UNIVERSITÀ DEGLI STUDI DI TRIESTE

Regulatory Framework and Building Energy Design

The second topic

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Regulatory Hierarchy



Primary energy

Introduction to regulatory hierarchy:

EU LEVEL

European Union acts through three institution

European Parliament

Members are selected through European election

Approves Commission's acts

European Commission

27 Commissioners

(one for each member State of the European Union)

Proposes and implements acts

European Council

Composed by the ministers of each member state

Works together with the Parliament

Primary energy

Introduction to regulatory hierarchy:



EU LEVEL

There are 6 main types of documents through which European Union acts:

- **Regulation –** it is binding in all its parts, it does not need to be implemented by member States to come into force
- **Directive –** binds the objectives but not the methods to achieve them, usually member States have 2 years to implement it
- **Decision –** valid only for some States on certain topics, on which it is binding
- **Recommendation –** expresses a non-binding position
- **Communication –** adopts strategies, it is a non-binding act of direction
- **Opinion –** deals with specific topics, is not binding

Primary energy

EU LEVEL

1. Regulation EU

Think of a regulation as a **rulebook** that applies **directly**.

Once an **EU** regulation enters into force, it is **automatically** part of the **legal system of the Member States**. Countries generally do not need to pass a separate national law to implement it.

Example: **GDPR**

The General Data Protection Regulation establishes **common rules** for how personal data must be handled throughout the EU.

Regulation = same rules, directly applicable across the EU.

EU LEVEL

2. Directive

A directive **sets a target**, but gives Member States **freedom** to decide **how to reach it**.

Countries must adopt their own **national measures** to achieve the objectives of the directive, usually within a specified deadline.

Example: **Working Time Directive**

The EU establishes minimum requirements concerning working time, rest periods and annual leave. **Each Member State implements** these requirements through its own **national legislation**.

Directive = same goal, different ways of achieving it.

EU LEVEL

3. Decision

A decision is **binding**, but unlike a regulation, it can be addressed to **specific recipients** rather than everyone.

The recipients can include **Member States**, **companies**, or **individuals**.

Example:

The European Commission **can adopt a decision** finding that a company has violated EU competition rules and requiring it to pay a fine.

Decision = binding ruling for specific recipients.

EU LEVEL

4. Recommendation

A recommendation expresses **what the EU thinks should be done**, but it **does not create a legal obligation** to do it.

Member States and other actors are **encouraged to follow** it, but they cannot normally be legally forced to do so simply because of the recommendation.

Example:

The EU **could recommend** that Member States introduce measures to improve employment opportunities for young people.

Recommendation = “We suggest you do this.”

EU LEVEL

5. Communication

A communication is mainly about **strategy** and **direction**.

It can explain the **Commission's priorities**, present a **policy strategy**, or announce what the EU **intends to do** in a particular area. It is **not** itself legally binding.

Example:

The European Commission **might publish a communication** setting out its strategy for developing Europe's digital economy or achieving a particular environmental objective.

Communication = “Here is our strategy and direction.”

EU LEVEL

6. Opinion

An opinion **expresses a view on a particular issue**. It can be issued by an EU institution or body, depending on the procedure involved, but it is not legally binding.

Example:

The European Economic and Social Committee or the European Parliament **may issue an opinion on a proposed EU policy** or piece of legislation.

Opinion = “Here is our view.”

Primary energy

EU LEVEL

A very easy way to remember them:

Regulation → “Do this.”

Directive → “Achieve this goal.”

Decision → “You specifically must do this.”

Binding

Recommendation → “We suggest doing this.”

Communication → “This is our strategy.”

Opinion → “This is our view.”

Not binding

Primary energy

Introduction to regulatory hierarchy:



ITALIAN LEVEL

National Law – a regulatory act adopted by the legislative power (Parliament), hierarchically superior to all other sources of law, except for the Constitution

Legislative Decree – a regulatory act having the force of law adopted by the executive power (Government) by delegation of the legislative power (Parliament)

Primary sources

(Inter) Ministerial Decree – an administrative act issued by a Minister in the exercise of his function and within the scope of the matters falling within the competence of his department

Decree of the President of the Republic – lower regulatory value than laws, and are issued to implement and complete legislative provisions

Secondary sources

Introduction to regulatory hierarchy:

REGIONAL LEVEL

Regional Law – valid only in one Region, applied in compliance with the superior levels of legislation and depending on the primary competence of the legislative power delegated to the Regional administration

Friuli Venezia Giulia

Full competence	Partial competence	No competence
Urban planning	Landscape and antiquities protection	Energy

MUNICIPALITY LEVEL

General Municipal Master Plan – an urban territorial planning tool that regulates building activity within a municipal territory, which every Italian municipality must equip itself with.

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Energy Performance Building Directive (EPBD)

Directive (EU) 2024/1275 of the European Parliament and of the Council of 24 April 2024 on the energy performance of buildings (recast)



Energy Performance Building Directive (EPBD)

ARTICLE 1

EU 2024/1275 Directive – April 24, 2024

It **replaced** Directive **2010**/31/EU (the previous EPBD) from 30 May 2026.

The European Commission itself refers to it as the "**recast EPBD**."

EPBD requirement → Italian framework → design consequence → Italian example.

Energy Performance Building Directive (EPBD)

EPBD 2024/1275	What it means for Italy
EU Directive	**Sets** objectives and **obligations**
Italian transposition	**Converts** those obligations into **national legislation**
D.Lgs. 192/2005	Existing core Italian framework for building energy performance
D.M. 28/10/2025	Minimum requirements + calculation/application framework + APE guidelines
APE	Italian Energy Performance Certificate
SIAPE	National database of APEs
PNIEC 2024	National energy and climate strategy
National Building Renovation Plan	New planning instrument required by EPBD Art. 3
Regional rules	Important because energy certification/implementation has regional components

Energy Performance Building Directive (EPBD)

The evolution:

EPBD I (**2002**/91/EC)

↓

D.Lgs. 192/2005

EPBD II (**2010**/31/EU)

↓

D.L. 63/2013 + Law 90/2013 + D.M. 26/06/2015

EPBD III (**2018**/844/EU)

↓

D.Lgs. 48/2020

EPBD IV / **recast** (EU) **2024**/1275

↓

Italian transposition / new national framework

ENEA presents essentially this same legislative evolution in its material on EPBD implementation in Italy.

Energy Performance Building Directive (EPBD)

What is new about EPBD 2024?

- From **energy-efficient** buildings → **zero-emission** building stock
- The previous EPBD framework was strongly focused on:

❑ energy performance → efficiency → nearly-zero-energy buildings (**nZEB**)

- The new EPBD moves toward:

❑ energy efficiency + renewables + decarbonization + renovation + whole-life carbon + smart buildings

- The main direction is a **zero-emission building** stock by 2050.

Energy Performance Building Directive (EPBD)

What changes between designing an nZEB and designing a zero-emission building?

nZEB, Nearly Zero-Energy Building

- Very **high** energy **performance**
- Very **low** energy **demand**
- Significant share of energy from **renewable** sources
- Focus mainly on **energy efficiency** + **renewable energy**

Zero-Emission Building, EPBD 2024

- Very **low** energy **demand**
- No **on-site fossil-fuel emissions**
- Energy supplied increasingly from **renewable** sources
- Greater focus on **decarbonization**
- **Life-cycle global warming potential** progressively considered (GWP)

Energy Performance Building Directive (EPBD)

Key dates:

- 2024: Directive adopted
- 28 May 2024: Directive enters into force
- 29 May 2026: Main transposition deadline
- 30 May 2026: Directive 2010/31/EU is repealed
- 2030: All **new** buildings → zero-emission buildings
- 2050: Building stock → zero-emission building stock

Energy Performance Building Directive (EPBD)

ARTICLE 1

EU 2024/1275 Directive, April 24, 2024

It promotes:

- the improvement of the **energy performance** of buildings
- the reduction of **greenhouse gas emissions** from buildings within the Union

To achieve:

- a **zero-emission building stock by 2050**

Taking into account:

- local conditions
- external climate conditions
- indoor quality requirements and cost-effectiveness

Energy Performance Building Directive (EPBD)

ARTICLE 1

The **validity** of the energy performance certificate **shall not exceed 10 years**.

Member States shall ensure that, where a building was issued a energy performance certificate below **level C**, building owners are invited to a **one-stop shop** to receive **renovation advice** on whichever of the following is the **earlier**:

- immediately after the energy performance certificate of the building **expires**
- **five yea**rs after the issuance of the energy performance certificate

Member States shall ensure that a **digital energy performance** certificate is issued for:

- buildings or building units when they are **constructed**, when they have **undergone a major renovation**, when they are **sold**, when they are **rented out to a new tenant**, or for which **a rental contract is renewed**
- existing buildings owned or occupied by **public bodies**

Energy Performance Building Directive (EPBD)

ARTICLE 1- What does the EPBD regulate?

Article 1 establishes requirements concerning:

- calculation of **building energy performance**;
- **minimum energy-performance requirements** for **new** buildings;
- **requirements** for existing buildings undergoing **major renovation**;
- requirements for **building elements**;
- requirements for **technical building systems**;
- life-cycle **global warming potential**;
- **solar energy** in buildings.

Energy Performance Building Directive (EPBD)

ARTICLE 1- What does the EPBD regulate?

The Directive lays down requirements as regards:

- the **methodology for calculating** the energy performance of buildings
- the **application** of minimum energy performance requirements to:

1. **New buildings**
2. **Existing buildings** that are undergoing major renovation
3. **Building elements** that form part of the building envelope and that have a significant impact on the energy performance of the building envelope when they are retrofitted or replaced
4. **Technical building systems** where they are installed, replaced or upgraded

- the calculation and disclosure of the life-cycle global warming potential of buildings
- solar energy in buildings

Energy Performance Building Directive (EPBD)

ARTICLE 35- Why does the EU Directive matter in Italy?

A directive is not simply an Italian building regulation.

The **EU** establishes the **requirements** and **Italy** must transpose them into **national law.**

The Directive must be implemented by member States by **May 29, 2026**

Exception: member States shall bring into force the laws, regulations and administrative provisions necessary to comply with Article 17(15) by January 1, 2025

Extract from Article 17(15): “From 1 January 2025, Member States shall not provide any financial incentives for the installation of stand-alone boilers powered by fossil fuels, with the exception of those selected for investment, before 2025, in accordance with […]”

- When member States adopt these measures, they shall contain a reference to this Directive
- If a member State does not implement the measures within the deadlines it will be subject to violation procedure

Energy Performance Building Directive (EPBD)

ARTICLE 35- Why does the EU Directive matter in Italy?

Italy

- The 29 May 2026 deadline was missed.
- Italy did not have the complete new national framework in place by the deadline.
- Existing rules, including D.Lgs. 192/2005 and the D.M. 26 June 2015 framework, therefore remain important during the transition. Italy also updated the 2015 framework in October 2025.

As of **7 October 2026**, Italy has **not fully transposed the recast EPBD (Directive (EU) 2024/1275)** into national law.
The EU deadline was **29 May 2026**, and the European Commission stated in July 2026 that **all 27 Member States had failed to fully transpose** the recast directive by that deadline, including Italy.

Energy Performance Building Directive (EPBD)

One important reminder!

Directive → EU obligation

Italian transposition → national legislation

Technical standards → calculation/design procedures

Building permit / project → actual application to a building

EU: EPBD 2024/1275 → ITALY: D.Lgs. / decrees / regulations → TECHNICAL FRAMEWORK: UNI / CTI / calculation methods

↓

DESIGN: Envelope + HVAC + renewables + controls → BUILDING: APE / verification

- APE means Attestato di Prestazione Energetica, the **Energy Performance Certificate**.

Energy Performance Building Directive (EPBD)

ARTICLE 3

National Building Renovation Plan

- Each **member State** shall establish a **plan** to ensure **the renovation** of the national stock of residential and non-residential buildings, both public and private, into a **highly energy-efficient** and **decarbonized** building stock by **2050**
- Every **five years**, each member state shall **submit** to the commission its **national building renovation plan**
- Member States shall submit the first draft building renovation plan to the Commission by **31 December 2025**
- Member States shall submit the first national building renovation plan to the Commission by **31 December 2026**

Energy Performance Building Directive (EPBD)

ARTICLE 3

Italian connection: PNIEC

Italy's **PNIEC** 2024, Piano Nazionale Integrato per l'Energia e il Clima already provides an important national planning framework.

The PNIEC states that the **civil sector** accounts for approximately **44%** of Italy's **final energy consumption** and **26%** of direct **emissions** from ESR sector in 2022.

- **ESR** stands for Effort Sharing Regulation. It refers to the EU framework covering greenhouse-gas emissions from sectors outside the EU Emissions Trading System.

Requirement	EU deadline	Italy's status
First draft National Building Renovation Plan (NBRP)	31 Dec 2025	❌ Missed
Final National Building Renovation Plan	31 Dec 2026	⏳ Still pending

- Italy is currently late by about 9 months on the first milestone

Energy Performance Building Directive (EPBD)

ARTICLE 3 - National Building Renovation Plan

Each **national building** renovation plan shall include:

- an **overview of the national building** stock for different building types
- an overview of **market barriers** and failures
- a **roadmap** with targets and progress indicators, including the **reduction** of the number of people affected by **energy poverty**
- an **overview of implemented** and **planned policies** and measures, supporting the implementation of the roadmap
- an **outline of the investment** needs for the implementation of the plan
- the **minimum energy performance standards** for **non-residential buildings**
- the **national trajectory** for the **renovation** of the **residential building** stock
- an estimate of **expected energy savings** and improvements in **environmental quality**

Energy Performance Building Directive (EPBD)

ARTICLE 4

This is where regulation meets building physics.

Climate → Building envelope → Heating / cooling loads → Technical systems → Renewables

↓

Primary energy → Energy performance

Italy has an established calculation framework based on the national legislation and technical standards.

The Italian framework uses UNI/CTI technical standards, with **UNI/TS 11300** being particularly important in the calculation methodology.

For example: We have an apartment of 100 m²

What happens to energy demand? What happens to primary energy?

In each of these scenarios:

Energy Performance Building Directive (EPBD)

ARTICLE 4

A — 1970 building

- poor insulation
- old windows
- gas boiler

B — renovated

- insulation
- high-performance windows
- heat pump
- PV

Energy Performance Building Directive (EPBD)

ARTICLE 4- Case A, 1970 building



Energy Performance Building Directive (EPBD)

ARTICLE 4- Case A, 1970 building

Building characteristics:

- 100 m²
- Poor/no thermal insulation
- Old double/single-glazed windows
- Significant heat losses through walls, roof and windows
- Gas boiler: approximately 80% efficiency
- No PV
- Conventional radiators

For a simplified example, assume the building needs:

Useful heating demand:150 kWh/m²·year

For 100 m²: 150 × 100 = 15,000 kWh/year of useful heat

Energy Performance Building Directive (EPBD)

ARTICLE 4- Case A, 1970 building

The boiler has to consume more energy than this because it is not 100% efficient.

If efficiency ≈ 80%:

15,000 / 0.80 = 18,750 kWh/year of gas

So approximately:

Delivered energy ≈ 188 kWh/m²·year

And after applying the relevant primary-energy conversion factor to the gas, you could get an illustrative result of roughly:

Primary energy ≈ 197 kWh/m²·year

So the building has high energy demand and high primary-energy consumption.

Energy Performance Building Directive (EPBD)

ARTICLE 4- B, Renovated building







Energy Performance Building Directive (EPBD)

ARTICLE 4- B, Renovated building

Now imagine we renovate exactly the same 100 m² apartment.

Building envelope:

- External insulation added
- Better roof/floor insulation
- High-performance windows
- Better airtightness

The useful heating demand might fall from: 150 → 50 kWh/m²·year

For 100 m²: 50 × 100 = 5,000 kWh/year

That's a **67% reduction** in heating demand.

But now we also change the technical system.

Energy Performance Building Directive (EPBD)

ARTICLE 4- B, Renovated building

Heat pump

Instead of a gas boiler, we install a heat pump with an illustrative seasonal COP/SPF of 3.

So to provide 5,000 kWh of heat: 5,000 / 3 = 1,667 kWh of electricity

That's a huge difference.

PV

Suppose the apartment has an allocated share of PV producing: 2,000 kWh/year

If, for simplicity, 1,500 kWh is used to cover the apartment's electricity needs, the net electricity associated with heating could be substantially reduced.

Energy Performance Building Directive (EPBD)

ARTICLE 4- what happens to primary energy?

Simplified comparison

	A, 1970 building	B, Renovated
Floor area	100 m²	100 m²
Insulation	Poor	Good
Windows	Old	High-performance
Heating	Gas boiler	Heat pump
PV	No	Yes
Useful heating demand	**150 kWh/m²·yr**	**50 kWh/m²·yr**
Useful heat/year	15,000 kWh	5,000 kWh
Energy for heating	~18,750 kWh gas	~1,667 kWh electricity
Approx. primary energy*	**~200 (197.4) kWh/m²·yr**	**~30–50 kWh/m²·yr**

Energy Performance Building Directive (EPBD)

ARTICLE 4- what happens to primary energy?

1970 apartment

150 kWh/m²·yr heating demand → Gas boiler → ~200 kWh/m²·yr primary energy

RENOVATION

Insulation + windows → 50 kWh/m²·yr heating demand → Heat pump → PV → ~30–50 kWh/m²·yr primary energy

Message:

I. First reduce the energy demand.

II. Then improve how that demand is supplied.

III. Finally, add renewable energy.

Energy Performance Building Directive (EPBD)

ARTICLE 4

Methodology for calculating buildings energy performance

- Article 4 is strictly related to Annex I

“The energy needs and energy use for space heating, space cooling, domestic hot water, ventilation, lighting and other technical building systems shall be calculated using **monthly**, **hourly** or sub-hourly time calculation intervals in order to account for varying conditions that significantly affect the operation and performance of the system and the indoor conditions, and to optimize health, indoor air quality, including comfort levels, defined by Member States at national or regional level.”

Energy Performance Building Directive (EPBD)

ARTICLE 5

Setting of minimum energy performance requirements

Member States shall take the necessary measures to ensure that minimum energy performance requirements are set for:

- **existing** and **new buildings**
- **building elements** that form part of the building envelope and that have a significant impact on the energy performance of the building envelope when they are **replaced** or **retrofitted**

Considering the requirements, member states may **differentiate** between **new and existing buildings** and between **different categories** of building

Member states shall **review their minimum energy performance** requirements at **regular intervals** which shall not be longer than **five years** and shall, if necessary, update them in order to reflect technical progress in the building sector and updated national energy and climate targets and policies

Energy Performance Building Directive (EPBD)

ARTICLE 5

Requisiti minimi (minimum requirements)

Italy's existing framework includes the D.M. 28 October 2025, which established national methodologies and minimum requirements for building energy performance.

The EPBD principle is that minimum requirements should reach at **least cost-optimal levels**.

The EU has subsequently adopted a methodological framework for calculating cost-optimal levels under EPBD 2024.

	Option A	Option B	Option C
Renovation cost €	30,000	50,000	70,000
Energy saving %	20%	45%	60%

Energy Performance Building Directive (EPBD)

ARTICLE 5

Is **maximum energy saving** automatically the regulatory objective?

No, the EPBD also considers **cost-optimality** and **feasibility**.

Option	Cost	Energy saving	Simple saving per €1,000
A	€30,000	20%	0.67%
B	€50,000	45%	0.90%
C	€70,000	60%	0.86%

$$Simple\ saving\ per\ 1000€ = \frac{Energy\ saving\ \%}{Cost\ €} \times 1000$$

Energy Performance Building Directive (EPBD)

ARTICLE 7

Requirements for new buildings

Member States shall ensure that new buildings are zero-emission (or at least nearly zero-energy) buildings:

- from **1 January 2028**, **new buildings owned by public bodies**
- from **1 January 2030**, **all new buildings**

Member States shall address, in relation to new buildings, the issues of:

- optimal indoor environmental quality
- adaptation to climate change
- fire safety
- risks related to intense seismic activity
- accessibility for persons with disabilities

Energy Performance Building Directive (EPBD)

ARTICLE 7- New university building in Trieste, 2030

- orientation
- solar gains
- shading
- insulation
- glazing
- thermal bridges
- ventilation
- heat pump
- PV
- DHW
- lighting
- controls
- life-cycle GWP

Energy Performance Building Directive (EPBD)

ARTICLE 8

Requirements for existing buildings:

- Member States shall take the necessary measures to ensure that, when **buildings undergo major renovation**, the energy performance of the building or of the renovated part meets the minimum energy performance requirements set in accordance with Article 5
- Those requirements shall be applied to the renovated building or building unit as a whole. Additionally or alternatively, requirements may be applied to the **renovated building elements.**
- Member States shall in addition take the necessary measures to ensure that, when a **building element** that forms part of the **building envelope** and has a significant impact on the energy performance of the building envelope is retrofitted or replaced, the energy performance of the building element meets minimum energy performance requirements in so far as technically, functionally and economically feasible.

Energy Performance Building Directive (EPBD)

ARTICLE 8

This is extremely important for Italy. Italy's energy challenge is not primarily about replacing all buildings with new construction. It is about: renovating the existing stock.

- **Ecobonus**
- **Superbonus**
- **Bonus Casa**
- **Conto Termico**
- **PNRR programmes**

The **PNIEC** specifically identifies deep renovation of buildings as an important route for reducing energy demand.

Energy Performance Building Directive (EPBD)

ARTICLE 8 - Italian incentives for building renovation

- **Ecobonus** Tax deduction for energy-efficiency improvements (insulation, windows, efficient systems, etc.).
- **Superbonus** Exceptional high-rate tax incentive introduced to accelerate deep energy/seismic renovation; now significantly reduced compared with its original 110% scheme.
- **Bonus Casa** Tax deduction for general building renovation, including some energy-related works.
- **Conto Termico** Direct **financial incentive** from **GSE** for efficient heating systems and renewable thermal technologies (e.g., heat pumps, solar thermal).
- **PNRR programmes** EU/Italian public funding programmes supporting strategic investments such as energy efficiency, building renovation, renewable energy and public buildings.

Tax deductions → Ecobonus, Superbonus, Bonus Casa

Direct GSE incentive → Conto Termico

Public investment programmes → PNRR

Energy Performance Building Directive (EPBD)

ARTICLE 9

Progressive renovation of the building stock

Each member State shall set **two maximum energy performance thresholds** so that:

- 16 % of its national non-residential building stock is above that threshold
- 26 % of its national non-residential building stock is above that threshold

The threshold will be expressed in kWh/(m^2 year) as the main parameters used for energy performance classes

The minimum energy performance standards shall ensure, at least, that **all non-residential buildings** are below:

- the 16 % threshold from 2030
- the 26 % threshold from 2033

After 2033? → Roadmaps to lower energy performance threshold by 2040 and 2050

Exceptions are set for particular situations like: buildings damaged by natural disasters or where there is a unfavourable cost-benefit assessment.

Energy Performance Building Directive (EPBD)

ARTICLE 9- Progressive renovation of the building stock

By **29 May 2026**, each member state shall establish a **national trajectory** for the progressive renovation of the **residential building stock** in line with the National Building Renovation Plan ensuring that the average **Primary Energy** (PE) use in kWh/(m^2 year) of the residential building stock:

- decreases by at least 16% compared to 2020 by 2030
- decreases by at least 20-22% compared to 2020 by 2035

After 2035?

There must be a **progressive decrease** in the average PE use in line with the transformation of the **residential building stock** into a zero-emission building stock by 2050

- ❑ At least 55% of the decrease in the average PE use after 2035 is achieved through the renovation of the 43% **worst-performing residential buildings**.

Energy Performance Building Directive (EPBD)

ARTICLE 9- Progressive renovation of the building stock

	Residential	Non-residential
2030	−16% average primary energy use	16% worst-performing buildings
2033	—	**26% worst-performing buildings**
2035	−20–22% average primary energy use	—
2050	Zero-emission building stock	Zero-emission building stock

Imagine that, the average primary energy use of Italy's residential building stock in 2020 was:200 kWh/m²·year

The EPBD trajectory would then require the national average to reach at least:2030 → −16%200 × (1 − 0.16) = 168 kWh/m²·year

And by 2035:2035 → −20–22% −20% → 160 kWh/m²·year −22% → 156 kWh/m²·year

This does NOT mean every house must individually achieve −16% by 2030.

The **target** applies to the **average primary energy use** of the **entire residential building stock**. Member States have flexibility in deciding which buildings to renovate and which measures to use (-55% of the worst 43%)

Energy Performance Building Directive (EPBD)

ARTICLE 13

Technical building systems

System requirements shall be set for **new** and for the **replacement** and **upgrading** of **existing technical building systems**.

System requirements shall be set for technical building systems in order to facilitate the effective installation and operation of **low temperature heating systems** in new or renovated buildings.

Stand-alone boilers powered by fossil fuels in **existing buildings** shall be **replaced**, in line with the national phase-out plans for fossil fuel boilers.

Non-residential buildings shall be equipped with building automation and control systems:

- continuously monitoring, logging, analysing and allowing for adjusting energy use
- benchmarking the building's energy efficiency, detecting losses in efficiency of technical building systems
- monitoring of indoor environmental quality

Energy Performance Building Directive (EPBD)

ARTICLE 13 - Technical building systems

This article is ideal for introducing smart buildings.

Technical building systems include systems such as:

- heating
- cooling
- ventilation
- DHW
- lighting
- building automation and control.

❑ Two buildings with exactly the same envelope can have very different energy consumption because of their technical systems and controls.

Energy Performance Building Directive (EPBD)

ARTICLE 10

Solar energy in buildings

Member States shall ensure the deployment of suitable solar energy installations:

- by 31 December 2026, on all **new public** and **non-residential buildings** with useful floor area larger than 250 m^2
- on all **existing public buildings** with useful floor area larger than:
  - 2.000 m^2, by 31 December 2027
  - 750 m^2, by 31 December 2028
  - 250 m^2, by 31 December 2030
- by 31 December 2027, on **existing non-residential buildings** with useful floor area larger than 500m2, if the building undergoes a major renovation
- by 31 December 2029, on all **new residential buildings** and on all new roofed car parks physically adjacent to buildings.

Energy Performance Building Directive (EPBD)

ARTICLE 10 - Solar energy in buildings

The EPBD requires Member States to ensure that new buildings are designed to optimize their solar-energy potential and introduces requirements for solar installations on appropriate buildings.

It’s not simply: Roof → PV

Orientation → Massing → Window-to-wall ratio → Solar gains → Shading → Roof/façade solar potential → PV / solar thermal

Compare Palermo Vs Trieste

- solar radiation
- heating demand
- cooling demand
- shading
- PV production
- overheating risk.

Energy Performance Building Directive (EPBD)

ARTICLE 14

Infrastructure for sustainable mobility

Non-residential buildings, **new** or undergoing **major renovation**, with **more than five car parking spaces** shall ensure:

- installation of at least **one recharging point** for every five car parking spaces
- installation of **pre-cabling** for at least 50 % of car parking spaces
- provision of **bicycle** parking spaces representing at least 15 % of average or 10 % of total user capacity of non-residential buildings

All **non-residential buildings**, with **more than 20 car parking spaces**, shall ensure, by 1 January 2027:

- installation of at least one recharging point for every 10 car parking spaces, or of ducting, for at least 50 % of the car parking spaces
- provision of bicycle parking spaces representing at least 15 % of average or 10 % of total user capacity of non-residential buildings

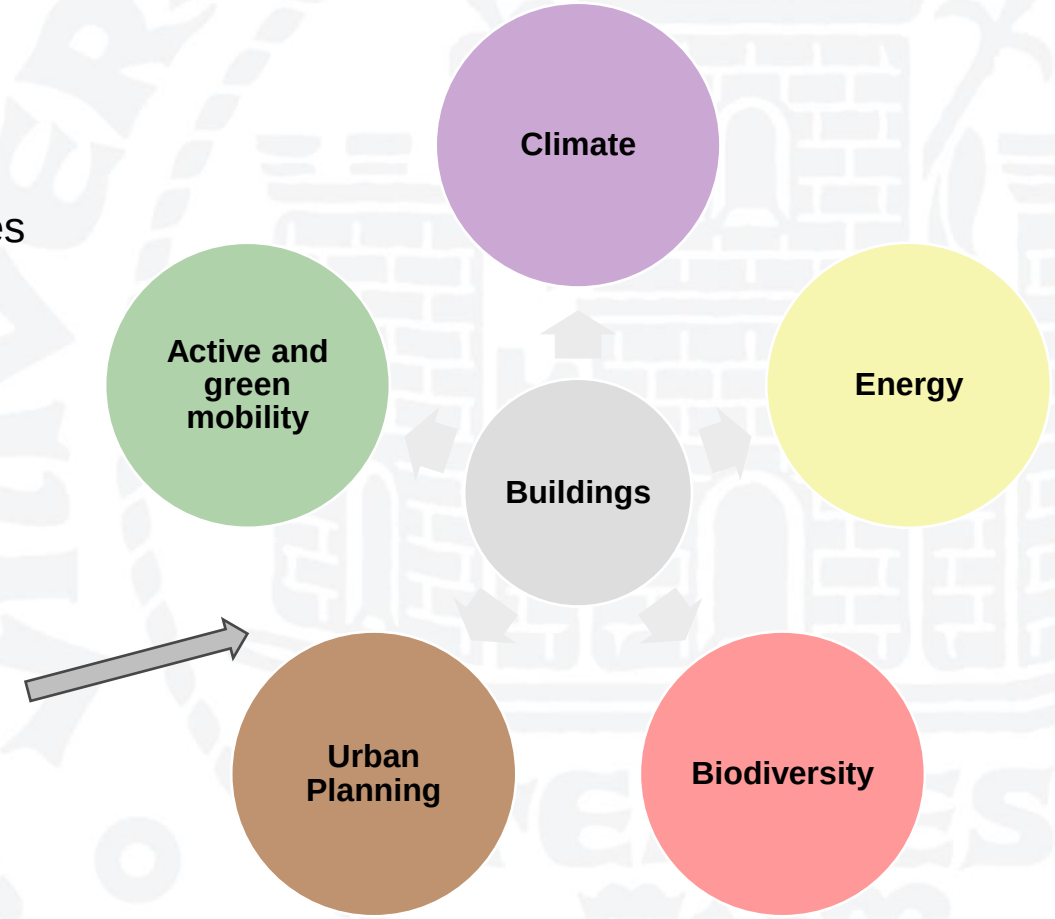
Energy Performance Building Directive (EPBD)

ARTICLE 14- Infrastructure for sustainable mobility

Residential buildings, **new** or undergoing **major renovation**, with **more than three car parking spaces** shall ensure:

- installation of at least one recharging point
- installation of pre-cabling for at least 50 % of car parking spaces
- the provision of at least two bicycle parking spaces for every residential building unit

Member States shall ensure the coherence of policies between:



Energy Performance Building Directive (EPBD)

ARTICLE 14 - Infrastructure for sustainable mobility

This is an important topic because the building becomes connected to the transport-energy system.

For buildings with parking spaces, EPBD requirements can involve:

- recharging points for electric vehicles;
- pre-cabling / ducting;
- bicycle parking infrastructure;
- infrastructure integration with building systems.

Article 14 is not only about installing chargers. It links **parking layout**, **electrical infrastructure**, **load management**, **renewable energy** and **active mobility** into one integrated design problem.

Energy Performance Building Directive (EPBD)

ARTICLE 12

Renovation passports

A renovation passport provides a **long-term renovation roadmap** for an individual building, allowing renovation to happen in stages while **maintaining a coherent pathway** toward deep renovation.

An example: Condominium built in 1975 Current: Class G

Renovation passport:

2027 → roof

2030 → façade

2032 → windows

2035 → heating system

2036 → PV

Instead of: "What can we renovate today?“ → "What is the complete pathway for this building?"

Energy Performance Building Directive (EPBD)

ARTICLE 12 - Renovation passports

By **29 May 2026**, member States shall introduce a scheme for **renovation passports**

Renovation passports provide a **clear roadmap** for **staged deep renovations**, helping owners and investors plan the best timing and scope for interventions

There are some synergies between renovation passports and **energy performance certificates**, in particular as regards the assessment of the current performance of the building and the recommendations for its improvement



In case of joint drawing up and issuing, the renovation passport should substitute the recommendations in the energy performance certificate

Energy Performance Building Directive (EPBD)

ARTICLE 19

Energy Performance Certificate

It shall include the energy performance of a building expressed by a numeric indicator of PE use in kWh/(m^2 year), and reference values such:

- minimum energy performance requirements
- minimum energy performance standards
- nearly zero-energy building requirements and zero-emission building requirements

By **29 May 2026**, the energy performance certificate shall specify the energy performance class of the building, on a closed scale using only letters from **A** to **G**

The letter **A** shall correspond to **zero-emission buildings**, and the letter **G** shall correspond to the very **worst-performing buildings** in the national building stock at the time of the introduction of the scale

Member States shall ensure that the classes have an appropriate distribution of energy performance indicators among the energy performance classes.

Energy Performance Building Directive (EPBD)

ARTICLE 19- Energy Performance Certificate

Member States may define an **A+** energy performance class corresponding to buildings with a maximum threshold for energy demand which is at least 20 % lower than the maximum threshold for zero-emission buildings, and which generates more renewable energy on-site annually than its total annual primary energy demand

Member States shall ensure that energy performance certificates are issued by independent experts **on the basis of an on-site visit**

The energy performance certificate shall include recommendations for the cost-effective improvement of the energy performance and the reduction of operational greenhouse gases emissions and the improvement of indoor environmental quality of a building or building unit, unless the building or building unit already achieves at least energy performance class A.

Energy Performance Building Directive (EPBD)

ARTICLE 19- Energy Performance Certificate

The validity of the energy performance certificate **shall not exceed 10 years**.

Member States shall ensure that, where a building was issued a energy performance certificate below **level C**, building owners are invited to a one-stop shop to receive renovation advice on whichever of the following is the earlier:

- immediately after the energy performance certificate of the building expires
- five years after the issuance of the energy performance certificate

Member States shall ensure that a digital energy performance certificate is issued for:

- buildings or building units when they are constructed, when they have undergone a major renovation, when they are sold, when they are rented out to a new tenant, or for which a rental contract is renewed
- existing buildings owned or occupied by public bodies

Energy Performance Building Directive (EPBD)

ARTICLE 19- Energy Performance Certificate

APE: Attestato di Prestazione Energetica

The EPBD requires an energy-performance certification system and moves toward a harmonized A–G scale, with A representing the highest performance and G the lowest

In Italy:

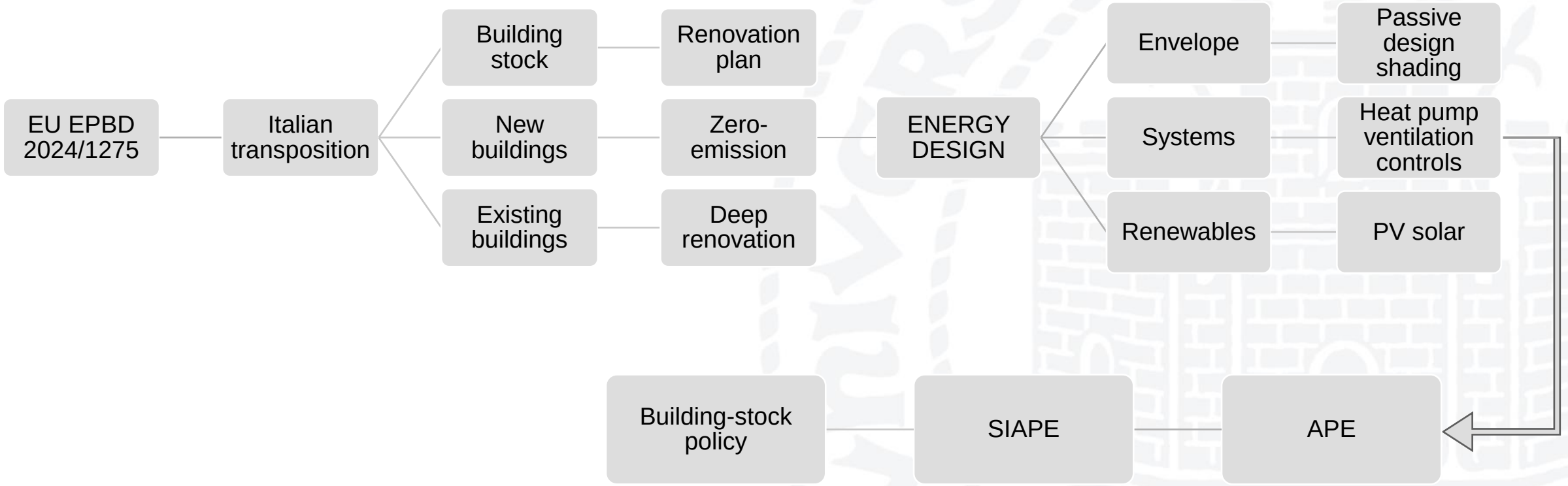
APE → Regional systems → SIAPE → National building-stock information

This is important because the APE isn't just a document given to a buyer. It can become:

a data source for national renovation policy.

ENEA's SIAPE system collects information from APEs, while regional systems provide much of the underlying certification data.

Energy Performance Building Directive (EPBD)



UNIVERSITÀ DEGLI STUDI DI TRIESTE

Case studies:

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Energy Performance Building Directive (EPBD)

Case studies:

Case 1: New residential building

Turin / Northern Italy, new construction, 2030

Main EPBD themes: Articles 1, 4, 5, 7, 10, 13, 19

Case 2: Existing condominium

Trieste, 1970s residential building, deep renovation

Main EPBD themes: Articles 3, 5, 8, 9, 12, 19

Case 3: Public school

Bologna, existing public school, renovation + mobility + renewable energy

Main EPBD themes: Articles 3, 8, 9, 10, 13, 14, 19

Energy Performance Building Directive (EPBD)

Case study 1:

New residential building, Turin, 2030

1. Building brief:

Location: Turin, Piemonte Construction: new Year: 2030

Use: residential Floors: 5 Apartments: 20

Gross floor area: 2,000 m² Heated floor area: approximately 1,600 m²

assume a compact building:

- rectangular plan
- south-facing main façade
- north-facing service façade
- flat roof
- basement parking
- 20 apartments

Energy Performance Building Directive (EPBD)

Case study 1:

This is the "future building" case.

How should an Italian engineer design a building that will have to satisfy the direction of EPBD 2024 toward zero-emission buildings?

Article 7 requires all **new buildings** to be zero-emission buildings from **1 January 2030**. Publicly owned/occupied new buildings have the earlier **2028** date.

So this case can represent the 2030 design condition.

Envelope:

Element	Initial proposal
External wall	U = 0.28 W/m²K
Roof	U = 0.20 W/m²K
Floor	U = 0.30 W/m²K
Windows	Uw = 1.4 W/m²K
Window-to-wall ratio	35%
Air tightness	normal
External shading	limited

Energy Performance Building Directive (EPBD)

Case study 1:

Systems

- gas condensing boiler
- split air-conditioning
- natural ventilation
- gas DHW
- no PV

Would you design this building this way in 2030? Why / why not?

Energy Performance Building Directive (EPBD)

Case study 1- Redesign:

Envelope

- external insulation
- high-performance glazing
- thermally broken frames
- controlled solar gains
- external shading
- reduced thermal bridges
- improved airtightness

HVAC

Replace gas heating with: air-to-water heat pump

with:

- low-temperature floor heating
- high-efficiency cooling
- heat-pump DHW

Energy Performance Building Directive (EPBD)

Case study 1- Redesign:

Ventilation

Mechanical ventilation with heat recovery

Renewable energy

PV on roof

Potentially:

PV + battery + smart control

Energy Performance Building Directive (EPBD)

Case study 1- Article 4 connection:

Article 4 concerns the methodology for calculating building energy performance.

From concept to quantitative energy model.

The Italian framework already contains a calculation methodology and minimum-requirement framework through the 26 June 2015 decree that has been updated in 28 October 2025. The decree is formally titled "Applicazione delle metodologie di calcolo delle prestazioni energetiche e definizione delle prescrizioni e dei requisiti minimi degli edifici."

What should be considered in calculations:

- transmission losses
- ventilation losses
- solar gains
- internal gains
- heating demand
- cooling demand
- DHW
- lighting
- system efficiencies
- renewable contribution
- primary energy

Energy Performance Building Directive (EPBD)

Case study 1- Article 5 connection:

Minimum requirements

Engineers must demonstrate compliance with the applicable Italian requirements.

The important conceptual distinction:

EPBD: sets the European framework.

↓

Italian legislation: sets the national implementation.

↓

Technical calculation: demonstrates compliance.

- The 28 October 2025 decree is therefore a very useful Italian reference when explaining how an EU requirement becomes a technical building requirement.

Energy Performance Building Directive (EPBD)

Case study 1- Article 10, Solar energy:

Design process:

Stage 1: Orient building.

↓

Stage 2: Analyze solar exposure.

↓

Stage 3: Control summer solar gains.

↓

Stage 4: Optimize roof/façade solar potential.

↓

Stage 5: Design PV system.

❑ This is exactly the type of integrated design logic encouraged by Article 10.

Energy Performance Building Directive (EPBD)

Case study 1- Article 13, Technical systems:

These systems should be designed:

Heating: Heat pump

Cooling: Reversible heat pump

Ventilation: MVHR (Mechanical Ventilation with Heat Recovery)

Lighting: LED + presence/daylight control

Controls: Smart thermostats

Monitoring: Energy metering

Building automation

Central monitoring of:

- heating
- cooling
- DHW
- PV
- electricity
- indoor temperature

Energy Performance Building Directive (EPBD)

Case study 1- Article 19, APE:

APE = Attestato di Prestazione Energetica

To produce a mock APE.

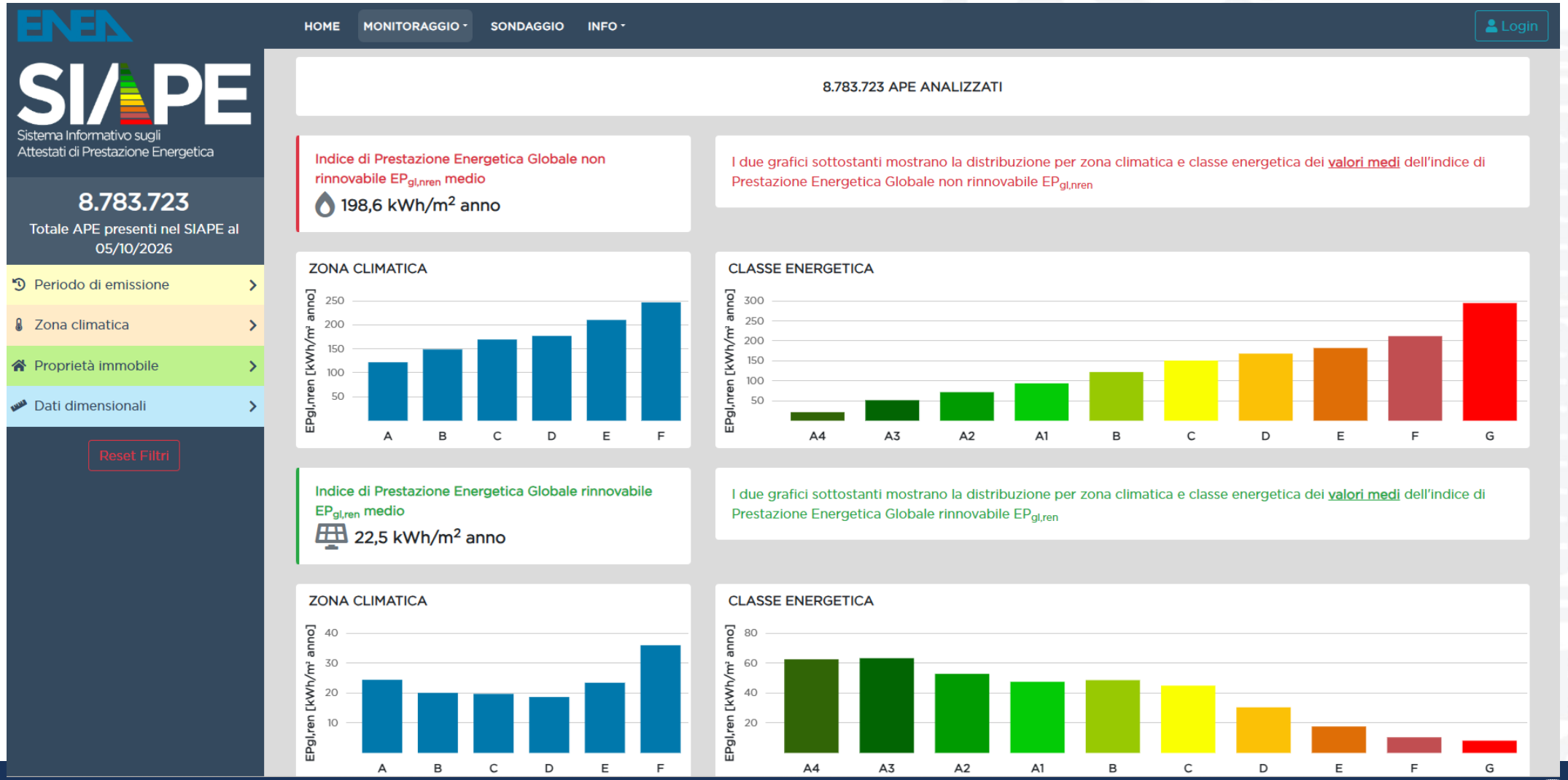
You should show:

- energy class
- primary energy
- renewable energy
- CO_2 emissions
- energy services
- recommendations.

❑ Italy's SIAPE is the national database for APEs and is managed by ENEA. As of 28 September 2026, it contained 8,765,035 APEs.

Energy Performance Building Directive (EPBD)

Case study 1- Article 19, APE:



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Energy Performance Building Directive (EPBD)

Case study 2:

1970s Condominium, Trieste



This one is probably the most educationally important of the three.

It represents the problem EPBD is fundamentally trying to solve:

What do we do with millions of existing buildings?

Energy Performance Building Directive (EPBD)

Case study 2- Building brief:

Location: Trieste, Friuli-Venezia Giulia

Construction: 1974

Use: residential condominium

Floors: 6

Apartments: 24

Heated area: 2,400 m²

Existing construction

External wall: 30 cm masonry

Roof: poorly insulated

Windows: old double glazing / mixed replacement

Heating: central gas boiler

Cooling: individual split units

DHW: gas PV: none

Energy Performance Building Directive (EPBD)

Case study 2- Existing condition:

For teaching purposes, assume:

Existing energy performance

Energy class: G

$EP_{gl,nren}$: 210 kWh/m²·year (Global non-renewable energy performance)

Annual non-renewable primary energy: ≈ 504,000 kWh/year

CO_2: approximately 90–100 tonnes/year depending on the assumed energy carriers.

These numbers are teaching assumptions, not an actual APE.

This is a synthetic case-study baseline. A real APE requires an accredited calculation.

Energy Performance Building Directive (EPBD)

Case study 2- Article 8, Existing buildings:

The question is not: "How do we make this building **perfect**?"

Instead: How do we **transform** an existing building **progressively** toward a **zero-emission building**?

Possible interventions:

Package A: Roof insulation

Package B: Façade insulation

Package C: Windows

Package D: Heat pump

Package E: PV

Package F: Ventilation / controls

Energy Performance Building Directive (EPBD)

Case study 2- Article 8, Existing buildings:

Strategy A: Minimum intervention

roof

boiler replacement

controls

Strategy B: Envelope + systems

façade

roof

windows

heat pump

Strategy C:Deep renovation

façade

roof

windows

heat pump

MVHR where appropriate

PV

controls

thermal bridges

airtightness

Parameter	Existing	A	B	C
Heating demand				
Cooling demand				
$EP_{gl,nren}$				
Renewable energy				
CO_2				
Investment				
Payback				

Energy Performance Building Directive (EPBD)

Case study 2- Article 9, The building-stock perspective:

Now **zoom out**. The condominium is not important only because of itself. There are **millions of similar buildings**.

Italy's 2024 PNIEC explicitly identifies **the importance of building renovation** and notes that the **civil sector** accounts for approximately **44%** of **national final energy consumption**. It also identifies the EPBD trajectory of reducing average residential primary-energy use by 16% by 2030 and 20–22% by 2035, with requirements targeting the worst-performing buildings.

Building scale: One condominium

↓

Urban scale: 10,000 condominiums

↓

National scale: Italian building stock

↓

EU scale: 2050 zero-emission building stock

That is exactly the logic behind Article 9.

Energy Performance Building Directive (EPBD)

Case study 2- Article 12, Renovation passport:

to make a renovation passport for the condominium.

2027: Energy audit + roof

↓

2029: Windows

↓

2031: Façade

↓

2033: Heating system

↓

2035: PV + controls

↓

2040: Final optimization

Energy Performance Building Directive (EPBD)

Case study 2- Article 12, Renovation passport:

To make a renovation passport for the condominium.

This introduces an important architectural principle:

Do not perform a renovation that prevents or makes **the next renovation** unnecessarily **difficult**.

For example:

Don't replace a **façade** today in a way that makes future **external insulation** impossible.

Energy Performance Building Directive (EPBD)

Case study 2- Article 19, APE as baseline:

APE 1: Before renovation, **G**

↓

APE 2: After envelope, **E/D**

↓

APE 3: After systems, **C/B**

↓

APE 4: Deep renovation, **A**-level performance

depending on the actual design.

Again, these class outcomes should be treated as targets for the exercise, not guaranteed regulatory results.

Energy Performance Building Directive (EPBD)

Case study 2- Italian data connection:

ENEA's 2025 report found that, among the APE sample analyzed for **2023**, buildings in the **lowest-performing F** and **G** classes fell **below 50%** for the first time. ENEA also reported about 1.1 million APEs registered for 2023.

Our hypothetical building = G

then:

Real Italian building stock = large share of low-performing buildings

and finally:

EPBD Article 9 = national trajectory to improve the stock

Energy Performance Building Directive (EPBD)

Case study 3- Public school, Bologna:

1. Building brief

Location: Bologna, Emilia-Romagna

Construction: 1985

Use: public primary/secondary school

Area: 3,500 m²

Students: 450

Staff: 60

Existing:

- reinforced concrete frame
- masonry infill
- poorly insulated roof
- older windows
- gas boiler
- radiators
- fluorescent lighting
- no PV
- conventional parking
- no EV infrastructure
- bicycle parking inadequate

Energy Performance Building Directive (EPBD)

Case study 3- Public school, Bologna:

2. Existing energy model

$EP_{gl,nren}$ = 240 kWh/m²·year

Annual energy: ≈ 840,000 kWh/year



Energy Performance Building Directive (EPBD)

Case study 3- Article 8, Renovation:

Envelope	Systems	Renewable	Controls
roof insulation	heat pump	PV roof	occupancy sensors
façade insulation	low-temperature emitters		CO_2 sensors
window replacement	ventilation		daylight sensors
solar shading	heat recovery		BMS
	LED lighting		

Energy Performance Building Directive (EPBD)

Case study 3- Article 10, PV:

Suppose the roof has: 1,000 m² usable area

- available PV area
- installed kWp
- annual electricity production
- self-consumption
- export
- battery feasibility.

For example, as an exercise assumption: 400 kWp PV

Then calculate annual generation using local solar irradiation.

Annual irradiation = X kWh/kWp

and calculate:

PV production = installed kWp × specific yield

Energy Performance Building Directive (EPBD)

Case study 3- Article 13, Smart systems:

The school becomes a teaching example of **a smart building**.

Sensors: CO_2, Temperature, Occupancy, Daylight

↓

BMS (Building Management System)

↓

HVAC

↓

Lighting

↓

Shading

↓

Energy monitoring

Energy Performance Building Directive (EPBD)

Case study 3- Article 13, Smart systems:

What happens if the building is empty for three weeks in August?

A traditional building may **continue operating unnecessarily**.

A smart building can:

- reduce ventilation
- reduce cooling
- reduce lighting
- adjust temperature
- monitor faults.

Energy Performance Building Directive (EPBD)

Case study 3- Article 14, Sustainable mobility:

This is where the school becomes particularly interesting.

Suppose the site has: 40 car parking spaces

You have to design:

EV	Bicycle	Accessibility
charging points	secure bicycle parking	accessible parking
electrical infrastructure	covered bicycle spaces	pedestrian safety
load management	access routes	separation between vehicles and students.

Energy Performance Building Directive (EPBD)

Case study 3- Article 19, APE:

The school receives an APE.

Before: G/F

↓

After envelope: E/D

↓

After HVAC: C

↓

After PV + controls: A/B-type performance, depending on the final calculation.

Energy Performance Building Directive (EPBD)

Case study 3- Article 3, National Building Renovation Plan:

Now zoom out again.

If Italy has **10,000 schools requiring reno**vation, how should the government **decide** which schools to **renovate first**?

You should develop criteria:

Priority 1: Very poor energy performance

Priority 2: High energy consumption

Priority 3: High occupancy

Priority 4: Energy poverty / vulnerable communities

Priority 5: Technical feasibility

Priority 6: Cost-effectiveness

- This is much closer to what Article 3 is actually about: not merely renovating buildings, but creating **a national roadmap** based on **building-stock information**, **targets**, **measures**, **financing** and **implementation capacity**.

Energy Performance Building Directive (EPBD)

Short summary - The Directive related to Fit For 55 targets

Increase the rate of energy renovations	Increase deep renovation	Decarbonization	Leading role of the public sector
Article 9 Retrofit all non-residential buildings that are above the 16% threshold (by 2030:16% of the Worst-performing Non-residential buildings must meet the national energy-performance threshold so that the16% worst-performing of the 2020 building stock is addressed)	**Article 8** Buildings undergoing **major renovation** shall met the **minimum energy performance requirements** set in accordance with Article 5 **Article 17** Incentives and support for the National Building Renovation Plans	**Article 10** Solar Ready buildings **Article 15** No financial incentives for the installation of stand-alone boilers powered by fossil fuels	**Article 7** From 1 January 2028 all new public buildings must be zero-emission **Article 9** Retrofit all non-residential buildings that are above the 26% threshold **Article 17** Financial support to boost investments on public buildings

Energy Performance Building Directive (EPBD)

Short summary - The Directive related to Fit For 55 targets

Better building planning	Investments on energy efficiency	Fighting energy poverty	Increase of skills
Article 3 National Building Renovation Plans **Article 12** Renovation Passports **Article 19** Update of the Energy Performance Certificates **Article 22** One-stop-shops for informations on energy efficience	**Article 9** Financial incentives and support to reach energy performance minimum requirements **Article 17** Financial incentives and support for energy efficiency projects	**Article 7** Standards for dwellers internal comfort **Article 8** Buildings undergoing major renovation shall guarantee healthy internal comfort	**Article 17** Education and training to ensure a qualified workforce