZ)⁴, which is the new sustainable certification system for residential buildings, has also been launched (further explanations can be found in chapter III).

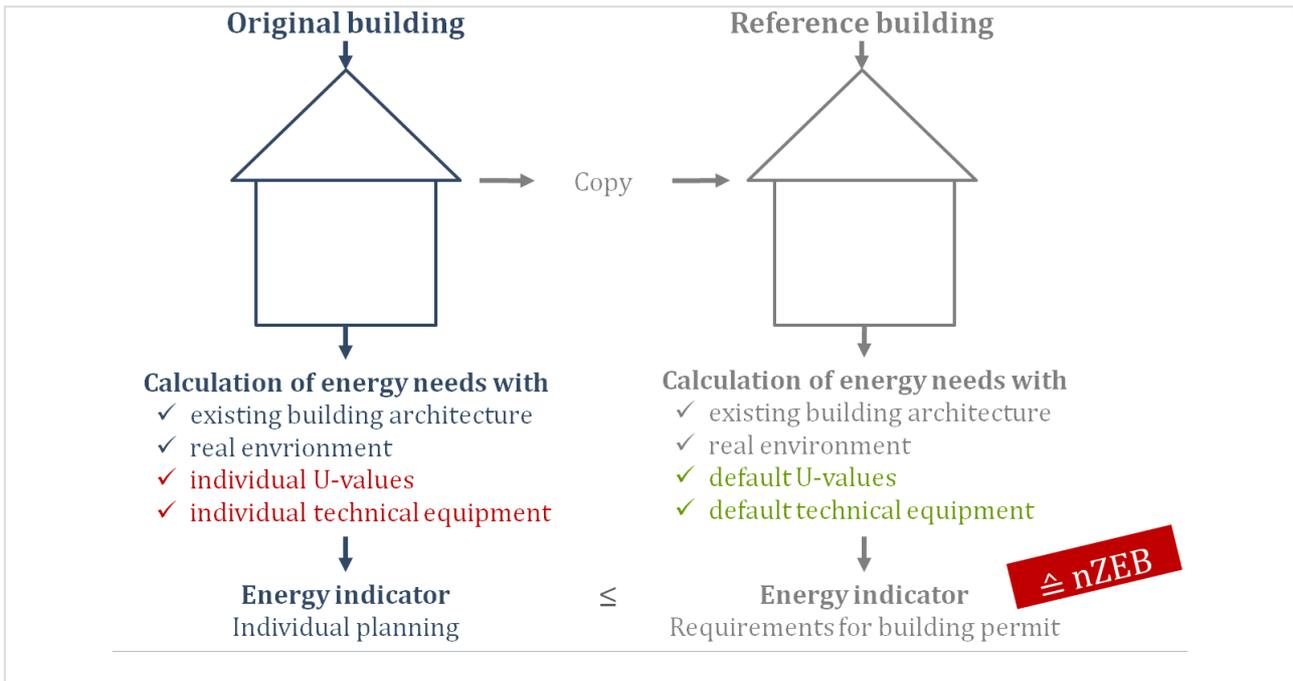


Figure 3. Methodology of the reference building. SOURCE: Dr. Markus Lichtmess, Goblet Lavandier & Associés Ingénieurs-Conseils S.A.

2.1.ii. Format of national transposition and implementation of existing regulations

For residential buildings, the energy performance calculation for new and existing buildings is based on the calculated energy needs for heating, domestic hot water, ventilation and auxiliary needs. The results are expressed in terms of primary energy needs, heating energy needs and CO₂ emissions. Since 2016, photovoltaic production can be partly taken into account (only the part which is consumed by the technical equipment of the building).

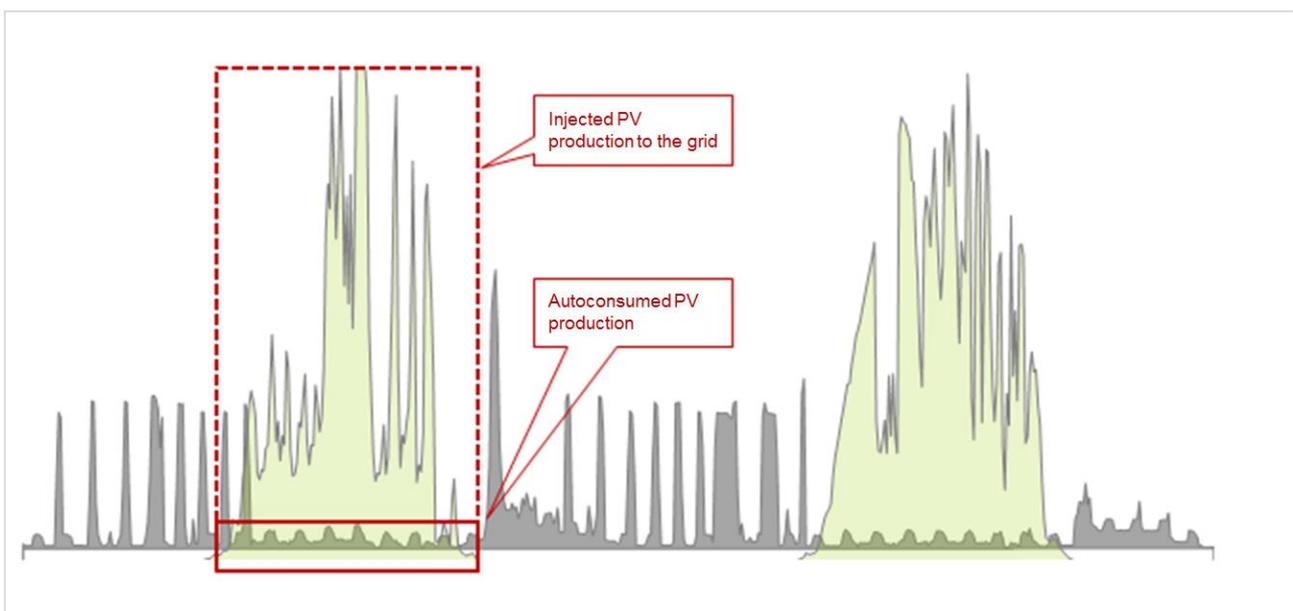


Figure 4. Integration of photovoltaic production. SOURCE: Dr. Markus Lichtmess, Goblet Lavandier & Associés Ingénieurs-Conseils S.A.

For non-residential buildings, the energy performance calculation for new buildings is also based on the calculated energy needs for heating, domestic hot water, ventilation, and auxiliary needs, but also on AC, lighting, humidification and dehumidification. For existing non-residential buildings, the real energy consumption (metered energy) is taken into account.

All new residential and non-residential buildings have to fulfil - besides minimum requirements for building envelope elements and technical equipment - global requirements expressed in heating energy needs and primary energy needs. These requirements are cost-optimal.

In order to sensitise consumers' awareness for the strengthening of the energy performance requirements for buildings and more generally energy-efficient policies, the government is operating a hotline for consumers through "myenergy"⁵. Further, the Ministry of Economy takes part in expert meetings and exchanges on best practices within the building sector. The Ministry regularly updates FAQ documents that are made available to the public.

Concerning quality controls, the EPC database for residential buildings is an important tool. A plausibility check of each EPC is integrated into the database as well as the software calculating the EPCs. Controls of EPCs take place regularly. A few experts who had issued EPCs containing errors have been penalised with a temporary ban, mandatory advanced training and the correction of errors in the EPCs.

2.1.iii. Action plan for progression to NZEB for new buildings

The national plan of 2013, which aims to increase the number of NZEB, mentions a number of milestones to achieve this goal: the exemplary role of the public sector, research, the update of subsidy schemes, information and communication campaigns for consumers and experts, the quality assurance of EPCs through plausibility checks and in-depth EPC control, incentive measures like energy-related advisory service, the continuous training of the workforce, including architects and engineers, and regulatory implementation of NZEB.

As aforementioned, the NZEB standard entered into force in 2017 for residential buildings. For non-residential buildings, it is scheduled for 2019 for public buildings and for 2021 at the latest for non-public buildings. Today, public authorities are requested to design very energy-efficient buildings which, if feasible, include on-site production and consumption of RES. An example is a new building in the Nature and Forestry Administration⁶ that obtained an excellent score in its sustainability certification. This building is equipped with a water/water heat pump, a rainwater utilisation system, a LED-lighting system, a photovoltaic installation and an energy management system. The calculated heating energy demand of the building is 26.4 kWh/m².year and the primary energy demand is 70.6 kWh/m².year.

Concerning research, one of the priorities of the government is sustainable building. In this context, support was given to the national structure, called "Neobuild"⁷, which is an innovation centre developing and supporting future-oriented projects in the building sector. *Neobuild* is a private sector initiative and its objective is to promote research, development and innovation in the sustainable construction industry. Besides this, a national green building council called "Conseil national pour la construction durable" (CNCD) has been reformed. The CNCD regroups the main actors of the national construction sector and the relevant ministries. The main goal of this structure is to prepare the sector for future opportunities and evolution in a streamlined manner.

In the field of communication and information, free basic advice with respect to the energy-efficient renovation and construction of energy-efficient buildings has been provided since 2010 by *myenergy*.

2.1.iv. Requirements for systems and / or building components for new buildings

Requirements for technical building systems are set in different regulations covering gas-, wood- and oil-fired boilers, AC systems, heat pumps, and ventilation systems.

Some decades ago, Luxembourg established a mandatory acceptance procedure for new oil- and gas-fired boilers as well as regular inspections of these boilers in existing buildings. For wood-fired boilers this system became mandatory in 2014. The acceptance procedure and the regular inspection of AC systems have been mandatory since 2009 in residential as well as non-residential buildings. The acceptance procedure checks the conformity of the security equipment, the location, the smoke exhaust and the combustion quality and efficiency. Dimensioning is not checked at this stage, but is done so during the periodic inspection. Since Luxembourg imports nearly all appliances and equipment, European standards as well as the standards of the import countries are applicable in Luxembourg.

RGD 2007 and RGD 2010 set energy performance requirements concerning building envelope elements, pipework insulation, ventilation and AC systems.

2.II. Energy performance requirements: EXISTING BUILDINGS

As aforementioned, there is no distinction with respect to the energy performance requirements for new and existing buildings.

2.II.i. Progress and current status of existing buildings

As described in the requirements for new residential buildings, the same changes apply to existing residential buildings (with the ability to partly take into account photovoltaic production: aligning real energy consumption in the EPC with the calculated theoretical energy need and introducing an interface in the EPC calculating tool for measured air-tightness values).

Subsidy schemes for the refurbishment (*PRIME-House*) of existing buildings have been reviewed and the priority is put on deep renovations by doubling the financial bonus (20-60% bonus of the previously granted aid) if a very good energy class is reached after refurbishment⁸. In addition, the more a building element is isolated, the more specific aid is granted. More sustainable isolation materials are also promoted by a bonus system. For sustainable isolation material, a specific bonus aid (15-40 €/m², depending on the building element) is paid.

2.II.ii. Plans to improve the existing building stock

Luxembourg is still working on fine-tuning the national long-term strategy for boosting investment in refurbishing the national stock of residential and non-residential buildings. As part of this initiative and in conjunction with the relevant actors in the construction sector, Luxembourg's energy renovation strategy

has been developed by different theme-based workshops to analyse the barriers to refurbishment and come up with potential solutions. The various themes focused on finding ways to remove natural architectural constraints and regulatory and financial barriers, motivating building owners to refurbish and encouraging refurbishment as an opportunity for the construction sector in Luxembourg. These workshops concluded that financially supporting energy refurbishment programmes, providing information and energy advice and raising awareness play an important role in this area. As described above, Luxembourg tries to promote major renovations through aid schemes that have been updated for 2017. Deep renovations are promoted and EPCs have to be issued before and after refurbishment. In relation to the obtained energy class after refurbishment, a bonus is granted in addition to the previously received aid. The better the energy class after refurbishment, the higher the bonus.

myenergy, the national body for information and advice in the fields of energy efficiency and renewable energy, provides support to all sectors with respect to refurbishing buildings. Various market analyses made by *myenergy* have identified the existence of barriers between information and the public and the perception and motivation of building owners to finance renovations. Significant efforts have been made regarding the barriers to information (*myenergy*) by creating national information points all over the country.

In recent years, Luxembourg has introduced several measures for promoting the energy refurbishment of buildings. These range from regulatory measures to financial incentives, an increase in information and advisory measures and improvements to education and training.

RGD 2007 and RGD 2010 define minimum requirements for extensions or renovations of existing building elements. Furthermore, besides the subsidy programme *PRIME-House*, an energy efficiency obligation (*EEO*) scheme which applies from 1 January 2015 to 31 December 2020 has been introduced. The *EEO* obliges all electricity and gas suppliers to achieve energy savings among their energy end-users. Suppliers have to deploy efforts that result in customers gaining access to information on energy efficiency, which then encourages them to implement energy efficiency measures.

2.II.iii. Regulation of system performance, distinct from whole building performance

Requirements for technical building systems and building envelope elements are set in multiple regulations⁹ concerning the respective buildings or technical elements.

These regulations cover gas-, wood- and oil-fired boilers, AC systems, heat pumps, ventilation systems and components of the envelope of buildings. The Ministry of Sustainable Development and Infrastructure and the Ministry of Economy share the responsibility with respect to these areas.

Every new individual building element has to fulfil minimum requirements defined in these regulations.

Furthermore, large installations must comply with certain requirements set by the environmental and safety impact authorisation procedure¹⁰; such requirements depend on the scale and type of the installation. They can be grouped into general security requirements, technical requirements and energy performance requirements (according to the best available technology).

2.II.iv. Encouragement of intelligent metering

As of 1 July 2016, all new gas and electricity meters installed in Luxembourg are smart meters. From 2016 to 2020, the plan is to replace all existing electricity and gas meters with smart meters. In order to optimise operating costs, all meters will be read via a central system managed by an entity set up by the grid operators, *Luxmetering GIE*. Besides electricity and gas meters, the system will be open to other flows such as water and urban heat. Regarding deployment, more than 95% of the existing meters for electricity will have to be replaced by 31 December 2019, and more than 90% of the existing meters for gas will have to be replaced by 31 December 2020. Each customer will receive information about the meter's functionality, its use and the use of its data. Frequently asked questions and a point of contact will be made available by each grid operator via its website as well as leaflets distributed to customers.

2.II.v. Financial instruments and incentives for existing buildings

The financing mechanism in place for technologies based on RES (solar panels, heat pumps, wood-fired boilers, etc.) and the refurbishment of building envelope elements set minimum energy efficiency requirements. For building envelope elements, the aid scheme has been linked to the use of sustainable insulation materials.

In order to promote the energy renovation of existing residential buildings, the government has for several years already implemented the *PRIME-House* subsidy programme¹¹ to provide financial support for renovation projects related to energy performance. As of 2017, this programme has been updated to become even more effective. In the new version of *PRIME-House*, the procedure for aid applications has been administratively simplified by introducing a one-stop shop for citizens which examines, advises, grants projects and guides investors in all administrative procedures related to subsidies. In the new subsidy programme, the bonus for major renovations is doubled to amount to an extra 20%, 40% or 60% of the granted subsidy if the energy class after refurbishment corresponds to the C, B, or A index, respectively.

As of 2017, an additional increase of the granted aid is possible if sustainable insulation materials are used. Another new feature is *Climate Bank*, which provides a zero-interest rate or a reduced interest rate for loans granted for energy refurbishment projects. Mandatory energy advice is foreseen for this aid and the energy expert is required to control the implementation of the measure.

The zero-interest-rate loan is reserved for low-income households in order to unlock these investments (with a maximum loan of 50,000 € for over a period of 15 years). The costs for the mandatory energy advice are also paid directly by the state budget. In addition, investment aid can be granted. Every other household can apply for loans with reduced interest rates (the measure is limited to a loan of 100,000 € over a period of 15 years, with the loan rate in principle being reduced by 1.5%).

2.II.vi. Information campaigns / complementary policies

Over the last few years, Luxembourg has made numerous efforts to provide detailed information on energy savings and the use of RES to energy consumers.

These efforts are illustrated by the achievements of the public energy advisory and information provider *myenergy*, whose activities include raising awareness as well as informing and assisting households,

companies, municipalities and professionals regarding energy savings, the use of renewable and sustainable energy and the development of sustainable residential buildings.

The website www.myenergy.lu is an important tool for informing the aforementioned target groups.

The free, impartial and basic advice to private individuals is provided over phone (hotline number 8002 11 90) or in personal advisory sessions held in one of the numerous regional *myenergy* information points. These information points are part of a large network of *myenergy*'s local advice centres.

Representatives of *myenergy* also organise action weeks, including on-site consultations, information events with presentations and awareness-raising activities, attend national trade shows, create information flyers and internet platforms and ensure a regular presence in the national media. *myenergy* has also developed virtual interactive gamification tools, providing key messages in the conception of high-energy-efficient buildings.



Figure 5. Miss Energy campaign (*myenergy*).

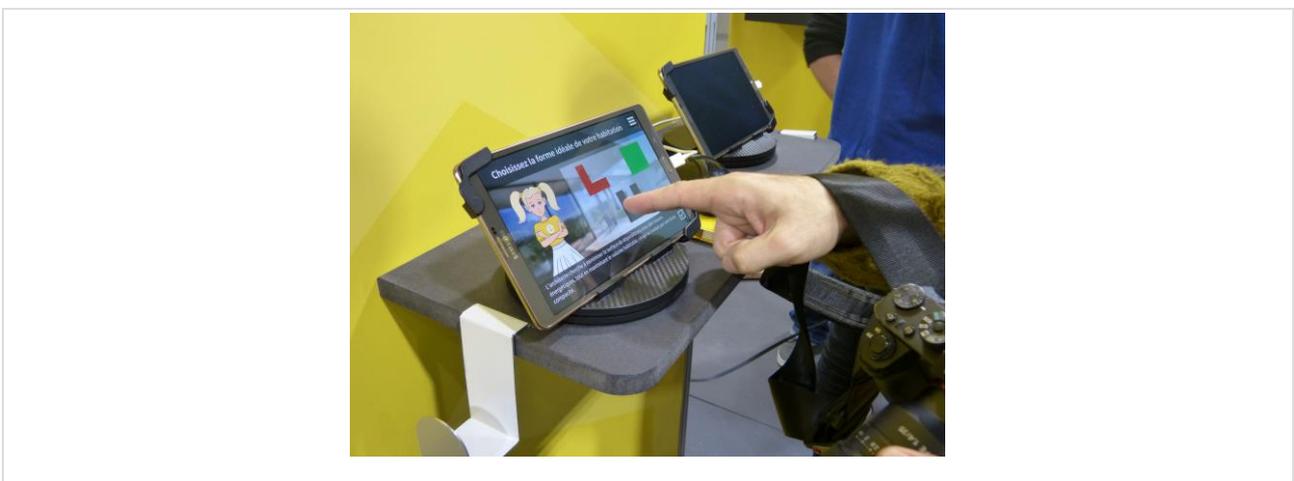


Figure 6. Serious game – my AAA.

2.III. Energy performance certificate requirements

For residential buildings, one single type of EPC exists. The EPC has not been changed as regards the recent modifications of the energy performance requirements in 2016, so that the classes remain the same. This is essential to ensuring the comparability of the issued EPCs within the buildings market.

For non-residential buildings, two types of EPCs exist. One type covers new buildings (based on calculated energy needs) and the other type covers existing buildings (based on energy consumption).

As the managing body, the General Directorate of Energy designs, develops and supports the certification system with the help of external experts, if needed. A national database has been developed which collects all EPCs (existing and new) issued by the experts for residential buildings and aims to draw statistics from the national building stock in the future. In a later phase, the database shall be extended to non-residential buildings.

The *LENOZ* certification¹², the new sustainable certification system for residential buildings, launched in 2017, is voluntary and is subsidised by financial aids of up to 1,500 €. In total, the system regroups 143 individual criteria categorised into six (6) categories and 37 sub-categories. It covers locational, societal, economic, environmental, functional and technical aspects.

2.III.i. Progress and current status on sale or rental of buildings and EPCs

All existing residential and non-residential buildings need to be certified when sold or rented. There is no minimum requirement for existing buildings, and they are labelled from class A to I.

The EPC for existing buildings requires the indication of energy efficiency improvement measures. The owner of a building must present a valid EPC to a potential buyer or tenant. When issuing the EPC, a qualified expert visits the building and assesses the geometry and the type of construction (walls, windows, insulation, thermal bridges, ventilation and airtightness, etc.) as well as the type and quality of heating, ventilation, AC and hot water systems. The establishment of the EPC includes a calculation of the heating and primary energy needs of the building. In case of sale, the notary checks the presence of the EPC. He or she will not proceed to the sale if there is no EPC.

2.III.ii. Quality Assessment of EPCs

The Ministry of Economy organises controls of EPCs in order to verify their compliance with the legal requirements. These controls comprise two levels. The first level consists of a plausibility check of the calculated values, whereas the second level is a deeper analysis of EPCs containing non-plausible elements. The control consists of a check of all data entered into the EPC. Penalties in the form of a time-limited suspension were imposed on two experts who were also required to establish corrected EPCs (through another accredited expert) and deliver them to the client.

The EPC database as well as the national software currently checks the plausibility of the EPC automatically.

2.III.iii. Progress and current status of EPCs on public and large buildings visited by the public

For residential buildings and non-residential buildings occupied by public authorities and frequently visited by the public with a surface exceeding 250 m², the energy performance certificate must be displayed in a clearly visible place. For the same types of buildings which are not occupied by public authorities but frequently visited by the public, this obligation applies for buildings with a surface exceeding 500 m².

2.III.iv. Implementation of mandatory advertising requirement - status

A modification of RGD 2007 and RGD 2010 has introduced the obligation to insert the overall energy performance class (primary energy) and the heating performance class in real estate advertisements in all commercial media (paper, internet, etc.).

This obligation came into force on 1 July 2012. A large number of real estate advertisements comply with this obligation and the ministry checks compliance randomly. Penalties are foreseen in case professionals or private persons do not comply with the regulations.

2.IV. Inspection requirements - heating systems, air conditioning

The Environmental Administration manages the implementation of heating and AC system inspections on behalf of the Ministry of Sustainable Development and Infrastructure. The Ministry of Economy is responsible only for gas-fired heating systems.

2.IV.i. Report on equivalence of model A and B for Heating Systems

Luxembourg implemented inspection systems for all kind of heating systems. The report on equivalence has therefore not to be done.

2.IV.ii. Progress and current status on heating systems

The inspections of heating systems (gas-, oil- and wood-fired systems) are regulated by their respective regulations (gas, oil or wood regulations). After the reception procedure, a periodic control of the heating system (every four (4) years for gas-fired heating systems and every two (2) years for oil- and wood-fired heating systems) is mandatory. Most of the results of these reception procedures and inspections are currently stored in a central database.

The periodic controls are carried out by installers who have successfully completed special training and certification and own the necessary tools that allow them to perform the inspection in a professional and cost-effective manner.

The Ministry of Sustainable Development and Infrastructure created a specific website (www.heizungscheck.lu) and an informational advertisement (flyer) distributed to the public at fairs and via

other media. The flyer is dedicated to informing the public on all the different aspects of heating system inspections (legal requirements, environmental issues and cost-optimisation).

2.IV.iii. Progress and current status on AC systems

New AC systems are subject to a similar reception procedure as heating systems, carried out by the experts of the Chamber of Handicrafts.

In existing buildings, inspection of AC systems is performed by certified refrigeration mechanics.

Experts are certified after having completed special training courses. Certifications issued in other Member States can be recognised by the Minister of Sustainable Development and Infrastructure.

The inspection of AC systems is enforced by the Environmental Administration.

In order to support refrigeration mechanics in carrying out the evaluation of the overall efficiency and dimensioning of AC systems, the Environmental Administration has produced a guide on the energy efficiency of AC systems. Complementing this guide, a comprehensive checklist summarises the main aspects of energy efficiency and associated recommendations. This qualitative assessment tool is best suited to deal with the high complexity of AC systems, as it allows refrigeration mechanics to judge on-site which aspects of energy efficiency are best suited to the individual AC system.

2.IV.iv. Enforcement and impact assessment of inspections

Enforcement and penalties

With respect to heating systems, non-compliance of the regulatory requirements can be penalised. If a craftsman fails to follow the reception procedure, or if an owner fails to do an inspection, sanctions (penalties of up to 25,000 € and 2 months' imprisonment) could be applied. The relevant ministries regularly remind owners to meet their obligations, and the Chamber of Handicrafts regularly exhorts its members to respect the legal procedures. There are no records on penalties levied.

For AC systems, sanctions (administrative penalties) for non-compliance with existing European and national legal requirements can be levied, e.g., for cancelling an authorisation, which can result in fines of up to 500,000 € and/or imprisonment of up to one (1) year, depending on the kind and severity of the infringement. Compliance is checked by the Environmental Administration. So far, no administrative sanction has been issued in the context of AC systems registration and inspection.

Quality control of inspection reports

Most reception and inspection reports are controlled and centralised in a database, which is operated by the government. Inspection reports are controlled with respect to their conformity and in case of non-conformity, sanctions (penalties) can be imposed or administrative procedures can be initiated.

3. A success story in EPBD implementation

The EPBD of 2010 introduced the concept of the NZEB. For residential buildings, Luxembourg defined this concept as being in principle an A-A-rated building (heating energy demand and primary energy needs). Luxembourg decided to advance the application of the NZEB standard in comparison to the EPBD. The NZEB standard is mandatory as of 1 January 2017. The timeline for NZEB, which was published in 2012, gave the sector enough time to create and adapt the training offer ("*Luxbuild*" project¹³ under the BUILD UP Skills initiative to train blue-collar workers as well as planners). Thanks to "*LuxBuild2020*", Luxembourg's construction sector considers itself ready to build new residential buildings in "nearly zero-energy"-standard from 2017 onwards. The main results of the project are:

- Creation of centres of excellence for craftsmen based on a competency framework
- Innovative training concept: practical training, internal and external coaches, pedagogical tool
- Innovative learning material: toolbox for AAA-houses
- Gateway "*LuxBuild2020*": support services and tools

The "*LuxBuild2020*" initiative made it possible to improve the professional skills in the field of energy efficient constructions, and to develop and promote a broad offer of related training programmes. This training and education offer can be split into theoretical and practical on-site courses (within a "test house"). The organisation of the offer is a continuous work-in-progress which is monitored by the "*Conseil national pour la construction durable*" (CNCD) to constantly adapt and improve the available structures.

Additionally, the construction sector has created the platform "*Neobuild*¹⁴", with the mission to identify innovative technological and managerial concepts and to develop tools, methods and protocols for their implementation. As part of its mission, a testing laboratory was built containing over 100 different materials, products and systems. This zero-energy building, unique in Europe, offers many possibilities for life-sized monitoring and testing. The building is a complementary tool – a kind of living laboratory – to observe and analyse innovations in real-life conditions.

Working in this dynamic and future-oriented environment will improve the capacities and adaptability of the stakeholders to address the upcoming challenges.

4. Conclusions, future plans

Luxembourg has fully transposed the EPBD and is promoting increasingly more energy-efficient buildings through regulations. The aim is to further develop the energy efficiency renovation policy by granting relevant aids and low-interest loans.

Luxembourg is preparing for the future by creating financial incentives for new sustainable buildings and sustainable insulation materials for refurbishment. In September 2015, the government, the Chamber of Commerce and IMS Luxembourg jointly launched the strategic study titled, "*The Third Industrial Revolution Strategy*¹⁵", in close collaboration with American economist Jeremy Rifkin and his team of experts (Figure 7). This process, using an "open-societal innovation" approach, was aimed at making the existing economic model more sustainable and interconnected for future generations. It resulted in a comprehensive strategic study and a summary-synthesis with recommendations on how to deal with all these new challenges.

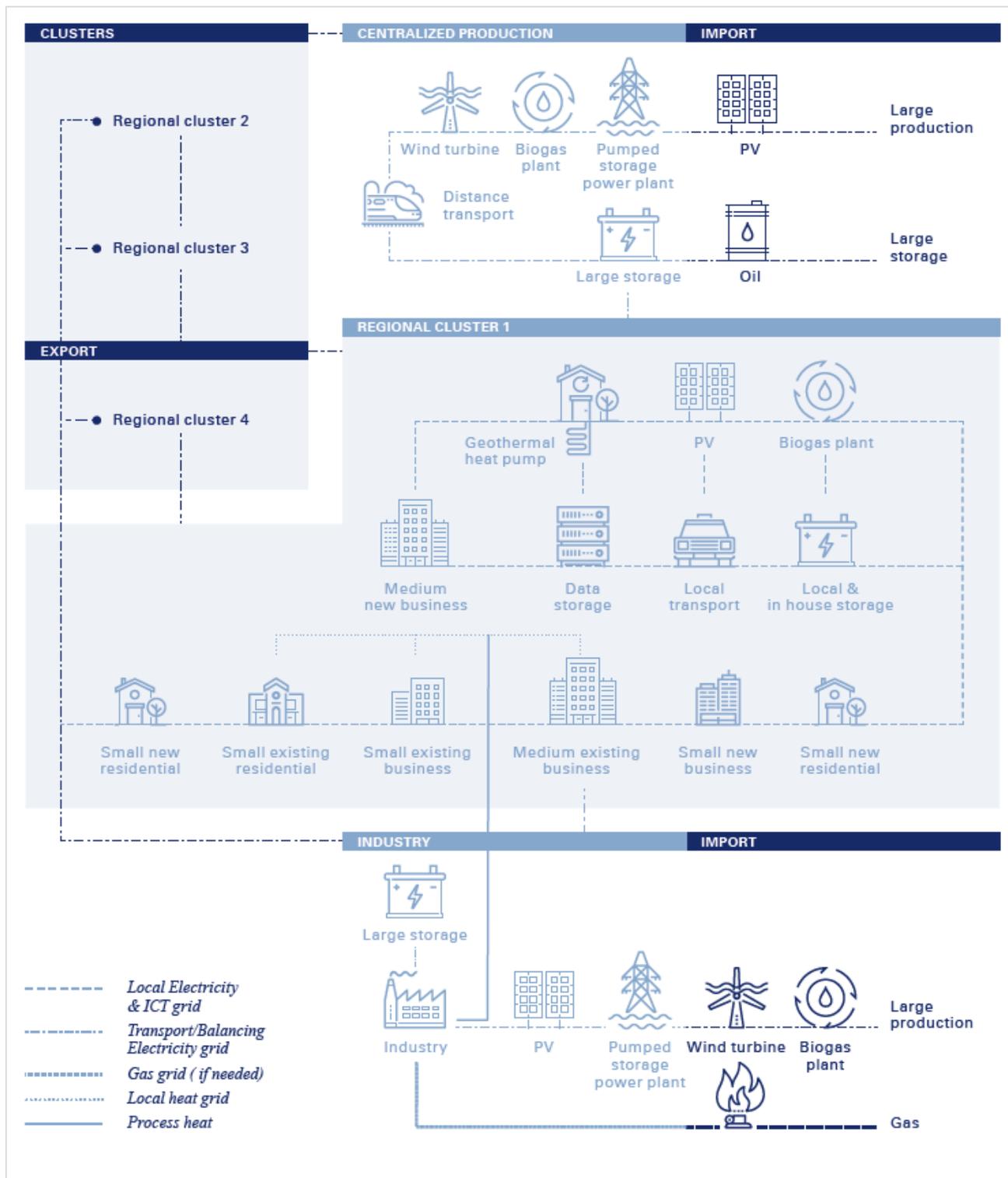


Figure 7. Schematic representation of the energy system in 2050. SOURCE: The Third Industrial revolution, study for the Grand Duchy of Luxembourg, Thematic Summary

The EU population growth will increase by 0.1% annually over the years 2013 to 2050, while Luxembourg’s population could grow by 1.8% per year over that same period. The potential increase in population could provide an opportunity to build and scale up a new generation of buildings and accompanying infrastructures.

Concerning the building level, the results identified by the strategic study are detailed as follows: buildings connected to a so-called “*Energy Internet*” will play an increasingly important role in data handling, green power production and energy storage, and will act as transport and logistic hubs that will rise to the next stage – a smart-energy Luxembourg. The building-out and scaling-up of a new generation of neighbourhoods and buildings can develop aggregate efficiency, increase productivity and reduce marginal costs as well as the ecological footprint.

Within a district/eco-neighbourhood, buildings will become nodes connected to every other surrounding building to allow families, businesses, and communities to analyse big data flows along the value chains and to perfect algorithms and applications foreseen to improve the energy efficiency of the interconnected neighbourhood.

With regard to energy, RES harvesting technologies like solar, wind, geothermal, and biomass will need to be installed in and around residential, commercial, and industrial sites to generate green electricity and heat and cold for immediate use within the concerned area, or to inject the energy surplus into the electricity, heating and cooling networks. Energy storage technologies, notably including batteries, hydrogen fuel cells and thermal storage tanks, will need to be installed alongside the RES harvesting technologies to store intermittent green energy for use or sale back to the energy grids to ensure a reliable energy supply. Electric charging stations will need to be installed in or alongside buildings to power, for instance, electric, GPS-guided and self-driving vehicles, or freight vehicles belonging to the transport and logistic Internet.

Throughout 2017 and beyond, Luxembourg will continue focusing on all the strategic aspects of the medium- and long-term energy transition as well as implementing the “*Energy Internet*”. The desired ambition is not simply the transition to a fully sustainable energy system, but the use of this transition to achieve energy savings while intelligently combining technical and commercial innovations.

Endnotes

1. Mémorial A – 70 du 6 septembre 1993, p. 1359 - legilux.public.lu/eli/etat/leg/loi/1993/08/05/n1/jo
2. Mémorial A – 221 du 14 décembre 2007, p. 3762 ; - legilux.public.lu/eli/etat/leg/rgd/2007/11/30/n7/jo
3. Mémorial A – 173 du 1^{er} octobre 2010, p. 2850 - legilux.public.lu/eli/etat/leg/rgd/2010/08/31/n1/jo
4. www.ml.public.lu/fr/lenoz/
5. www.myenergy.lu
6. abp.public.lu/publications/brochures/anf_brochure/ANF_revue-technique_2015_011_finale-4.pdf
7. www.neobuild.lu
8. www.myenergy.lu/fr/particuliers/lois-et-reglements/soutien-financier#prime-house-nouveau-regime
9. RGD 2007; RGD 2010; Règlement grand-ducal modifié du 27 février 2010 concernant les installations à gaz (Mémorial A – 60 du 22 avril 2010 - legilux.public.lu/eli/etat/leg/rgd/2010/02/27/n2/jo); Règlement grand-ducal du 7 octobre 2014 relatif a) aux installations de combustion alimentées en combustible solide ou liquide d'une puissance nominale utile supérieure à 7 kW et inférieure à 20 MW b) aux

installations de combustion alimentées en combustible gazeux d'une puissance nominale utile supérieure à 3 MW et inférieure à 20 MW (Mémorial A – 195 du 17 octobre 2014 - legilux.public.lu/eli/etat/leg/rgd/2014/10/07/n1/jo); Règlement grand-ducal du 22 juin 2016 relatif a) aux contrôles d'équipements de réfrigération, de climatisation et de pompes à chaleur fonctionnant aux fluides réfrigérants du type HFC, HCFC ou CFC; b) à l'inspection des systèmes de climatisation (Mémorial A – 114 du 1^{er} juillet 2016 - legilux.public.lu/eli/etat/leg/rgd/2016/06/22/n3/jo)

10. Loi modifiée du 10 juin 1999 relative aux établissements classés (Mémorial A – 100 du 28 juillet 1999 - legilux.public.lu/eli/etat/leg/loi/1999/06/10/n5/jo)
11. www.environnement.public.lu/guichet_virtuel/energie/index.html
12. www.ml.public.lu/fr/lenoz/index.html
13. <http://www.luxbuild.lu/de>
14. www.neobuild.lu
15. www.tirlux.lu



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