



HI-SMART: HIGHER EDUCATION PACKAGE FOR NEARLY ZERO ENERGY
AND SMART BUILDING DESIGN

MODULE #1

CHAPTER 1: DIRECTIVES

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1.1.1 INTRODUCTION

Since the 19th century, industrialization, deforestation, and large scale agriculture have increased the amount of greenhouse gases, driving up temperatures, accompanied with extreme weather and melting polar ice. Naturally global temperature is always changing, however climate scientists have agreed the current temperature is now rising faster than at many other times. This is linked to the greenhouse effect, an effect when the Earth's atmosphere traps some of the solar energy. The Earth's climate nowadays is about 1 degree Celsius warmer than before the industrialization, every year is warmer than the other and sea levels are rising, ice caps are melting. The projections show that the global average temperature between the mid-19th century and the end of the 21st Century is likely to exceed the critical 1.5 Celsius. The Intergovernmental Panel on Climate Change (IPCC) report in 2018 suggested that keeping to the 1.5°C target would require 'rapid, far-reaching and unprecedented transitions in in energy, land, urban and infrastructure (including transport and buildings), and industrial systems'¹. The list of possible hazards is long: water and food shortages, extreme, life-threatening weather anomalies (i.e. floods, storms and heatwaves), decreasing biodiversity, rising sea levels.

Climate change is not only the single greatest challenge facing our civilization, but also a great opportunity to create a more sustainable and more equitable political and economic system. The European Union's goal is to tackle this problem and be the global leader in the environment and energy sectors.

Carbon-free Europe by 2050 is one of the main elements of tackling climate change. Crucial pillar of this target is energy efficiency, completed with the exploitation of renewable sources. In 2019 the EU completed a comprehensive update of its energy policy framework to facilitate the transition away from fossil fuels towards cleaner energy and reducing greenhouse gas emissions.

The agreement - called the Clean energy for all Europeans package - consists of eight legislative acts. Following the political agreement by the Council and the European Parliament (between May 2018 and May 2019) and the entry into force of the different EU rules, EU countries have 1-2 years to transpose the new directives into national law.

The new rules will bring considerable benefits from a consumer perspective, from an environmental perspective, and from an economic perspective. By coordinating these changes at EU level the legislation also underlines EU leadership in tackling global warming

¹ Global warming of 1,5°C, IPCC, 2018



and provides an important contribution to the EU's long-term strategy of achieving carbon neutrality by 2050.

As the part of Clean energy for all Europeans package **Energy Performance of Buildings Directive (EPBD)** focuses the buildings sector's modernization, **Renewable Energy Sources Directive (RES/RED)** focuses on renewables with a binding target of 32% for renewable energy sources in the EU's energy mix by 2030 while the **Energy Efficiency Directive (EED)** focuses on energy efficiency to saving money for consumers and for reducing greenhouse gas emissions by decreasing energy consumption by 32.5%.

These so-called directives are legislative acts that set out goals that all EU countries must achieve. However, it is up to the individual countries to devise their own laws on how to reach these goals.

European Green Deal

The EU's goal is to become the world's first climate-neutral continent by 2050. To achieve this, the European Commission presented the European Green Deal, a package of measures that should enable European citizens and businesses to benefit from sustainable green transition. Measures accompanied with an initial roadmap of key policies range from cutting emissions, to investing in cutting-edge research and innovation, to preserving Europe's natural environment. Above all, the European Green Deal sets a path for a transition that is just and socially fair. It is designed in such a way as to leave no individual or region behind in the great transformation ahead. Elements and financial sources of the European Green Deal are in the phase of negotiation between the member states.

1.1.2 ENERGY PERFORMANCE OF BUILDINGS DIRECTIVE (EPBD)

The Energy Performance of Buildings Directive (EPBD) is one of the most important legislation regarding the CO₂ reduction in the European Union. The first version of the directive was presented in 2002, since then there were several updates of it. The main goal is to realize the saving potential in buildings, as they account for almost 40% of the consumption of energy.

The specific goal of EPBD is to create better and more energy efficient buildings in order to improve the quality of citizens' life while bringing additional benefits to the economy and the society. The specific goals of the EPBD are:

1. achieve a highly energy efficient and decarbonized building stock by 2050
2. create a stable environment for investment decisions
3. enable consumers and businesses to make more informed choices to save energy and money



In order to reach these goals the EPBD defined several tools and rules for the member states to implement.

EU countries must establish **concrete long-term renovation strategies with financial incentives**, aiming at decarbonizing the national building stocks by 2050, with indicative milestones for 2030, 2040 and 2050. These measures and goals should be implemented into the national energy and climate plans. These are crucial elements to draw integrated national energy and climate plans (NECPs). The long-term renovation strategies should overview the state of the national building stock, should define the measures of cost-effective renovation of buildings, target the worst performing buildings, split-incentive dilemmas, market failures, energy poverty and public buildings, furthermore promote smart technologies and skills and education in the construction and energy efficiency sectors.

For every new and existing building in the EU member states regulators should set cost-optimal minimum energy performance requirements. For example, heating, cooling or roof systems must have energy performance requirements, which is defined in kWh/m²year annual primary energy use.

One of the most visible measure in EPBD, that every new building in the EU should be **nearly zero-energy buildings (NZEB)** from 31 December 2020. Since 31 December 2018, all new public buildings already need to be NZEB. National plans and regulations need to be met with these standards as well.

EPBD set for each member state the obligation to introduce a **system of energy performance certificates**. These documents and analyses must be issued when a building is sold or rented, and inspection schemes for heating and air conditioning systems must be established.

Electric vehicles are on the rise, so it is expected to increase significantly in the coming years, which generates demand for adequate recharging infrastructure both in public and private spaces. So a relatively new measure of the EPBD is the **promotion of electro-mobility**. The new rules introduced minimum requirements for car parks over a certain size and other minimum infrastructure for smaller buildings.

EPBD has introduced the **Smart Readiness Indicator**, which is a voluntary European scheme for rating the “smart readiness” of buildings. The SRI will be able to measure a building’s “smartness”: it needs to be ready to adapt the needs of the occupant, ready to facilitate maintenance and efficient operation and ready to adapt in response to the situation of the energy grid (energy flexibility). SRI will add new comparable information to building owners and occupants about the buildings’ value. Besides the introduction of the new indicator system every smart solution is promoted by the EPBD (i.e.: building automation and control systems and devices that regulate temperature at room level).

Important new perspective of the EPBD, that it is focused on the health and well-being of building users, not only the building's infrastructure itself. The directive also set rules through the consideration of air quality and ventilation.

| Main EPBD requirements | nZEB aspects |
|---|----------------------------|
| Member States shall ensure that by 31 December 2020, all new buildings are NZEBs and after 31 December 2018, new buildings occupied and owned by public authorities are NZEBs | Private/Public |
| New, and existing buildings that are subject to major renovation, should meet minimum energy performance requirements adapted to the local climate. Member States shall [...] stimulate the transformation of refurbished buildings into NZEBs. | New/Retrofit |
| [...] buildings should be adequately classified into [...] categories. | Building category |
| [...] energy performance of a building means the calculated or measured amount of energy needed to meet the energy demand [...] | Balance type |
| The Directive lays down requirements as regards the common general framework for [...] buildings and building units. [...] building' means a roofed construction having walls, for which energy is used to condition the indoor climate. | Physical boundary |
| [...] energy performance of a building means the calculated or measured amount of energy needed to meet the energy demand associated with a typical use of the building, which includes, inter alia, energy used for heating, cooling, ventilation, hot water and lighting. | System boundary demand |
| [...] energy from renewable sources means energy from renewable non-fossil sources, namely wind, solar, aerothermal, geothermal, hydrothermal and ocean energy, hydropower, biomass, landfill gas, sewage treatment plant gas and biogases. [...] minimum levels of energy from renewable sources [...] to be fulfilled through district heating and cooling | System boundary generation |
| [...] The methodology for calculating energy performance should be based not only on the season in which heating is required, but should cover the annual energy performance [...] | Balance period |
| [...] including a numerical indicator of primary energy use expressed in kWh/m ² /y | Normalization |
| The energy performance of a building shall be expressed in a transparent manner and include an energy performance indicator and a numeric indicator of primary energy use, based on primary energy factors per energy carrier, which may be based on national or regional annual weighted averages or a specific value for on-site production. [...] primary energy means energy from renewable and nonrenewable sources which has not undergone any conversion or transformation process [...] | Metrics |
| Primary energy factors [...] may be based on national or regional yearly average values and may take into account [...] European standards. | Time weighting |
| Member States shall introduce [...] appropriate measures [...] to increase the share of all kinds of energy from renewable sources in the building sector [...], require the use of minimum levels of energy from renewable sources in new buildings and in existing buildings [...] The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources [...] | Fraction of renewables |

| | |
|---|---------------------------|
| <p>NZEB means a building that has a very high energy performance [...]. The energy performance [...] shall [...] include an energy performance indicator and a numeric indicator of primary energy use [...]. The methodology shall [...] take into consideration: thermal characteristics [...], heating installation, hot water supply, air-conditioning, natural, mechanical ventilation, built-in lighting, the design, positioning and orientation of the building, outdoor climate, passive solar systems and solar protection, [...] internal loads.</p> | <p>Energy performance</p> |
| <p>This Directive [...] takes into account [...] indoor climate requirements [...] The methodology shall [...] take into consideration [...] indoor climatic conditions [...] that includes [...] indoor air-quality, adequate natural light []</p> | <p>Comfort & IAQ</p> |
| <p>[...] energy performance of a building means the calculated or measured amount of energy needed [...] EU Member States shall encourage the introduction of intelligent metering systems [...], the installation of automation, control and monitoring systems [...]</p> | <p>Monitoring</p> |

Figure 1.1.1 – Main EPBD requirements / Source:

https://publications.jrc.ec.europa.eu/repository/bitstream/JRC97408/regno_jrc97408_online%20nzeb%20report%281%29.pdf

1.1.3 RENEWABLE ENERGY SOURCES DIRECTIVE (RED)

One of the political priorities of the European Union is to become the global leader of renewables, so in order to reach this goal the Renewable Energy Sources Directive (RES/RED) was adopted. The first version in 2009 to promote renewable energy sources such as wind, solar, hydro, tidal, geothermal and biomass. It set a goal for the EU to fulfil at least 20% of its total energy needs with renewables by 2020 and became less dependent on “foreign” fossil fuels. The directive was amended and set a new goal: for 2030 of at least 32% energy should come from renewables, with a clause for a possible upwards revision by 2023. This goal should also be included in the 10-year National Energy & Climate Plans (NECPs) with the concrete targets and policy measures of upscaling renewable sources for the electricity, heating and cooling, and transport sectors.

FIGURE 1 Overall Share of RES in Gross Final Energy Consumption in EU Member States, Iceland and Norway

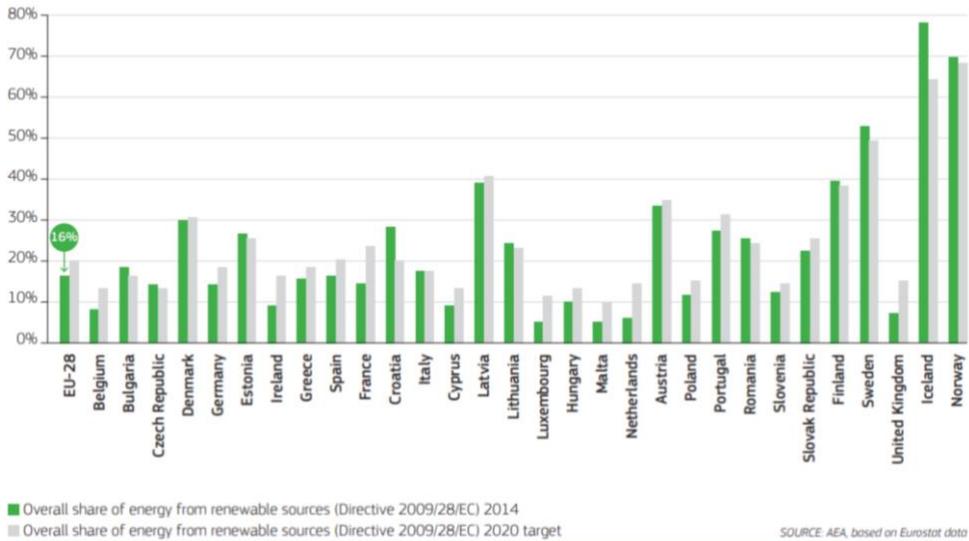


Figure 1.1.2 – Source: https://www.ca-res.eu/fileadmin/cares/PublicArea/CARES2FinalPublication/CA-RES_Executive_Summary_2016.pdf

The directive also introduced a cooperation mechanism by promoting statistical transfers of renewable energy, joint renewable energy projects and joint renewable energy support schemes in order to make such projects easier to do.

Sustainable and strict biofuel usage was also defined in the directive with exact levels for liquid biofuels used in transportation, as well as for solid and gaseous biomass fuels for power, heating and cooling production. All EU countries should reduce total consumption of energy in transport and increase energy efficiency: at least 14% of their transport fuels should come from renewable sources.

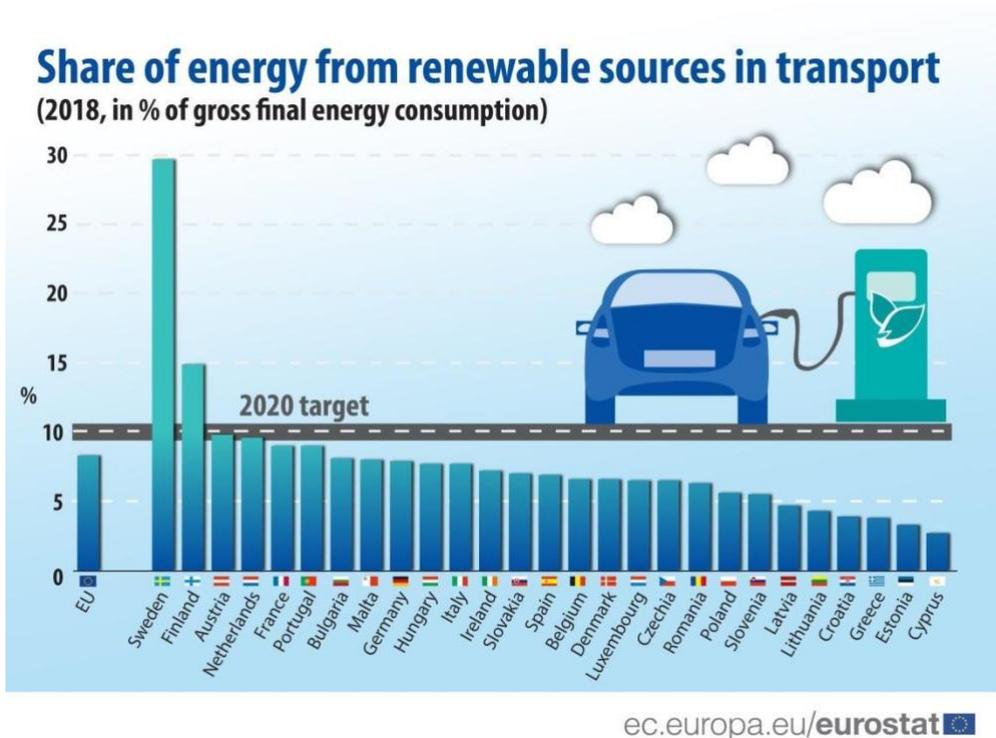


Figure 1.1.3 – Share of energy from renewable sources in transport / Source:

https://ec.europa.eu/eurostat/statistics-explained/index.php/Renewable_energy_statistics

RED also set goals for the building industry: each member state must be able to guarantee the origin of electricity, heating and cooling produced from renewable energy sources. The directive also promotes – by easier regulations - local energy consumers to produce their own electricity, individually or as part of renewable energy communities.

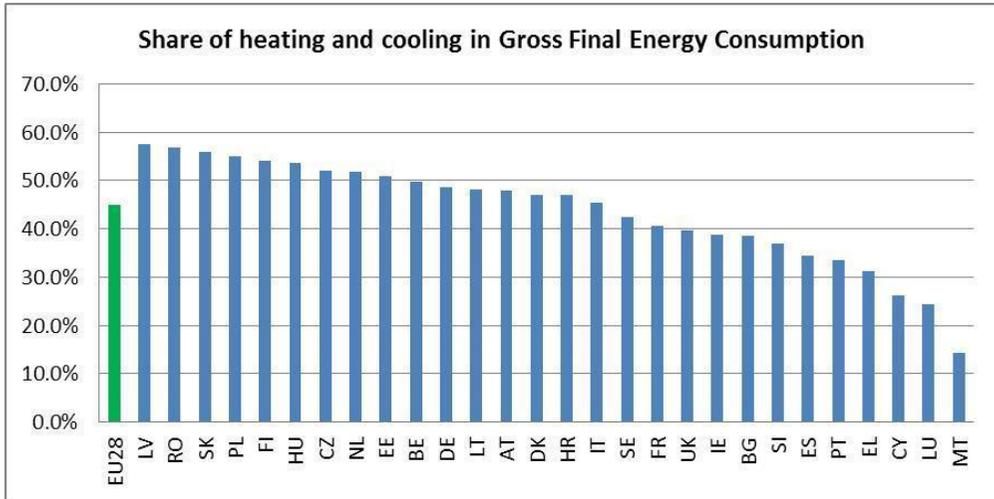


Figure 1.1.4 – Share of heating and cooling in gross final energy consumption / Source: <https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52016SC0418&from=EN>

Because of the high share of heating and cooling in gross final energy consumption the current EED also set an annual increase of 1.3 percentage points in the share of renewable energy at the heating and cooling of the buildings. The principle of decentralized and more dynamic heating / cooling systems is also an import factor, because it gave the right for consumers to disconnect from inefficient district heating and cooling systems and third-party access for suppliers of renewables and waste heat and cooling to district heating and cooling networks.

| | Electricity | Heating & cooling | Transport | Governance |
|-----------------------------|---|---|--|--|
| Reduce investor uncertainty | - Consolidated framework: EU toolkit for support schemes | - Mainstream renewables: obligation on heating and cooling | - Increase renewables: obligation on renewable fuels | - 2020 Baseline - Trajectory towards 2030 target - Avoid and fill delivery gap |
| Improve cost-effectiveness | - Consolidated framework: tendering design principles - Reducing cost of capital - Administrative simplification | - Facilitate renewables in district heating and cooling: Energy performance | | |
| Create functioning market | - Consolidated support framework: market-based design principles - Consolidated framework: energy communities | - Facilitate renewables in district heating and cooling: Access rights | - Increase renewables: obligation in aviation and maritime | |
| Update regulatory framework | - Coordinated regional approach | | - Increase renewables: phase-out of food based biofuels | - Avoid an ambition gap - Avoid and fill delivery gap |
| Ensure citizen buy-in | - Empower consumers: self-consumption and storage-consumption - Consolidated support framework: fair tendering for small producers - Disclose information on electricity generation | - Facilitate renewables in district heating and cooling: Consumer rights - Trace origins of renewable fuels in heating and cooling | - Trace origins of renewable fuels in transport | |

Figure 1.1.5 – Overview of measures and linkage to the identified problems by RES / Source: <https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52016SC0418&from=EN>

The RED has applied since 24 December 2018 and has to become law in EU countries by 30 June 2021.

1.1.4 ENERGY EFFICIENCY DIRECTIVE (EED)

The original Energy Efficiency Directive (EED) - which was adapted in 2012 - establishes a set of binding measures to help the EU reach its 20% energy efficiency target by 2020. In 2018, the original directive was amended with new goals: to reach **the energy efficiency target for 2030 of at least 32.5%** compared to the base year of 2007. The European Union's (without UK) energy consumption should be no more than 1128 Mtoe of primary energy and/or no

more than 846 Mtoe of final energy at all parts of the energy chain, including energy generation, transmission, distribution and end-use consumption.

The EED not only set this target, but defined exact measures, which member states need to be implemented into their national legislative system.

EU countries must achieve new savings each year of 1.5% of final energy consumption from 2024 to 2030, up from the current level of 0.8%². This is an important instrument to drive energy savings in end-use sectors such as buildings, industry and transport. In order to do this reduction, energy efficient renovations of buildings owned and occupied by central governments is mandatory for at least 3% per year of all public buildings. Besides that it promotes the renovation of residential buildings as well.

Besides the duty of implementing long-term renovation strategies for the building stock in the member states, every three years they have to update national energy efficiency action plans (NEEAPs). However, this part of the EED is overwritten by the measures of the new EPBD directive with more fresh standards.

| EU Member State | Indicative national energy efficiency targets for 2020 | Absolute 2020 level of energy use [Mtoe] | |
|-----------------------|--|--|-------|
| | | Primary | Final |
| Austria | Final energy consumption of 1100 PJ | 31.5 | 26.3 |
| Belgium | 18% reduction in primary energy consumption by 2020 relative to the Primes 2007 baseline (53.3 Mtoe) | 43.7 | 32.5 |
| Bulgaria | Increase of energy efficiency by 25% until 2020 (5 Mtoe primary energy savings in 2020) and 50% energy intensity reduction by 2020 compared to 2005 levels | 15.8 | 9.16 |
| Croatia | Energy efficiency 20% (9 192 toe) | - | - |
| Cyprus | 0.463 Mtoe energy savings in 2020 (14.4% reduction in 2020 compared to a reference scenario) | 2.8 | 2.2 |
| Czech Republic | 47,84 PJ (13,29 TWh) savings of final energy consumption* | 39.6* | 24.4* |
| Germany | Annual improvement of energy intensity (energy productivity) by 2.1% pa on average until 2020 | 276.6 | 194.3 |
| Denmark | Primary energy consumption of 744.4 PJ (17.781 Mtoe) in 2020 | 17.8 | 14.8 |
| Estonia | Stabilisation of final energy consumption in 2020 at the level of 2010 | 6.5 | 2.8 |
| Greece | Final energy consumption level of 20.5 Mtoe | 27.1 | 20.5 |
| Spain | 20% energy savings to be achieved by 2020 | 121.6 | 82.9 |
| Finland | 310 TWh of final energy consumption in 2020 | 35.9 | 26.7 |
| France | 17.4% reduction of final energy consumption in 2020 compared to a baseline | 236.3 | 131.4 |
| Hungary | 1113 PJ primary energy consumption in 2020 (236 PJ savings compared to business-as-usual), resulting in 760 PJ final energy consumption | 26.6 | 18.2 |
| Ireland | 20% energy savings in 2020 along with a public sector energy saving target of 33% | 13.9 | 11.7 |
| Italy | 20 Mtoe primary energy reduction by 2020, 15 Mtoe final energy reduction by 2020 | 158.0 | 126.0 |
| Lithuania | 17% reduction in final energy use compared to 2009 level (reduction of 740 ktoe) | 6.485 | 4.278 |
| Luxembourg | Preliminary target value for 2020 of 49,292 GWh or 4,239.2 ktoe final energy | 4.482 | 4.239 |
| Latvia | Primary energy savings in 2020 of 0.670 Mtoe (28 PJ) | 5.37 | 4.47 |
| Malta | 22% energy or 237.019 toe savings target by 2020 | 0.825 | 0.493 |
| Netherlands | 1.5% energy savings per year (partial) | 60.7 | 52.2 |
| Poland | 13.6 Mtoe primary energy savings in 2020 | 96.4 | 70.4 |
| Portugal | Reduction of primary energy use in 2020 by 25% compared to projections | 22.5 | 17.4 |
| Romania | Reduction of 10 Mtoe (19%) in the primary energy consumption | 42.99 | 30.32 |
| Sweden | Energy use shall be 20% more efficient by 2020 compared with 2008 and a 20% reduction in energy intensity between 2008 and 2020 | 45.9 | 30.3 |
| Slovenia | 10.809 GWh energy savings by 2020 | - | - |
| Slovakia | 3.12 Mtoe of final energy savings for the period 2014-2020 | 16.2 | 10.4 |
| United Kingdom | Final energy consumption in 2020 of 129.2 Mtoe on a net calorific value basis | 177.6 | 157.8 |

² https://ec.europa.eu/energy/topics/energy-efficiency/targets-directive-and-rules/energy-efficiency-directive_en

Figure 1.1.6 – Source: "Energy Financing Energy Efficiency Towards 2020 and beyond" - Dr. Tóth András György <https://slidetodoc.com/financing-energy-efficiency-towards-2020-and-beyond-dr/>

The EED set new standards for the whole building industry. It declares minimum energy efficiency standards and labelling for a variety of products such as boilers, household appliances, lighting and televisions (energy label and ecodesign), mandatory energy efficiency certificates accompanying the sale and rental of buildings and mandatory energy audits for large companies conducting at least every four years.

The application of new smart technologies is also in the focus of the EED. It sets goals for close to 200 million smart meters for electricity and 45 million for gas. Besides the technical and financial feasibility of the installation process, the distribution of smart meters is adding new and live information of the actual energy consumption of the end user, therefore making the energy efficient decisions easier.

For energy companies EED set an annual sales decrease of 1.5% energy sales to final consumers and declared the protection of consumer rights in the energy sector to receive easy and free access to data on real-time and historical energy consumption. It is also required to have transparent monitoring efficiency levels in new energy generation capacities. EU countries must have transparent, publicly available national rules on the allocation of the cost of heating, cooling and hot water services in multi-apartment and multi-purpose buildings where these services are shared. Furthermore, the EED also strengthened social aspects of energy efficiency by taking energy poverty into account in designing energy efficiency schemes and alternative measures.



Figure 1.1.7 – Source: <https://www.agoria.be/>

1.1.5 REFERENCES

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