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Fit for Energy Efficiency First (EE1st)?

An in-depth analysis of how to implement the EE1st principle in Germany, Hungary, and Spain

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EXECUTIVE SUMMARY

The recast of the Energy Efficiency Directive proposed by the European Commission as part of the Fit-for-55 package (July 2021) clarified in its new Article 3 that the Energy Efficiency First (EE1st) principle should apply to all planning, policy and major investment decisions related to energy systems as well as non-energy sectors that have an impact on energy consumption and energy efficiency.

Member States provided limited, if any, information in their National Energy and Climate Plans (NECPs) in 2019-2020 on what EE1st means in their national context and how they plan to operationalise it. EE1st was then a relatively new concept, and implementing it has proved to be a difficult task for Member States. Acknowledging this, the European Commission developed further guidelines for the implementation of EE1st in the energy, end-use, and finance sectors.

To support the implementation of EE1st in the Member States, this report offers a deep-dive analysis of the implementation of EE1st in three different countries: Germany, Hungary, and Spain. Under consideration are the different policy frameworks in these countries, with a focus on buildings and their energy supply (more specifically, power and district heating sectors). The main policies relevant for EE1st implementation, potential, gaps and national specificities are analysed. The policy assessment is based on the combination of literature review and semi-structured interviews.

Most of the national policies analysed were not specifically designed to meet the EE1st principle, but some have been identified as fitting EE1st. For example, the main renovation programmes in Germany include criteria or requirements that favour projects achieving higher energy performance and/or combining different types of energy efficiency actions. However, the impact of these programmes on energy supply systems are rarely explicitly considered in their rationale. Rapidly developed incentives to replace fossil fuel heating systems as a response to the current energy crisis due to the Russian war in Ukraine are another example. Although an effective and straightforward direct response to this crisis, it creates a dilemma vis-à-vis the EE1st principle, and locks-in supply systems that could be different or downsized through a holistic approach that would incorporate energy efficiency solutions.

Making EE1st a reality requires a systemic approach to policymaking, with integrated planning and investment decisions, so that supply-side and demand-side resources are considered jointly. The debate around EE1st should embrace policies that are often seen from a supply perspective. Reciprocally, the energy efficiency policies should be designed with supply-side impacts in mind, considering the energy system as a whole. Implementing EE1st is not necessarily about adopting new policies: it is firstly about ensuring that the existing policies are in line with the EE1st principle.

It is important to identify policies that work against EE1st, such as revenues for municipalities when they award gas concessions (Germany), or subsidised fuel prices (Hungary). The indicator(s) used to set the main energy requirements in building regulations or financial incentives can also bias decisions in favour of investing in supply systems rather than reducing energy demand.

The increase in the share of RES in the energy supply could represent an opportunity for more integrated energy planning, policies, and investment decisions if demand-side resources are well recognised as part of the solution. to secure that energy supply can meet a manageable demand. Another opportunity for more integration can be found in the adaptation, upgrading or development of district heating and cooling.

The implementation of EE1st also calls for careful planning to anticipate the jobs and skills needed, especially cross-cutting skills: from the capacity to combine different models (for integrated energy modelling) to the capacity to coordinate building trades (for deep renovation dealing with both building envelope and heating system).

EE1st means taking a new approach to policymaking, involving more integration across topics, and aligning policy targets and solutions to limit negative impacts (social, economic, urban planning, etc.). Planners, policymakers, professionals in other disciplines and the general public can all get multiple benefits from a successful implementation of EE1st.

INTRODUCTION

The recast of the Energy Efficiency Directive proposed by the European Commission as part of the Fit-for-55 package (July 2021) clarified in its new Article 3 that the Energy Efficiency First (EE1st) principle should apply to all planning, policy and major investment decisions related to energy systems, as well as non-energy sectors where those sectors have an impact on energy consumption and energy efficiency ([1]).

Planning practices, policies and investment frameworks should thus consider energy systems as a whole, with resources available on both sides (supply and demand), and interactions between demand and supply. This means that policies or regulatory frameworks dealing with energy supply and infrastructures should consider demand-side options as alternatives to supply-side options, thereby valuing the contributions of energy efficiency to the energy systems and, where possible, other objectives (e.g., reducing GHG emissions, improved health). And on the other side, policies and regulatory frameworks dealing with energy end-use efficiency should consider their impact beyond the demand side, as they can also have an impact on the supply side (e.g., on the investments needed).

The Energy Union has made EE1st the focus of the energy transition and has enshrined it in various pieces of legislation. The Governance Regulation of the Energy Union ((EU) 2018/1999) has defined EE1st (see Article 2(18)) and made EE1st a guiding principle for energy policies. The Governance Regulation thus set requirements ensuring that the national energy efficiency targets are now defined as part of the overall planning exercise to be reported by Member States in their National Energy and Climate Plans (NECPs).

However, the first round of NECPs (in 2019-2020) provided extremely limited information on how the various Member States understand and intend to implement the principle ([2]). The level of information is limited to:

1) referring to it as a principle that has been considered in the preparation of the NECP,
2) stressing the importance of energy efficiency policies and measures as "being the first pillar of the energy transition" or as the "key horizontal policy",
3) referring to demand-side participation in energy markets, and
4) a few countries linking energy efficiency with investment decisions or other decarbonisation measures in general (Cyprus, Ireland, Malta, Portugal).

This can be at least partly explained because EE1st was still a relatively new concept at the time Member States had to prepare their first NECPs ([3]). More generally, implementing the EE1st principle has proved to be a difficult task for Member States. Acknowledging this, the European Commission (EC 2021a) developed further guidelines for the implementation of EE1st in the energy, end-use, and finance sectors.

As a contribution to providing Member States with resources supporting the implementation of EE1st, this report offers a deep-dive analysis of the implementation of EE1st in three different countries: Germany, Hungary, and Spain. It takes a look at the different background conditions and policy frameworks in the countries, with a focus on buildings and their energy supply (more specifically, the power and district heating sectors). From this, the report analyses the main policies relevant for EE1st implementation, potential, gaps and national specificities. This policy analysis builds on previous work done in the ENEFIRST project, where

[1] For more details about the EE1st definition and background, see ENEFIRST 2020a.

[2] "[*T]hey set out limited details on the application of this principle* [EE1st principle]", highlighting that "*co-benefits and possible trade-offs between energy efficiency measures and climate adaptation remain unrecognised and untapped*". European Commission, 2020.

[3] Official definition adopted in December 2018 in the Governance Regulation, while the draft NECPs were due by Member States in January 2019, with final NECPs due by 31 December 2019.

policy approaches were analysed per main policy area (buildings, power sector, district heating) (ENEFIRST, 2021a and 2021b), and provided the groundwork for guidelines for integrated approaches (ENEFIRST, 2021c).

Table 1 presents the definitions used in this report to structure the analysis of these policy areas.

Table 1. Definitions of policy area, policy approach and policy option

Concept	Definition	Example
Policy area	A general topic addressed by public policies that are structured together to meet general policy objectives; usually this aligns with the structure of legislation.	Power market
Policy approach	How public interventions are designed and structured to address the policy area (e.g., policy framework, legislation, policy instruments).	Market rules and regulations
Policy option	Alternatives/variations that can be used to implement the policy approach, if applicable.	Ensuring access for demand-side resources to capacity markets

Previous ENEFIRST publications defined the EE1st principle (ENEFIRST, 2020a), collected international experience in the form of 16 examples (ENEFIRST, 2020b) and analysed their transferability (ENEFIRST, 2020c) to the EU policy framework as well as the main general barriers (ENEFIRST, 2020d) to a broad implementation of EE1st. In a parallel work stream, the project assessed the impacts that EE1st implementation can have on the energy system and total system costs (ENEFIRST, 2022).

1 METHODOLOGY

This policy assessment is based on the combination of literature review and semi-structured interviews.

The literature review collected 16 international best practice examples of policies operationalising EE1st. These analyses were complemented with a review of the EU legislative framework for buildings and links to the power sector. The combination of these reviews identified policy approaches relevant for the implementation of the EE1st principle in EU Member States regarding buildings and their energy supply.

Next, policy mapping was carried out for Germany, Hungary, and Spain.

This report presents our analysis of how the EE1st principle is operationalised in these countries – jurisdictions with different climates, different policy systems and priorities, and differences in terms of buildings sector composition (see Table 2).

Table 2. Selected countries

	Population (millions)	Climate	Energy mix of dwellings (2019)*	Tenure**	Governance
Germany	83m	Temperate	Oil: 20.6% Gas: 38.8% RES: 14.4% DH: 6.9% Elec.: 18.8%	50.5% owners 49.5% tenants	Federal state
Spain	46.6m	Mediterranean	Oil: 1.3% Gas: 49.2% RES: 22.6% DH: 8% Elec.: 17.6%	75.1% owners 24.9% tenants	Central state with decentralised powers, strong regions
Hungary	9.6m	Continental	Oil: 16.3% Gas: 20.4% RES: 20.3% DH: 0% Elec.: 42.6%	91.3% owners 8.7% tenants	Centralised decision making, limited local competences

*Based on Eurostat data (heating oil, natural gas, renewable energy sources other than electricity, district heating, electricity)

**Share of people living in households owning or renting their home (2020) https://ec.europa.eu/eurostat/cache/digpub/housing/bloc-1a.html

The overall analysis produced a descriptive catalogue of the major buildings policies in each country. Key policy stakeholders, both at national and local levels, were contacted to fine-tune the catalogue and discuss this policy landscape, with particular emphasis on existing or potential policy approaches suitable for implementing EE1st. Altogether, 19 stakeholders were interviewed between October and December 2021 across the three countries.

The analysis for each country and sector aimed at identifying the most important strategic and legislative documents relevant to EE1st, regardless of whether the principle is already integrated. It is important to note that we do not offer a comprehensive assessment of these pieces of legislation but focus solely on aspects relevant to EE1st. The key points of the review for each policy area are:

- rationale for integrating EE1st in this policy area,
- major national legislation for this policy area, highlighting provisions that have (or could have) a link with implementing the EE1st principle, along with the key decision frameworks and timelines at EU level,
- investment/infrastructure schemes directly related to the policy area, and
- potential gaps in legislation and policies for integrating EE1st.

The following three chapters present the analyses for each country. The final chapter summarises the main findings.

Each country chapter provides an overview of the overarching policy framework and targets related to energy, overall trends in energy consumption (with a focus on buildings) and key features of the building stock. This description is complemented with a short analysis of the governance system for energy policies. The national policy landscape is analysed in more detail, considering policies for buildings, the power sector and district heating.

2 GERMANY

2.1 Overview of the energy sector in relation to EE1st

Germany, known as an energy efficiency frontrunner, introduced ambitious legislation that led to a consideration of energy saving as the 'first fuel'. Energy efficiency, one of the pillars of Germany's energy transition (*Energiewende*), is very important for the country's economic competitiveness. Germany's long-term goals of achieving net GHG neutrality by 2045 (Federal Climate Change Act) for the entire energy system and a fully GHG-neutral electricity supply by 2050 (EEG §1) can only be met if energy demand is minimised ([4]).

Germany's three-tiered *Energiewende* approach involves regulation, financial support and information to cover the industry, transport, and buildings. Buildings are responsible for 40% of primary energy consumption and approximately 33% of CO_2 emissions. 75% of buildings in Germany were built before 1979, when the first thermal insulation ordinance came into force. To ensure that these buildings are lifted to a higher energy standard, the German government is gradually raising minimum efficiency standards and has introduced a long-term modernisation roadmap for existing buildings. This is partly due to the EU's Energy Performance of Buildings Directive (EPBD) and the country's Paris Agreement commitment to decarbonise the entire economy.

The first energy efficiency policies and programmes were introduced during the oil shocks in the 1970s. The KfW renovation programme, which started in the late 1990s and continues to this day, is the flagship policy for energy renovation of buildings (Rosenow 2013). Germany was also one of the first EU countries to provide a strategic definition of EE1st, both in its Green Paper on Energy Efficiency (2016) and National Action Plan for Energy Efficiency (NAPE).

Over time, Germany has established a broad mix of energy efficiency policies. While some measures have been promoted as good practices, instances of rejecting stricter regulations can often be traced back to strong opposition from affected stakeholders arguing against their low cost-effectiveness or pointing to alternative measures already in place, such as energy efficiency obligations (Steuwer and Hertin 2020; Weyland and Steuwer 2018).

2.1.1 General framework and targets

Germany's path to climate neutrality is mapped out in the Federal Climate Change Act. Following a ruling of the Federal Constitutional Court on 29 April 2021 ([5]), and with a view to the European climate target for 2030, the German government presented the amended Climate Protection Act on 12 May 2021, which the two federal chambers (Bundestag and Bundesrat) ratified in June 2021.

[4] On 6 April 2022, the Ministry published a draft to change the EEG and raise the intermediate target for 2030 from 65% to 80% renewable electricity supply.

[5] The decision of the Court obliges the State to take active precautions so that in future there are no disproportionate restrictions on the fundamental liberties of today's younger population.

Higher climate targets for 2030

The amended Climate Protection Act aims to lower CO_2 emissions by further 10 percentage points to an at least 65% reduction by 2030 compared to 1990 levels. This higher ambition also affect the CO_2 reduction targets for 2030 in each individual sector: energy, industry, transport, buildings, and agriculture.

The climate targets will be continuously monitored and reviewed. For the first time, starting in 2022, the Expert Panel on Climate Issues will present a report every two years on the targets, measures and trends achieved to date. If targets are not met, the German government will take immediate action. The first such report, published on 13 April 2022, noted that the buildings sector failed to meet its GHG reduction targets for 2021, nor mobility ([6]). The government will therefore have to take immediate action to step up GHG emission reductions in these sectors. Progress on the energy transition has been monitored by an independent expert committee since 2012 ([7]). These results are published in annual monitoring reports, most recently in August 2021 ([8]).

Also in effect is a GHG reduction target of at least 88% by 2040. Along the way, the law provides for specific annual reduction targets throughout the 2030s. Germany seeks to balance its GHG emissions and their reduction to achieve GHG neutrality by 2045. Further, the German government aims to achieve negative emissions by 2050, after which time the country intends to sequester more greenhouse gases in sinks than it emits.

The amended Climate Protection Act fosters intergenerational justice, as the larger share of emission reductions will need to be achieved by the current generation. The fact that the path to climate neutrality is now defined in even greater detail also provides better planning security. Milestones of the Act include:

- 2021: Cabinet decision of 12 May on the Climate Protection Act: Increased annual reduction targets per sector for the 2023-2030 period, and statutory definition of annual reduction targets for the 2031-2040 period.
- 2024: Establishment of annual reduction targets per sector for the 2031-2040 period.
- 2032 (at the latest): Establishment of annual reduction targets for the 2041-2045 period.
- 2034: Establishment of annual reduction targets per sector for the final approach to GHG neutrality (2041-2045).

Germany does not have a general target in place to phase out fossil fuels, but coal-fired power plants are due to close by 2038 ([9]) and the installation of oil-fired boilers will not be allowed from 2026 ([10]). The assumed availability of renewable power as an alternative to coal will have a knock-on effect in terms of greening electricity use in new buildings, particularly in combination with renewable energy requirements.

[6] https://expertenrat-klima.de/content/uploads/2022/04/2022-04-13_ERK_Pruefbericht-Emissionsdaten-2021-1.pdf

[7] https://www.bmwk.de/Redaktion/DE/Artikel/Energie/monitoring-prozess.html

[8] https://www.bmwk.de/Redaktion/DE/Publikationen/Energie/achter-monitoring-bericht-energie-der-zukunft.pdf?__blob=publicationFile&v=32

[9] https://www.bmu.de/en/topics/climate-adaptation/climate-protection/national-climate-policy/translate-to-english-fragenund-antworten-zum-kohleausstieg-in-deutschland

[10] The German Ministry for Economic Affairs and Climate Action announced on 23 March 2022 that, as of January 2024, every newly installed heating system must operate with at least 65% renewable energy: https://www.bmwk.de/Redaktion/DE/Publikationen/Energie/massnahmenpaket-des-bundes-zum-umgang-mit-den-hohen-energiekosten.pdf?__blob=publicationFile&v=14

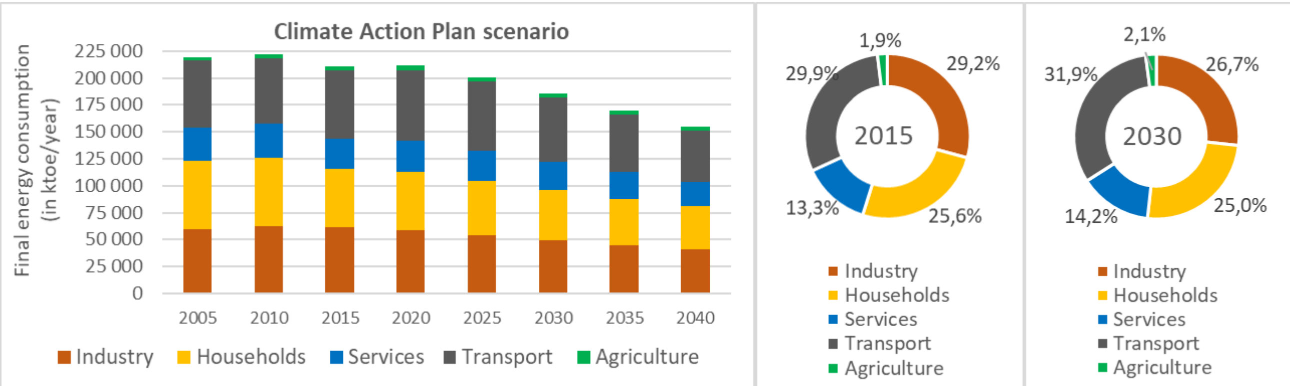
Introduction of measures in 2022 by the new government in view of the Russian war in Ukraine

In December 2021, a new German government was put in place. The coalition agreement between the Social Democratic Party (SPD), Green Party, and Free Democratic Party (FDP) includes a proposal to update existing policies on climate protection and energy efficiency in the buildings sector. With Russia's invasion of Ukraine, the new German government presented some immediate measures to be implemented as part of a 'relief package' (*Entlastungspaket*). Starting with measures to diversify supply, the package also includes measures to increase energy savings. To this end, the German government opted to increase its 'nearly zero-energy' (nZEB) requirements for new buildings, that will become the Efficiency House Level 55 as of January 2023 (the proposal was published on 2 May 2022). Also, every newly installed heating system must operate with at least 65% renewable energy from January 2024. In addition, the government has reaffirmed its commitment to renovate the worst-performing buildings first and to introduce municipal heat planning throughout the country.

In the meantime, a large part of the package consists of bonuses to compensate for higher energy prices (an increased commuter allowance, a reduced fuel tax, and a couple of one-time payments to especially benefit low-income households). Also, the Renewable Energy Law surcharge (*EEG-Umlage*) was abandoned from July 2022 to make electricity less expensive.

2.1.2 Overall perspective on energy and buildings

Households and services represented about 39% of Germany's total final energy consumption in 2015 (25.6% and 13.3%, respectively). The Climate Action Plan scenario expects these shares to remain the same to 2030, but with a 12% reduction in total final energy consumption in 2030 compared with 2015. The households sector is expected to account for about 30% of this reduction, with a further 7% reduction coming from the services sector.

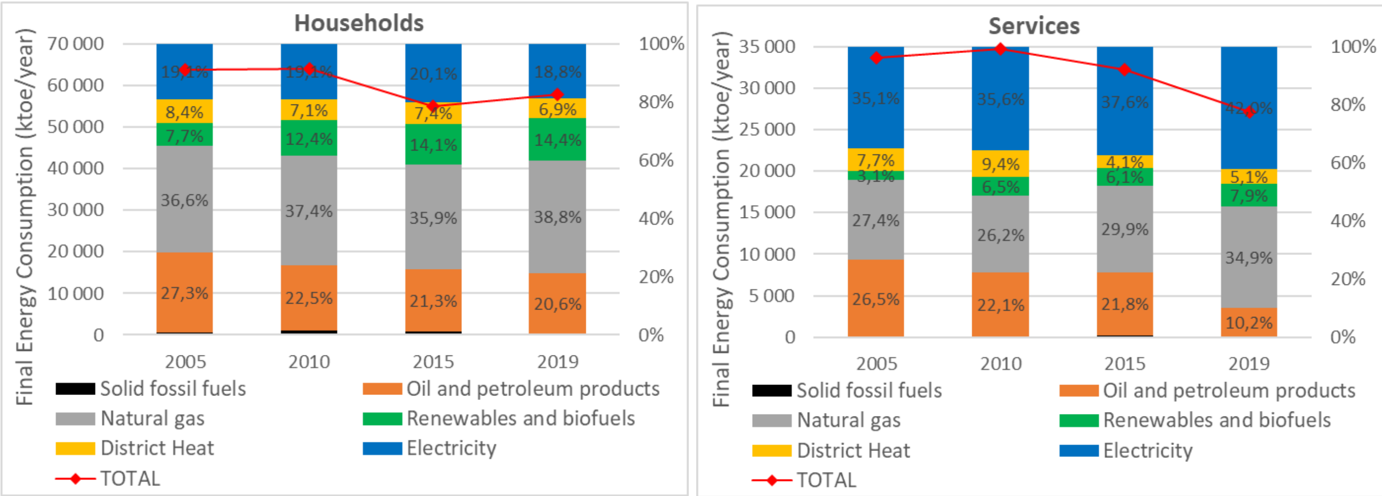


Source: Own graphs from data of Germany's NECP (Table C2.4.2). Statistics for 2005 to 2015 are from Eurostat, while results for 2020 to 2040 are modelled data for the scenario.

Figure 1. Final energy consumption per sector (*ktoe/year*) in Germany's Climate Action Plan scenario

Natural gas has remained the main energy source in households (about 39% in 2019) over the past 15 years, while the main energy source in services is electricity (42% in 2019). The decreased share of oil products is greater in services (from 26.5% to 10.2%) than in households (from 27.3% to 20.6%).

In 2019, direct use of fossil fuels still represented 60% of final energy consumption in households (not considering fossil fuels used for electricity supply or district heating).



Source: Eurostat (energy balances)

Figure 2. Germany's final energy consumption from 2005 to 2019 (*ktoe/year*) in households (*left*) and services (*right*), per energy source (%)

While it was expected that the share of RES in gross electricity consumption would be higher than 40% in 2020, the share of RES in final energy consumption for heating and cooling was just 15%. Significant increases in the share of RES are planned for each of the next two decades. Reduced final energy consumption, more specifically in the consumption of fossil fuels, will also contribute to growing these shares.

Table 3. Evolution of the RES share in gross electricity consumption and final energy consumption for heating and cooling in Germany's Climate Action Plan scenario

RES share (%)	2005	2010	2015	2020	2025	2030	2035	2040
– in gross electricity consumption	10.6%	18.3%	30.9%	41.5%	51.4%	62.7%	73.4%	85.7%
– in final energy consumption for heating and cooling	7.7%	12.1%	13.4%	15.1%	19.4%	23.9%	33.8%	46.8%

Source: Germany's NECP (Table C2.7.1)

2.1.3 Overview of the building stock

The German building stock is described in Germany's Long-Term Renovation Strategy (LTRS). The main building stock metrics are provided below using data from several sources, including Hotmaps ([11,]) and, Episcope ([12]), distinguishing residential and non-residential buildings.

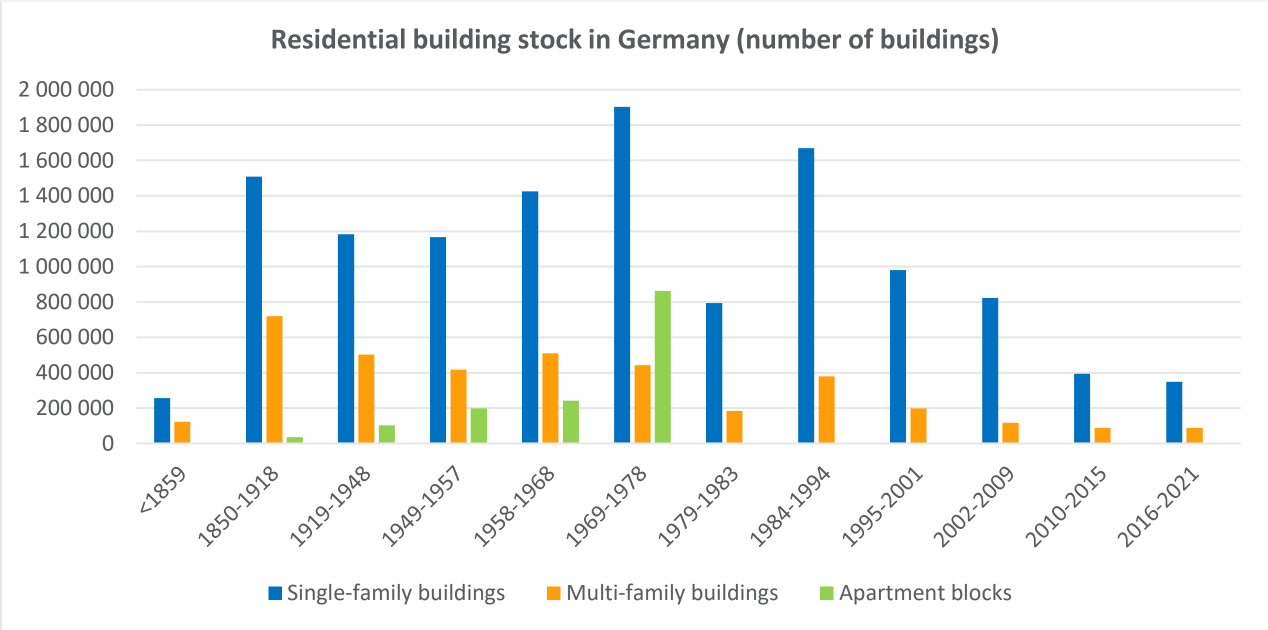
Residential buildings

Germany has a total useful residential floor area of 3.395 million m^2. The building stock features a predominance of single-family buildings (61.7% of useful floor area and 70% of the number of buildings). Multi-family buildings account for 28.7% of residential useful floor area, while apartment blocks account for the remaining 10.2%. Nearly half (47.5%) of buildings in Germany are at least 65 years old.

[11] https://www.hotmaps-project.eu/; https://gitlab.com/hotmaps/building-stock/-/blob/master/data/building_stock.xlsx

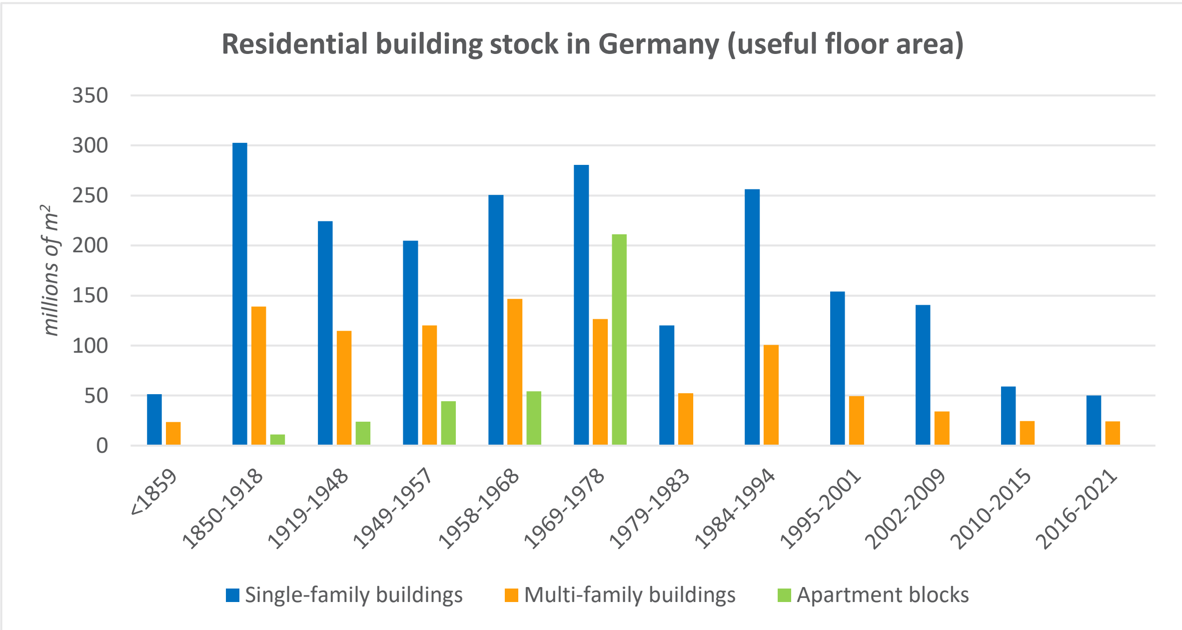
[12] https://episcope.eu/building-typology/

Figure 3 and Figure 4 ([13]) offer a breakdown of the number of residential buildings and useful floor area over time.



Source: Hotmaps

Figure 3. Total number of residential buildings in Germany per building type and construction period

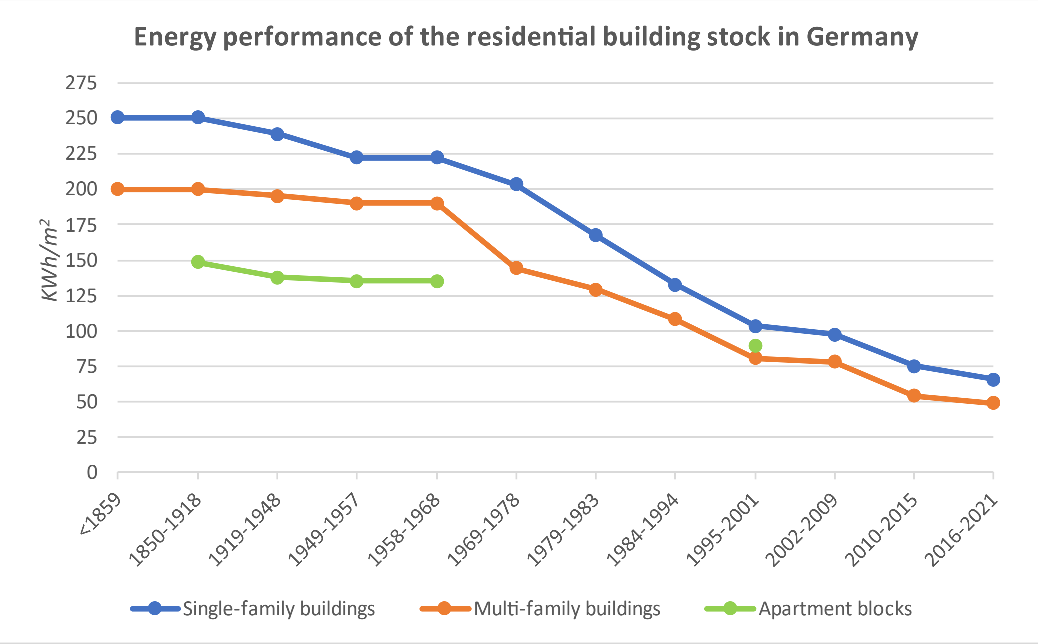


Source: Hotmaps

Figure 4. Total useful floor area (*m^2 millions*) of residential buildings in Germany per building type and construction period

[13] The graphed data for apartment blocks correspond to the entire 1969-2021 period, as the source classifies this type of building by making use of fewer construction period categories.

Figure 5 provides values of energy demand for heating (kWh/m²) for different segments ([14]) of residential buildings.



Source: Hotmaps

Figure 5. Energy performance of residential buildings in Germany, per type and construction period, as useful energy demand for heating (*kWh/m²*)

Heating demand has progressively decreased in all residential building types since the late 1960s. The decrease has been particularly steep since the oil crisis of 1973, which sparked implementation of the first policies to address energy efficiency in buildings. Overall, average energy demand for heating single-family buildings built after 2010 is roughly a quarter less than those built before 1969, and one-third less for multi-family buildings.

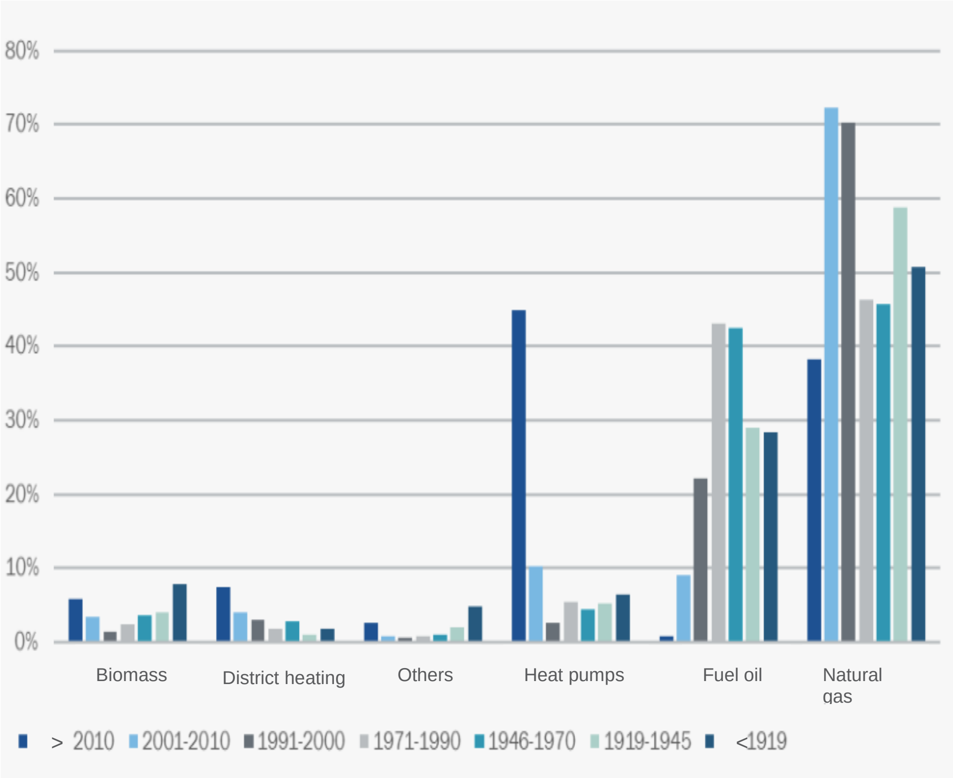
Figure 6 and Figure 7 show the percentage of consumption per energy source for single/two-family buildings and apartment buildings, respectively. Natural gas is the most prevalent source for every building stock segment in both single/two-family houses and apartment blocks (ranging roughly from 40% to 70%): the exception is about houses built after 2010, where heat pumps are the most common system (45%). District heating is used in 0-5% of buildings constructed before 2010, and in 8% of single/two-family houses built afterwards. District heating is used in 15-25% of apartment blocks, except in the most modern ones (built from 2010), for which the share rises to 35%.

Fuel oil is between two and three times more common in single/two-family houses than in apartment blocks, and most common in buildings built between 1971 and 1990 (43% in houses and 18% in blocks). The share plummets to almost zero in buildings constructed after 2010.

Biomass shares in single/two-family buildings are between 3% and 8%. The biomass share for apartment blocks is around 10% for buildings built after 2010 but almost non-existent for earlier stock. The presence of heat pumps is similar to that of biomass, except in buildings constructed after 2010, where.heat pumps account for 45% of heating systems in single/two-family houses and up to 12% in apartment blocks, making them slightly more widespread than biomass-powered systems. Other heating systems are rare in

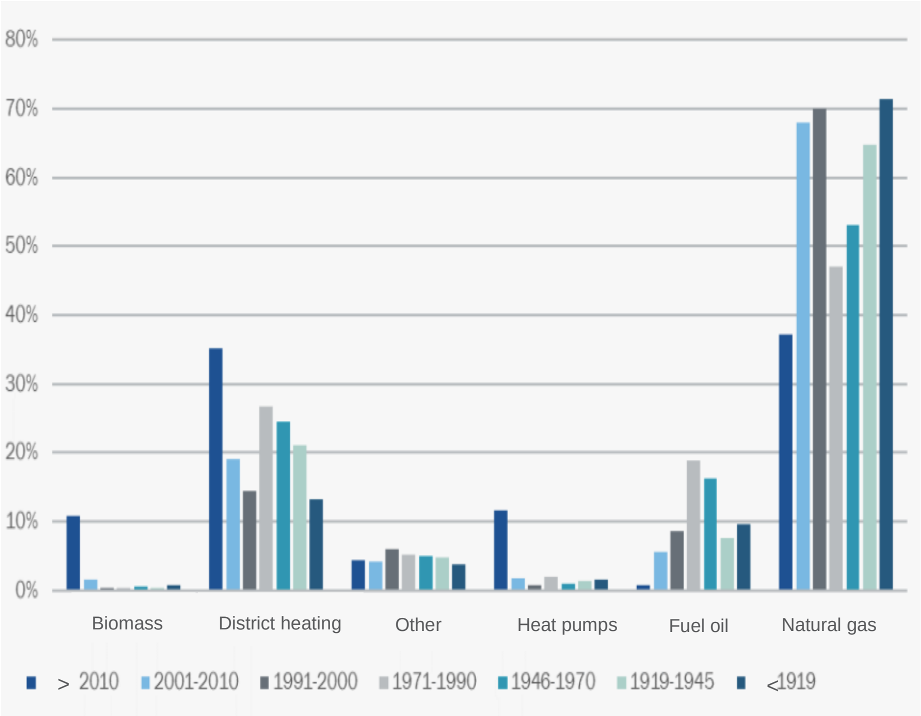
[14] The last segment of apartment blocks covers a single period ranging from 1969 to 2021 and is represented in the middle portion of the horizontal axis.

single/double-family houses, with a share of around 5% in the oldest segment and approximately 1-3% elsewhere. The presence of other systems is slightly higher in apartment blocks (4-7%).



Source: German LTRS

Figure 6. Principal energy sources in single/two-family houses in Germany

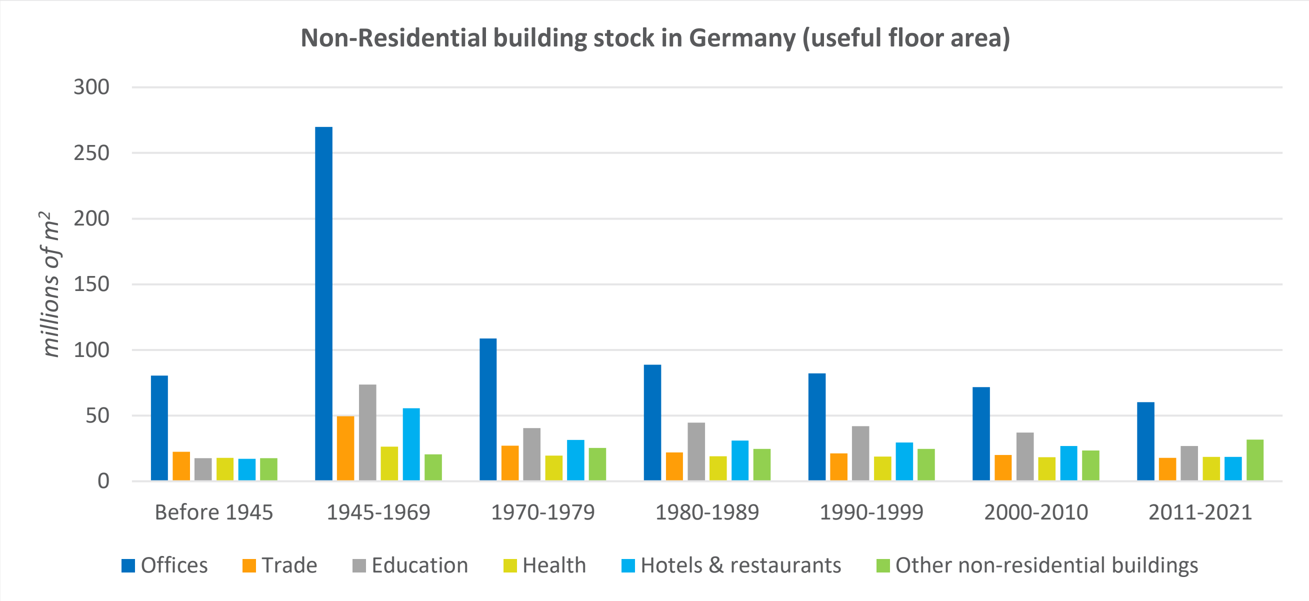


Source: German LTRS

Figure 7. Principal energy sources in apartment blocks in Germany

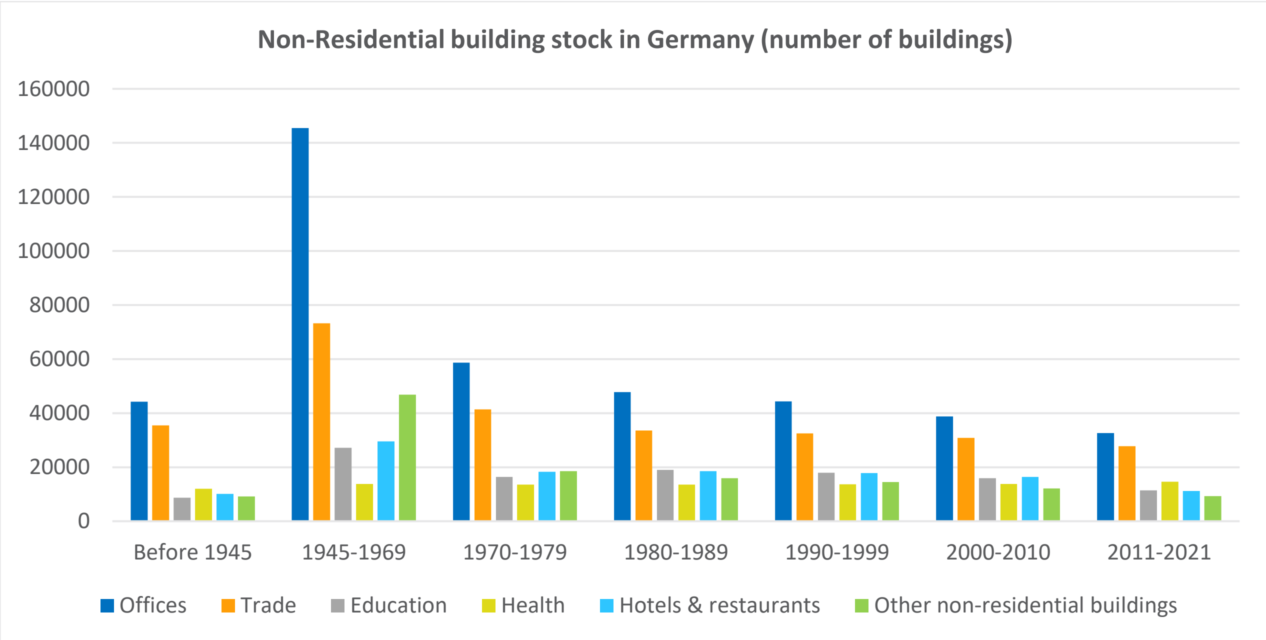
2.1.3.1 Non-residential buildings

Shares of Germany's non-residential building stock in terms of number of buildings and useful area (m^2 millions) are presented in Figure 8 and Figure 9. Office buildings represent 43.8% of total useful area, followed by educational buildings with 16.2% (Figure 8). The remaining shares of useful area of total building stock are spread quite evenly across other categories. Most non-residential buildings were built between 1945 and 1969 (Figure 9).



Source: Hotmaps

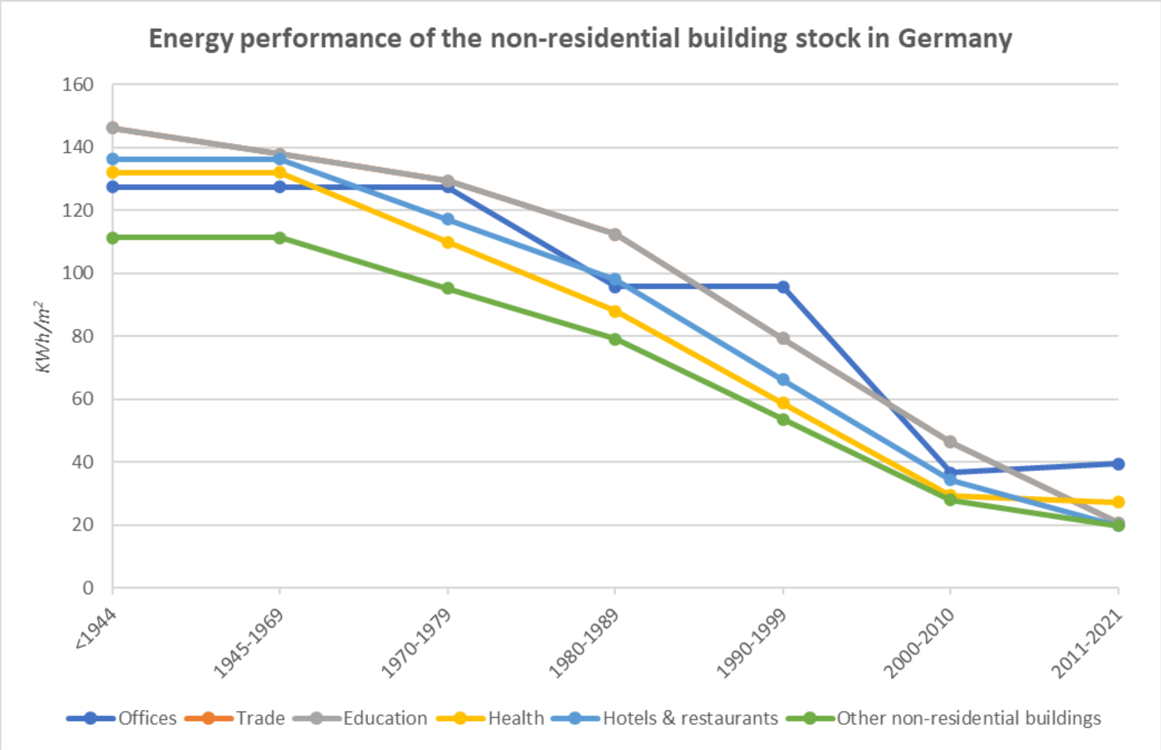
Figure 8. Total useful floor area (m^2 *millions*) of non-residential buildings in Germany, per use



Source: Hotmaps

Figure 9. Total number of non-residential buildings in Germany, per use

Regarding energy performance (kWh/m^2), Figure 10 provides a breakdown of different construction periods and uses [15].



Source: Hotmaps

Figure 10. Energy performance of non-residential buildings in Germany, per use and construction period, as useful energy demand for heating (*kWh/m^2*)

The graph shows a progressive and significant reduction in heating demand across all types, moving from 110-150 kWh/m^2 for the oldest buildings to 20-40 kWh/m^2 in buildings constructed more recently. The trend follows a more staggered and abrupt pattern for office buildings but is particularly remarkable from the 1990s to the 2000s, during which time average heating demand fell by around 60% (from 96 to 37 kWh/m^2).

2.2 Governance system and interplay of institutions

Climate protection is traditional domain for several Federal Ministries in Germany, with the Ministry for Economic Affairs and the Environmental Ministry [16] assuming most of the responsibility in past years. Other ministries are now involved, however, in sectoral climate protection policy, and this is especially true for the buildings sector. In the past, buildings policy traditionally had a ministry of its own, sometimes in conjunction with traffic policy (2005-2009, 2009-2013), but these areas were integrated into the Environmental Ministry (2013-2017) and then transferred to the Federal Ministry of Internal Affairs (2017-2021). With the election of a new government in 2021, the buildings units have been split: there is a newly founded Federal Ministry for Housing, Urban Development and Building, but all energy and climate protection-related tasks have been transferred to the Ministry of Economic Affairs and Climate Protection. While this allows the bundling of climate protection measures – and possibly a better integration of the single parts of the energy system,

[15] Buildings in the education and health categories have the same performance values according to the data consulted: they overlap in the graph.

[16] The official titles of departments often change with a new legislative period.

including buildings – it also separates policies for housing, including aspects related to 'just transition' and urban planning.

Germany's Länder (Federal States) and their municipalities are tasked with heat planning and urban planning, including the approval processes for construction work. Each of the German Länder has its own building code (*Bauordnung*), which has significant implications for construction and renovation projects carried out in Germany.

Apart from the Federal Ministries and the Länder/municipalities, there are separate higher governmental authorities that play a role in the governance system of climate and energy policy. The Federal Network Agency (*Bundesnetzagentur*), among others, implements parts of Germany's Energy Law (EnWG) and its respective ordinances. Since 2011, the Agency has taken on additional duties related to the Network Development Plan to ensure accelerated implementation and expansion of the 'extra high-voltage' (EHV) domain via planning and approval procedures. The Agency thus facilitates the expansion of supply infrastructure.

Similarly, the Federal Office for Economic Affairs and Export Control (BAFA) with its Federal Agency for Energy Efficiency (BfEE) is the authority acting on behalf of the Economic Ministry. The BAFA is, among others, partly responsible for governing the grant schemes for energy efficiency solutions, including on combined heat and power, heat supply networks and heat storage systems. It is also involved in the buildings sector. Germany's KfW Development Bank (KfW) oversees other aspects of German support schemes for efficient buildings (new constructions, renovation).

The German Environment Agency (UBA) provides support to external experts for internal evaluations and commission studies. Also, the UBA is responsible for Germany's greenhouse gas emissions inventory. While the UBA has traditionally been an agency of the Environmental Ministry, the Ministry for Economic Affairs now has partial oversight and authority as well.

The Federal Institute for Research on Buildings, Urban Affairs, and Spatial Development belongs to the portfolio of the Federal Ministry for Housing, Urban Development and Building. It provides expertise and advice (studies, data, reports to the Ministry). The subordinate Federal Office for Buildings and Regional Planning (BBSR) conducts research on a wide range of buildings-related topics.

Policymaking in the field of climate and energy is supported by various other institutions. The most important is the German Energy Agency (dena). Through its *Leitstudie*, dena provides transition pathways and concrete recommendations for policymaking and implementation of the energy transition in Germany. The Agency is known for its recommendation to expand natural gas as a heating fuel to bridge the way to a fossil-fuel energy supply in Germany. At the same time, dena has traditionally supported (and still supports) energy efficiency, looking at it explicitly from an EE1st perspective.

Several strategic documents and processes recognise EE1st as a core principle. The Energy Efficiency Strategy for Buildings from 2015 prepared the introduction of the EE1st principle into Germany's governance structure. The Strategy combined the three aspects of electricity, heat, and energy efficiency to create a clear policy framework for the energy transition in the buildings sector, while a corridor analysis explored different supply and demand options to achieve then-existing climate targets. A study commissioned by the Federal Ministry for Economic Affairs and Energy ([17]) puts the German Energy Efficiency Strategy for Buildings in a

[17] https://www.bmwk.de/Redaktion/DE/Publikationen/Studien/gesamtwirtschaftliche-einordnung-esg.html

wider economic context and concludes that an even greater focus should be placed on energy efficiency improvements.

In parallel to commissioning the study, a Green Paper on Energy Efficiency was launched by the Ministry for Economic Affairs and Energy as a main document to consult with interested stakeholders on the strategic importance of EE1st and its operationalisation. One of the main ideas was to anchor the principle to an Energy Efficiency Law ([18]). A strategy was adopted instead. The Energy Efficiency Strategy 2050, adopted in 2019, confirmed EE1st as a core principle guiding strategic investments in energy policymaking – a feature it shares with other documents, such as Germany's Long-Term Renovation Strategy (LTRS). The other strategies, however, did not take the next steps to operationalise the principle. The Energy Efficiency Strategy 2050 did so by launching the Roadmap Energy Efficiency 2045 process. Specifically, the Roadmap is the German government's scientifically supported dialog format for driving progress towards energy efficiency and is regarded as a central building block of the German Energy Efficiency Strategy. This is what the Roadmap process is all about: representatives from science, industry and civil society are to develop strategies, instruments and measures to increase energy efficiency in Germany. To ensure that the Roadmap really does take all the important issues into account, its foundations are being developed in three sector-specific working groups (buildings, industry, transport) and three cross-sectoral working groups (digitisation, skilled workers and qualifications, system issues). The focus is on medium-term instruments to 2030 and long-term strategies to 2045.

To sum up, Germany has produced several strategic documents over the years to establish and reaffirm EE1st as a core principle for energy policymaking in Germany, but operationalisation remains the missing key. While there is definite support for EE1st, the governance structure does not allow for its pragmatic implementation. Germany's energy and climate governance system is not only multi-level and highly complex, it also contains a plethora of organisations that design and implement policies horizontally: when it comes to energy policy discussions on supply-side and demand-side options, the supply-side tends to carry greater weight ([19]).

2.3 Policy landscape for EE1st in buildings

Germany has established a set of measures and programmes, including an update of the existing regulation, to achieve its target of a **climate-neutral building stock by 2045**.

The new **Buildings Energy Act (GEG)** came into force in 2020, bringing together the previous Energy Savings Regulation (EnEV) and the Renewable Energy Heat Act (EEWärmeG). The GEG sets requirements for the energy performance of buildings, the issuing and application of Energy Performance Certificates (EPCs), and the use of renewable energy in buildings. It also regulates the energy requirements for new and existing buildings and the use of renewable energies in buildings, and thus implements the EPBD in Germany.

[18] The idea was not adopted or discussed further until 2022, when the conservative-green-liberal government announced the launch an Energy Efficiency Law as part of measures. The Russian war in Ukraine was also a factor.

[19] This was strongly reaffirmed in the national workshop as part of the ENEFIRST project.

As decided in the Climate Action Programme 2030, funding conditions for existing programmes were improved and combined into the new **Federal Funding for Efficient Buildings (BEG)** programme, introduced in 2020, which consists of several modules from former funding programmes:

- BEG Residential Buildings – the former KfW programme for energy-efficient construction and renovation
- BEG Non-residential Buildings – the former KfW programme for energy-efficient refurbishment of non-residential buildings
- BEG Individual Measures ([20]) BAFA – the former KfW market incentive programme for renewable energies, including the Energy Efficiency Incentive Programme (APEE).

The BEG programme has been temporarily put on hold and is undergoing a recast. From 21 April 2022, support for new buildings will only be granted for the highest efficiency standard (Efficiency House 40) if it also meets sustainability criteria ([21]).

As an alternative to the BEG programmes, tax incentives for the energy-efficient renovation of residential buildings were also introduced from 2020. The Coronavirus Tax Assistance Act of June 2020 included increased funding for building refurbishment, which made it possible for the German government to increase funds distributed through the BEG mechanism.

These initiatives are consistent with the idea of EE1st even though specifications and implementation instructions to guide and facilitate its application are still missing.

2.3.1 Overview of policies relevant to EE1st

2.3.1.1 Buildings Energy Act (GEG)

The Buildings Energy Act (GEG) is the main legislative pillar for buildings efficiency in Germany. It entered into force in 2020, replacing the Energy Conservation Act (*Energieeinsparungsgesetz,* EnEG), the Energy Saving Ordinance (*Energieeinsparverordnung,* EnEV) and the Act on the Promotion of Renewable Energies in the Heat Sector (EEWärmeG). It creates a uniform, coordinated body of legislation to regulate energy performance requirements for new construction, existing buildings, and the use of renewable energy for heating and cooling buildings.

The Buildings Energy Act implements the Coalition Agreement (i.e., decisions reached at the 2018 housing summit) and the measures set out in the Climate Action Programme 2030 regarding energy conservation legislation for buildings. Like previous energy conservation legislation for buildings, the new Buildings Energy Act establishes requirements for the energy performance of buildings, the issuing and use of EPCs, and the use of renewable energy in buildings.

It also implements European requirements regarding the energy performance of buildings and integrates the regulations governing nearly zero-energy buildings (nZEBs) into standardised energy conservation legislation. It does not increase current energy performance requirements for new construction and renovation and is unlikely to lead to further increases in construction and living costs. The German government announced in the Coalition Agreement to increase the minimum energy performance

[20] https://www.bdh-industrie.de/en/service/funding

[21] https://www.kfw.de/inlandsfoerderung/Bundesf%C3%B6rderung-f%C3%BCr-effiziente-Geb%C3%A4ude/

requirements for new buildings equal to the Efficiency House 40 standard as of 2025 ([22]). In view of the Russian war in Ukraine, the German Ministry for Economic Affairs and Climate Action announced an update of nZEB requirements so that they equal the Efficiency House 55 standard from 1 January 2023 ([23]). A proposal to implement the new standard for new buildings was published on 2 May 2022 and should soon come into effect.

In line with the Climate Action Programme 2030, the Buildings Energy Act includes a clause on the review of energy performance requirements for new construction and building stock as of 2023. There are some features worth noting:

- The Buildings Energy Act introduces a new equivalent procedure for demonstrating compliance with energy performance requirements in the construction of residential buildings (the 'reference house' procedure for residential buildings).
- The obligation to use renewable energy in new construction can in future be met by using electricity generated on-site from renewable energy.
- The options for meeting energy standards in new construction have also been made more flexible. This particularly applies to the option of counting electricity generated on-site from renewable energy, and also from gaseous biomass, towards a building's energy balance.
- The primary energy factors to be used in calculating valid annual primary energy requirements are now laid out directly in the Buildings Energy Act. This improves the transparency and comprehensibility of primary energy factors for construction clients and owners.
- The Buildings Energy Act also introduces a short-term innovation clause.

This allows for two alternative implementation options. First, until the end of 2023 it will be possible to apply for a waiver from the relevant authority, thus enabling certification of the requirements set out in the GEG. These requirements are currently based on the main criterion of 'valid annual primary energy demand' and use a system that focuses on limiting GHG emission in addition to the main criterion, provided that the requirements are equivalent.

Second, where alterations are carried out on existing buildings, until the end of 2025 it will be possible for requirements to be met jointly by several buildings within the same neighbourhood. This and the opportunity to reach agreements on shared heat provision in the neighbourhood aim to foster neighbourhood-based strategies, while at the same time presenting new ideas for innovative approaches to energy efficient construction, as fostered by the Buildings Energy Act.

Another new feature is that CO_2 emissions resulting from primary energy demand or primary energy consumption of a building must be displayed on EPCs (starting in May 2021). This added information reflects the climate impact of energy use.

The Climate Action Programme 2030 also sets out the requirement for buyers or owners to undergo an obligatory energy consultation when single-dwelling or two-dwelling buildings are sold or will undergo major renovation. This obligation is independent from the release of an EPC and applies to all buildings, provided it is free of charge.

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[22] https://www.spd.de/fileadmin/Dokumente/Koalitionsvertrag/Koalitionsvertrag_2021-2025.pdf

[23] https://www.bmwk.de/Redaktion/DE/Publikationen/Energie/massnahmenpaket-des-bundes-zum-umgang-mit-den-hohen-energiekosten.pdf?__blob=publicationFile&v=14

The Buildings Energy Act also introduces a compliance statement (*Erfüllungserklärung*), which is required for new buildings and certain major renovations of the housing stock.

The GEG does not have any specific measure that implements the EE1st principle by way of comparing supply and demand options. However, in the interviews conducted, government officials agreed that if energy efficiency measures are properly assessed against a heating change or upgrade, the efficiency measures will be implemented first in most cases.

2.3.1.2 Federal Funding for Efficient Buildings (BEG)

The federal funding scheme for efficient buildings has undergone some major changes in recent years. An important step was the bundling of three sub-programmes under the BEG (*Bundesförderung für effiziente Gebäude*), governed by BAFA and the KfW: Federal Funding for Efficient Buildings – Residential Buildings (BEG WG) (*in German only*), Federal Funding for Efficient Buildings – Non-residential Buildings (BEG NWG) (*in German only*) and Federal Funding for Efficient Buildings – Individual Measures (BEG EM) (*in German only*). The BEG EM was launched by the Federal Office for Economic Affairs and Export Control (BAFA) on 1 January 2021. 'Individual measures' are those measures which do not lead to the Efficiency House (*EffizienzHaus*) standard being achieved for the entire building. For example, those wishing to replace their old, draughty doors and windows or to insulate their building façade and roof can apply for funding of 20%.

An important point for companies to note is that the three sub-programmes of the new federal funding programme do not fall under the category of 'aid' under the EU rules on state aid.

One application for multiple measures

By bundling the previous funding programmes into one, the funding programme has been modernised and made clearer. The application process has also become simpler. Since the start of 2021, homeowners have been able to apply for funding for multiple measures with a single application, and the level of funding they receive is higher as well. This increased rate of funding can be received, for example, for new buildings that are notably sustainable. The new funding programme therefore introduces a new class of building: the Efficient House RE. To be classed as such, at least 55% of the building's heating and cooling supply must be based on renewable energy: otherwise, the building needs to have sustainability certification that is recognised by the Federal government.

In future, anyone who wants to have their building project professionally planned and to receive support right through the construction process can receive funding under the Federal Funding for Efficient Buildings programme using the same application. According to the BAFA, applicants will also be able to view the processing status of their documents online.

Applications for funding within all three sub-programmes must be submitted to the BAFA before any measures are started. Building owners undertaking projects can consult energy efficiency experts to help them decide which measures to implement. Related costs are 80% funded through the Energy Advice for Residential Buildings (EBW) and Energy Advice for Non-Residential Buildings, Plants and Systems (EBN) programmes.

This support scheme has become very popular beyond Germany and is promoted as good practice. It has also provided several billions of euros each year to help reduce energy demand of the building stock. Roughly 85% of the budget is used to support efficient new buildings, while the remaining 15% goes to buildings renovation.

When the programme was put on hold in January 2022, many stakeholders – especially homeowners – complained about the ad hoc nature of the decision. The government responded by temporarily topping up the budget to secure financing for already planned projects. An adjusted support scheme with new rules entered into force on 21 April 2022 and will last until the end of the year before being replaced with an entirely overhauled scheme. The current scheme does manage to provide continuous support for renovation of existing buildings, but new buildings are supported only if they fulfil the EH 40 or EH 40 Plus standard and obtain a sustainability certificate ([24]).

2.3.1.3 Tax incentives for energy-related building renovations

In January 2020, after years of failed attempts, Germany succeeded in providing homeowners with tax incentives for energy efficient renovations, allowing them a 20% tax break on costs for renovations of up to EUR 40 000. Renovations eligible for support include insulation measures, fitting new windows and exterior doors, replacing or optimising old heating and ventilation systems, and installing digital energy management systems. Industry representatives welcomed the tax incentives as "very good news" and a "giant leap" for climate action in the buildings sector but were dismayed that the measures only cover owner-occupied homes. This rules out rented dwellings and means that less than half of Germany's approximately 42 million homes are eligible for support. A study by the German Alliance for Energy Efficiency in Buildings (geea) projects that the approved measures could save up to 3.4 million tonnes of CO_2 equivalent by 2030.

It remains to be seen if these tax incentives will result in higher savings and facilitate the implementation of the EE1st principle. The programme does not require a building owner to compare different possible options to improve the energy performance of their building or to complete an energy consultation/audit before applying for the tax incentive. For example, linking tax incentives to the delivery of a building renovation passport (*Individueller Sanierungsfahrplan*) to assess the ambition of measures adopted against the 'best possible principle' ([25]) and their alignment with national targets could incentivise maximised installation of energy efficiency measures. Another option would be to link the incentives to eligibility criteria, including high energy performance requirements (i.e., higher than regulation).

2.3.1.4 National emissions trading scheme on heating and transport fuels (Brennstoffemissionshandelsgesetz)

In 2019 ([26]), after long public debate, the German government introduced a carbon price in the form of a separate national emissions trading scheme (ETS) to implement the Climate Action Programme 2030. The national ETS (emissions trading system) complements the EU ETS in Germany's non-ETS sectors of buildings and transport as an upstream system that obligates suppliers and distributors bringing fossil fuels to the market to hold emissions allowances. To avoid double counting, fossil fuels burnt in a plant covered by the EU ETS are excluded from the national scheme. A fixed CO_2 price is set for transport (petrol, diesel) and heating fuels (heating oil, LPG, natural gas) from 2021 (EUR 25/tCO_2) until 2025 (EUR 55/tCO_2), which makes the system prone to criticism as it only unfolds the benefits of an expectedly higher market price in 2027. To phase-in the formation of a market-based price there will be a price corridor in 2026 of EUR 55-

[24] https://www.kfw.de/inlandsfoerderung/Bundesf%C3%B6rderung-f%C3%BCr-effiziente-Geb%C3%A4ude/

[25] In Germany, the building renovation passport (iSFP) introduced the concept of 'best possible principle', according to which auditors must recommend the most ambitious standards and options for each component of a particular building. If this is not possible, the auditor must explain any deviation from the best possible standard.

[26] The national law *Brennstoffemissionshandelsgesetz* (BEHG) was adopted in December 2019 and amended in November 2020 to increase the certificate price for each year (starting at EUR 25 instead of EUR 10 in the beginning and ending at EUR 60 instead of EUR 55 in 2025).

65/tCO_2. Experts still doubt the legal compliance of the system due to the fixed price in the first five years and its resemblance to a carbon tax (Matthes 2020).

Applying a CO_2 price is a way to internalise one impact (GHG emissions and climate change). This is in line with EE1st, especially when a broader scope of cost-benefit analysis is used: this means that the CO_2 is factored into energy prices, which in turn sends a price signal to consumers. German carbon pricing in buildings and transport is presented in Germany's NECP as the measure that would bring the largest share of final energy savings (713 PJ out of 3996 PJ) ([27]) and meet the target set according to EED Article 7. However, there are doubts that the German national ETS, with a starting price of EUR 25 will trigger any change in investment patterns in the buildings sector. The expected (small) price increases for natural gas/kWh and heating oil are shown in Table 1. Example calculations show a cost increase of EUR 120 per year in 2021 and EUR 264 per year in 2025 for an old, single-family house with heating energy consumption of 20 000 kWh/year with a gas boiler (202g CO_2/kWh), or EUR 158 per year in 2021 and EUR 348 per year in 2025 for an oil boiler (266g CO_2/kWh) (BPIE 2021).

Table 4: Increase in fuel costs from 2021 to 2025 in the buildings and transport sectors due to the carbon price in Germany

	Unit	2021	2022	2023	2024	2025
Natural gas	kWh	0.5 cent	0.5 cent	0.6 cent	0.8 cent	1.0 cent
Heating oil	l	7 cent	8 cent	10 cent	12 cent	15 cent
Petrol	l	6 cent	7 cent	8 cent	11 cent	13 cent
Diesel	l	7 cent	8 cent	10 cent	12 cent	15 cent

Source: BPIE

2.3.2 National specificities that might influence the implementation of EE1st

The mandate to work on buildings efficiency has moved regularly between different governmental departments. A change in leadership – and narratives – has sometimes led to greater ambitions and the introduction of new measures. At the same time, it has also hindered the consistent implementation of strategies to decarbonise buildings and make them more efficient. As analysed in ENEFIRST, EE1st requires the coordination of various areas of policymaking to break up policymaking silos. In Germany, due to strong additional requirements to establish coordination between Federal and Länder levels, the implementation of EE1st is a difficult challenge.

There are, however, some overarching strategies that are well placed to make things easier, and Germany was one of the first countries to publicly consult on the principle. Also, Germany has a long-standing tradition of support to energy efficiency of buildings, most notably through its widely known KfW programmes, which more recently have been subsumed under the BEG. These support programmes have been in place since the 1990s and have been successively refined to promote higher energy performance. The Efficiency House standard is well-established and provides a strong basis for the design of performance-based incentives – and by design it has helped steer the building envelope towards becoming an EE1st approach. Evaluations of the programme show three distinct developments: First, there has been a shift over time between the

[27] Expected cumulative energy savings from the Federal Funding for Efficient Buildings (BEG) programme are estimated at 305 PJ. Expected cumulative energy savings from the Building Energy Act are estimated at 573 PJ.

choice of efficiency level that gives an indication of more ambitious efficiency levels becoming gradually more cost-effective. Second, much more of the budget has been allocated to constructing efficient new buildings, compared to renovating the building stock. Third, single measures are preferred over one-step renovations to improve an efficiency level.

Scheme impacts could change in future, as it will be completely overhauled and adjusted to current targets. It is likely that Efficiency House solutions will focus more on the supply side. At the same time, the need for sustainable building materials could weaken implementation of the EE1st principle.

While there has been strong development of a market for energy advisors, including quality requirements for professionals, there is a considerable shortage of skilled workers to deliver a higher rate of deep renovations. Competition for workers with the new-build construction industry exacerbates the problem for the renovation segment.

Due to the high amount of renting in Germany and the nearly 60% of Germans who live in multi-family buildings, the split-incentive dilemma is rather tricky. This makes a strong case for stricter regulation due to the comparative lesser significance of other benefits that may appeal to owners of occupied buildings, such as gains in comfort.

2.3.3 Current situation with implementing EE1st

While there is a trend to make new buildings climate proof and put greater focus on the renovation of existing buildings compared to the new-build segment, there is also a tendency in Germany to decarbonise the buildings sector through the decarbonisation of supply. There is a growing trend in the country to renovate the building stock to a ‘heat-pump ready’ level instead of reducing energy demand as much as possible. Underlining this trend are the hydrogen agenda, a current emphasis on the new ETS (which directly supports a fuel switch but indirectly incentivises energy savings), and work in progress to change the calculation fundamentals from primary energy savings to carbon savings. There are nonetheless several recent examples that demonstrate Germany’s commitment to decarbonise the buildings sector, both from the supply side and the demand side (such as a willingness to implement mandatory minimum energy performance requirements for the existing buildings stock).

Interviews with German stakeholders reveal that the EE1st principle remains an expert-driven topic. Despite all attempts to integrate policymaking for various purposes (environmental policy integration, sector coupling, EE1st implementation), policymaking remains sector-specific. Calculating costs and benefits happens rather comprehensively at an aggregated level through modelling exercises, attesting to the high value of energy efficiency (see the Energy Efficiency in Buildings Strategy, ESG). However, when it comes to implementing EE1st in specific sectors, calculating costs and benefits typically remains within traditional paradigms, with short payback times, while lacking any integration of external costs such as CO_2 emissions. Other existing provisions that hamper EE1st implementation include certain tax exemptions and the abandonment of the renewables surcharge on electricity prices.

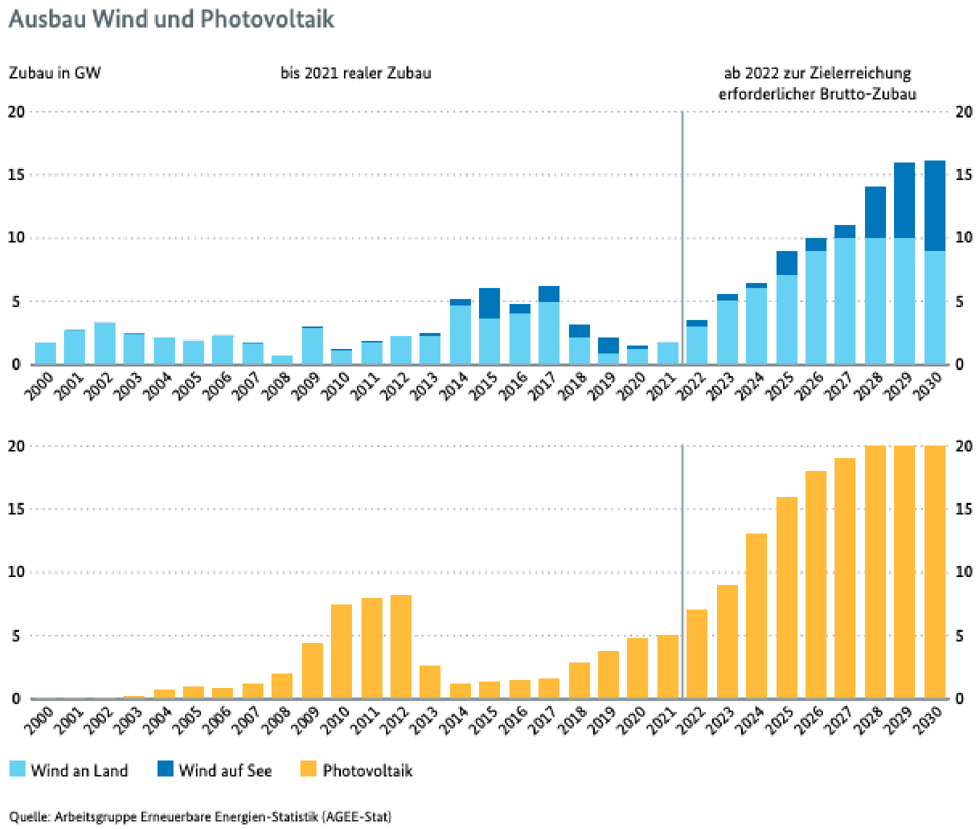
While it is understood that municipal heat planning (preferably integrated with local renovation strategies) is important for EE1st implementation, municipalities have few incentives to invest in efficient and renewable district heating because they earn money by awarding gas concessions.

The interviewees raised other important policy anchors to help operationalise EE1st. The integration of energy efficiency into strategic environmental assessment and environmental impact assessment is one such option. Also, mandatory performance standards for existing buildings should be designed to ensure demand reductions (focusing on end-use rather than on primary energy). At the same time, the BEG/KfW support scheme should provide higher incentives for renovation compared to new buildings. Data play a key role as well in EE1st operationalisation. Implementing a building logbook with an integrated renovation passport and monitoring energy performance and consumption of buildings will help to prioritise renovation measures and investments.

Finally, a proper definition of what is understood as 'deep renovation' – and linking such a definition to other policy instruments, such as a building renovation passport – would facilitate EE1st implementation.

2.4 Policy landscape for EE1st in the power sector

The German power sector is undergoing a period of major change. The last 4 GW of the former 21 GW of nuclear capacity will be shut down at the end of 2023. Domestic hard coal production has stopped, and coal and lignite-based power generation will be phased out by 2038 at the latest, according to plans of the new government. Coal power plants have been closed or transferred to a security standby reserve (getting capacity payment in exchange for being available when called in). Germany's current stock of fossil power includes about 20 GW of hard coal, 20 GW of lignite, and 32 GW of fossil gas units. Former overcapacity has almost disappeared but Germany remains a net exporter to neighbouring markets. At the same time, renewable capacities have expanded. In order to achieve the 2045 climate neutrality targets set out in the 2021 coalition agreement, the current 42% RES share in electricity use must be scaled up rapidly, both in PV and wind, according to the Minister of Economics and Climate (see Figure 11 for PV).



Source: Opening balance sheet on climate protection by the Federal Minister for Economy and Climate Protection (January 2022)

Figure 11. Wind and solar capacity development in Germany

Forecasts on required renewable generation capacity assume an increase in electricity demand due to the electrification of transport, heating and additional industrial demand, while also considering ambitious efficiency targets.

The German power system is moving from being a fossil fuel-based base load generation system to one consisting of intermittent RES resources coupled with flexible gas power plants. Higher volatility is evident from greater intraday spot market volumes and wider price spreads. For security reasons, the national regulator (BNetzA) has introduced several out-of-market reserves as backup.

Competition on the German electricity market has improved over the years. The regulatory framework has been adapted so that balancing power products and their procurement is more in line with flexibility needs (point of procurement, length and size of products). Supporting RES via market premiums has been brought closer to competitive wholesale trading, and transmission grid expansion has been carried out using scenario models that consider not only generation but also demand flexibility. Nevertheless, further improvements have been outlined by the government in its Market Reform Plan submitted to the EU Commission. The Commission Opinion lists further required changes on the power market but also highlights the need for joint optimisation of power markets and networks. Their interaction can be best described as a trade-off between incentives and mechanisms for grid expansion, and between cost allocation and associated incentive effects.

2.4.1 Overview of policies relevant to EE1st

The NECP mentions EE1st but does not provide further information concerning its implementation on the power market.

Industrial consumers connected to high-voltage and highest-voltage levels can participate in a demand response programme. Since its introduction, however, there have been several 'level playing field' and product design-related concerns within the auction-based reserves procurement process. The programme has been adjusted but is set to end by mid-2022 if not extended in the meantime. Consumers are otherwise limited to participating in the power system via their retailer/aggregator. Wholesale market prices and network costs offer some options to optimise customer bills.

Demand-response incentives for various customer groups are also available via grid charges intended to encourage base load consumption. In fact, these run counter to long-term system cost optimisation in some respects, as they contain thresholds (minimum bids, limits to high-voltage-connected assets, incentivised base load purchases, or disincentives to energy efficiency through a shift to standby fees).

The **Energy Industry Act**, the relevant law for the power market, has already provided some provisions relevant to EE1st, such as alternatives (non-wire solutions) to network extension. But these have not been used at all. The law was amended in 2021 and now contains more details on non-wire solutions for congestion management and network extension.

2.4.1.1 Distribution network extension

In principle, every distribution network operator must maintain and expand a network capable of meeting unlimited customer demand. However, the Energy Industry Act (EnWG §14d) requires the development of the high-voltage distribution network (and its transformation to mid-voltage) to be coordinated within geographical regions. Distribution System Operators (DSOs) operating in the same region must submit plans on existing and forecasted network congestions, measures to solve them (including solutions other than grid expansion) and the associated costs of various solutions. This obligation, introduced about a year ago, substitutes non-binding principles without practical significance. Whether the new regulation will have a direct effect will only become clear in the coming months and years. The legislator or the national regulator (BNetzA) can issue more detailed requirements, but there are no plans for this yet. The new regulation is indeed a clear step forward in implementing the EE1st principle in network planning but is only a first step, as mid-voltage and low-voltage networks are not included in this coordinated planning, nor are grids with fewer than 100 000 connected consumers. This means that only about 80 DSOs (less than 10% of total) are affected by the current obligation.

2.4.1.2 Congestion management in distribution networks

Grid expansion plans need to be preceded by identifying measures for optimised grid operation. The German regulatory framework, since its last legal amendment, stipulates that DSOs can procure flexibilities for this purpose (EnWG §14c). These must be contracted through a transparent, non-discriminatory and market-based procedure. The Federal Network Agency (BNetzA) can specify products and procedures in more detail. As this regulation was adopted in 2021, its application and effectiveness has yet to be evaluated.

Before the new provision, DSOs could only manage distribution grid bottlenecks by shedding so-called dispatchable consumption devices (EnWG §14a). Consumers receive reduced grid fees in exchange for the transfer of control to the DSO. This legal regulation should be greatly expanded, and all new end-uses such as electric vehicles and heat pumps should be connected to the distribution grid. Changes to the network tariff system would have limited the flexibility of consumers (below a certain peak-demand threshold) unless they were prepared to pay higher demand fees. As there were to be no market mechanisms or time-based price incentives, consumers, suppliers and the automotive industry saw their rights and market opportunities severely restricted. Shortly before being submitted to the Federal Cabinet, a draft law was withdrawn in January 2021. However, grid operators continue to push for a solution that will enable them to quickly implement comprehensive load curtailment options. Most network operators are critical of upstream time-based price incentives. The effort would be too great and the benefits too uncertain.

2.4.1.3 Demand-side aggregation

Demand-side aggregation is provided almost exclusively by suppliers and balancing-market operators. Demand-side flexibility can be extended to wholesale markets (day-ahead, intraday and reserve markets). In practice, however, this has been of little relevance, as the flexibilities are barely accessible in the SME sector (see 2.4.2.2) and are more profitable to use with large industrial consumers to optimise grid costs.

2.4.2 National specificities that influence the implementation of EE1st

2.4.2.1 Wholesale market

Regulation of the wholesale and balancing markets is fundamentally based on the target model of ‘energy only’ markets. Resources can bid on the various power market segments and profit from price differences. Redispatch (for management of the nationwide uniform supply zone) is organised via generation resources at an administrative price to prevent gaming or windfall profits. Supported generation from RES (FiT premium) and CHP (limited to kWh only) is also vulnerable to temporal price differences of wholesale trading so that optimisation of operation is linked to financial incentives.

On the balancing market, however, only the operational, volumetric costs of reserves are allocated to the originating balancing performance parties, while the costs of maintaining capacity are socialised. This approach has drawn criticism from DG ENER.

2.4.2.2 Smart metering and retail pricing

Consumers of up to 100 000 kWh per year are supplied via so-called standard load profiles. The distribution network operator specifies the average load profile, and the costs for individual deviations are then socialised via local network charges. The consumers must be balanced individually with their actual load profile for energy companies to be able to manage consumer flexibility directly and thus profitably. This, at minimum, incurs initial costs for conversion and installation. As a result, the previous national regulation that compelled suppliers to offer corresponding time-variable tariffs – but only if it was profitable – failed.

In 2021, Germany transposed its recast Electricity Directive (2019/944) into national law. Since 2022, all suppliers who supply more than 100 000 customers must offer dynamic tariffs. From 2025, the exemption will be reduced to 50 000 customers. At the same time, the obligation requires smart meters, without which time recording, data transmission and calculation are practically impossible. Rollout was long delayed due to IT security concerns, and costs have risen as a result. This in turn has led to consumers filing a series of successful lawsuits ([28]). Stopped for the time being, rollout will continue when a relevant number of consumers have the necessary technology, but the timing is uncertain.

2.4.2.3 Network fees for households

Grid tariffs represent a significant part of the electricity bill and there is a financial interest in optimising them. For household customers and SMEs (up to 100 000 kWh annually) there are volumetric charges and optional base prices. Over the last few years, DSOs have introduced and continuously increased the fixed prices – from EUR 35 in 2017 to EUR 57 in 2021 – and reduced volumetric prices at the same time. This means a redistribution of grid costs from higher consumption to lower consumption, but it also devalues energy efficiency.

2.4.2.4 Network fees for industrial consumers

Network fees also create incentives for industrial consumers that are not compatible with energy transition and the EE1st approach. Energy-intensive industries can save up to 90% of their network costs if their load factor ([29]) is above 80-90% (StromNEV §19(2)2). Due to the associated monetary savings opportunities, industries are using their flexibility to exceed load factor thresholds. Demand-side management based on electricity prices must either take a back seat or disappear altogether.

Since the calculation of grid costs for all industrial consumers is based primarily on peak demand within a calendar year (StromNEV §17), there is also a strong incentive to reduce this peak. This incentive overrides short-term spot market price incentives and is not aligned with network scarcity, as the basis of payment is 'individual' peak load and not 'system' peak load.

Demand response must consider these special regulations and can only take place in compliance with price-driven limits, even if used only to achieve or improve performance for these limits.

2.4.2.5 CAPEX bias

Network company regulation in Germany provides a higher return on capital cost. This means that grid and copper investments are more attractive than those to optimise operating costs. From a network perspective, this means a greater interest in network expansion than in improved management. This generates a reduced

[28] https://www.energiezukunft.eu/erneuerbare-energien/netze/stopp-per-gerichtsbeschluss/

[29] Load factor is a measure of the utilisation rate, defined as average load divided by peak load in a specified time period. The higher the load factor, the lower the peak load profile.

incentive for grid operators to innovate. In considering this incentive, the new regulation for non-wire alternatives of grid expansion must also be monitored.

2.4.3 Current situation with implementing EE1st

Germany has some initiatives in the electricity sector that are consistent with the idea of EE1st. SINTEG-funded pilot projects have explored and tested tools for load flexibility but detailed regulations to scale them up have not been developed.

Legislative changes adopted in 2021 have strengthened the implementation framework, but actual benefits and success can only be achieved if there are specifications and implementation instructions from the regulator. Even so, certain aspects of the wholesale market (direct interest on grid costs and grid fees) remain open. In this case, the new government must adjust cost allocation policies so that all stakeholders are encouraged to act efficiently or can offer third parties the right framework for taking optimised action.

2.5 Policy landscape for EE1st in district heating

Germany is the biggest market for district heating (DH) in the EU in terms of absolute figures for the year 2017 (Moczko 2019): 1 454 district heating systems serve about 12.3 million household consumers over a total network length of 21 610 kilometres. Total installed generation capacity is 49.5 GWth. The average district heating price is 7.2 ct/kWh (excluding VAT) and 8.9 ct/kWh (including VAT). Investments in network and storage, excluding generation capacities, amount to EUR 350-400 million per year. The energy supply composition of heat generated is dominated by fossil fuels, while the share of renewables (12% in 2017) – particularly biomass and biodegradable waste – has risen continually.

2.5.1 Overview of policies relevant to EE1st

The Ordinance on General Conditions for the Supply of District Heating (*Verordnung über Allgemeine Bedingungen für die Versorgung mit Fernwärme – AVBFernwärmeV*) sets a general framework for standard business conditions for the supply of DH to customers. Customers connected to the network have the right to be supplied according to general conditions laid out in the Ordinance. District heating utilities on the other hand can only deviate from these conditions with the explicit consent of the customer. German municipalities have the right to determine by statute that, within a certain area and under specific conditions, each property or building must be connected to the DH network (so-called zoning) (Bacquet et al. 2021).

Consumer prices are also regulated under the *AVBFernwärmeV*, while responsibility for regulatory supervision lies with the Federal Cartel Office (*Bundeskartellamt*, BKartA) and cartel offices of the Federal States. In practice, prices are defined by the DH operator with a price calculation rule in the form of price limits that must take into account both price changes in generation and the development of prices on the heating market. However, prices are not determined by the regulator through an ex-ante price control or price approval in the form of a revenue cap regulation or other price control regime. Ex-post price control action is taken only on request when there is a reasonable suspicion of abusive pricing practices (Bacquet et al. 2021).

Germany lacks dedicated legislation to address third-party access to district heating networks. The Competition Law (*Gesetz gegen Wettbewerbsbeschränkungen*, GWB) generally grants access if it is technically feasible and can be reasonably expected of the grid operator. In practice, grid connection is based on private contracts (negotiated grid access), and there are no obligations to date for DH operators to feed-in renewables or waste heat (Bacquet et al. 2021).

Metering of district heat consumption is regulated under the Ordinance on Heating Cost Account (*Verordnung über die verbrauchsabhängige Abrechnung der Heiz- und Warmwasserkosten*, HeizkostenV). It prescribes the use of heat meters or heat cost allocators to record proportional heat consumption for space and water heating, respectively. The use of smart meters to measure heat use is prescribed under the Act on Metering (*Gesetz über den Messstellenbetrieb und die Datenkommunikation in intelligenten Energienetzen*, MsbG) for co-generation plants with capacity greater than 7 MW (Bacquet et al. 2021).

Heat demand in buildings is governed by the Buildings Energy Act (*Gesetz zur Einsparung von Energie und zur Nutzung erneuerbarer Energien zur Wärme- und Kälteerzeugung in Gebäuden*, GEG). It regulates energy performance requirements for new construction, existing building stock and the use of renewable energy for heating and cooling buildings (see 2.3.1.1).

2.5.2 National specificities that might influence the implementation of EE1st

According to a survey across the EU-27 (Bacquet et al. 2021), German DH consumers are satisfied overall with their connection to the system. Considerations include high-quality heat delivery, good-quality hot water, ease of use, high security and uninterrupted heat supply. In turn, there are concerns about mandatory connection to the DH network (zoning) and monopoly-like structures that make it impossible to change suppliers (Bacquet et al. 2021).

2.5.3 Current situation with implementing EE1st

The EE1st principle is hardly established in German DH legislation. The existing legal framework for district heating has a clear focus on promoting cogeneration and renewable energy sources. There is no explicit reference to demand-side resources in the form of end-use energy efficiency or thermal demand response in buildings. Greater supply-side efficiency in the form of third-party access of waste heat providers in existing DH networks is also insignificant. Taking account of the EE1st principle means to explicitly consider these aspects of energy efficiency and to take an integrated approach to DH system planning.

- **Integrated district heating planning and operation**

In principle, municipally owned district heating companies could consider investments in demand-side resources (by contracting ESCOs to achieve end-use savings) as counterparts to upgrades of the DH system. Most German DH companies are public-private partnerships known as *Stadtwerke* (municipal utilities). They operate under private law but are completely or to a large extent owned by the municipalities. In practice, however, there is little experience with integrated planning for municipally owned DH companies. What is particularly missing are guidelines for evaluating demand-side resources alongside new investments in DH infrastructure. In other EU countries, such as Denmark, DH operators are required to conduct a comprehensive socio-economic assessment as part of DH system planning and expansion. DH systems can only be built where an assessment indicates that DH will provide heat options that are cheaper than the alternatives (Bacquet et al. 2021).

For private district heating companies there is a need for innovative design changes to regulatory price control regimes in the form of incentive-based regulation that drives DH companies to consider and procure demand-side resources as counterparts to supply-side investment. DH prices need to be regulated by law, beyond the mere customer protection from excessive prices that is practiced in Germany. In countries with explicit price regulation, a cost-plus method is usually applied. However, as argued before (ENEFIRST 2021a), a pure cost-plus approach does not provide incentives to ensure a cost-efficient supply. Some countries have implemented in their pricing models elements of an incentive-based regulation – for example, by benchmarking specific cost components over time (Bacquet et al. 2021).

In terms of DH supply, municipal and private owners alike are not incentivised to pursue demand-side actions because of reduced heat sales resulting from reduced heat demand. At present in Germany, the decline in heat demand is compensated for by the densification of existing networks in urban areas, thus creating an opening for development areas with isolated networks and local, small-scale projects. To maintain a viable business case for DH companies during a boost in deep buildings renovations, the possibility of and support for network expansion will remain critical.

- **Third-party network access**

The opening of DH networks to third-party RES or waste heat generators improves supply-side efficiency, a key component of EE1st. In general, the GWB entitles access to the network of another company against payment of an appropriate fee. While third-party access is possible in theory, the existing provision is ineffective in practice. Due to the lack of a concrete set of rules, the uncertainties for a potential heat provider in the enforcement of the law are too great to realise a substantial financial investment. What is missing are regulations on how to appropriately define grid charges, along with a definition of rights and obligations of grid operators and third-party producers. Hence, grid operators can easily put obstacles in the way of any third-party grid access request in such a way that these parties are prevented from realising their access claims (Bacquet et al. 2021).

3 HUNGARY

3.1 Overview of the energy sector in relation to EE1st

The Hungarian energy system and related policies have been restructured several times over the last century, which has led to **fragmentation of institutions and responsibilities, including the separation of demand, supply, and network systems** (Járosi and Kovács 2018). The energy sector was restructured on the basis of public ownership after World War II into large, centrally controlled and vertically integrated energy systems. During the regime change in 1989-1990, the energy system – like other large, centrally organised systems – underwent privatisation (Ürge-Vorsatz et al. 2003). The process was further reinforced by liberalisation (‘market opening’) as part of accession to the EU in 2004. A turning point came in 2014, with energy system management and energy pricing characterised by the restoration of national interests and centralisation (Járosi and Kovács 2018). Despite a complete unbundling of the market, the Hungarian government has gradually moved to intervene in key sectors (energy, media, banking and retail), limited free-market competition, and adopted legislation that discriminates against specific sub-sectors or companies ([30]). Examples include the introduction of residential utility price caps, an extra levy on specific providers, and the direct purchase of companies (see more below).

The population of Hungary is 9.6 million as of 2022 and has been decreasing at a constant rate of approximately -0.25% per year since 1998 – one of the fastest rates of decrease in the world ([31]). Current life expectancy in the country is 77 years of age ([32]). The country’s climate and energy strategies are built on a statistical forecast of further decrease in population, falling to 9.17 million by 2030 (NECP 2020). Urbanisation rate is 71.7% and rising (Worldometers). Hungarian GDP per person has increased from 63% of the EU average in 2004 at the time of joining the EU to 76% in 2021, outperforming the average annual differential in real GDP and PPP. A decline in GDP of 5% per year in 2020 is attributed to the pandemic (EC 2021b). The inflation rate has been well above the EU average since 2018 and is projected to stay above (Eurostat

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[30] BTI Atlas, 2022. Transformation Index. Hungary Country Report 2022. URL: https://bti-project.org/en/reports/country-report/HUN

[31] Eurostat

[32] Worldometers

and IMF), affecting forecasts of economic slowdown. The national deficit reached 7.8% and 6.8% of GDP in 2020 and 2021, respectively, and public debt rose from 65.5% of GDP in 2019 to 76.9% in 2021.

Hungary's economy and energy system are increasingly vulnerable due to a combination of global and European events, national decisions and political orientation. These include the COVID-19 pandemic, the Russian war in Ukraine, soaring expenditures and less-than-ambitious policies, etc. (EC 2022). Increased energy demand and supply alongside tighter energy price regulation, combined with deteriorating infrastructure and political moves to monopolise markets have increased rather than decreased energy dependence, insecurity, energy poverty, infrastructure resilience, etc. Newly generated revenues (tax revenues, for example) have been spent on one-off compensations and social measures, and to provide economic assistance to selected sectors (such as tourism), while large reserves have been spent on the basis of political aims and with limited scrutiny, and not on the basis of expert guidance and long-term sustainability.

Primary energy intensity decreased by 31% between 2008 and 2017 ([33]), and emissions intensity of the economy improved by 22% between 2010 and 2018, indicating a gradual decoupling (NECP 2020), continuing progress from the early 1990s (Ürge-Vorsatz et al. 2003). There have been multiple pandemic-related impacts on the economy, including demand-side changes. The share of renewable energy per hour reached record levels in Hungary – and in many other countries – during the pandemic (Wang et al. 2022), though electricity consumption dropped by 3.6% in the first half of 2020 compared to the same period in 2019 (Morva and Diahovchenko 2020).

3.1.1 General framework and targets

In the past decade, the operation of Hungary's energy sector has been differentiated for residential and non-residential end-use sectors, with different energy system-, social- and economic frameworks (EC 2022).

- On one hand, energy supply for residential end-users is characterised by greater centralisation (monopolisation of energy supply), utility price caps, non-differentiated tax benefits, and a separation of energy and social goals. At the same time, attention to the demand side has been limited to a few dedicated construction and renovation programmes. This approach has partly shielded households from commodity price increases but is also locking-in low-efficiency solutions and deterioration of stock (buildings, mobility infrastructure, and even networks) ([34]).
- On the other hand, large consumers (mostly non-residential) operating on more market-based conditions, are affected by volatility. Economic conditions and regulatory uncertainties influence energy investments and decisions by players on both the demand and supply sides.

Hungary, like many Member States, **has been operating its energy supply (generation, transmission) and demand (consumption and savings) mostly through separation, but including demand-side actions and efforts to improve flexibility**. A further **dichotomy between residential (small) and non-residential (large) consumers** is another layer of policy relevance when considering the simultaneous handling of different parts of the energy value chain.

[33] Hungarian Statistical Office (2022) Indicator 3.1.2.1. Total primary energy consumption, TJ.

[34] Utility price caps were introduced in 2013 and will be drastically cut back as of 1 August 2022. At the time of writing and finalising this report, they dominated the energy policy of Hungary regarding the residential sector. MEKH found in June 2022 that households in Hungary were paying among the lowest energy prices for gas (2.75 cent/kWh vs. 14.92 cent/kWh in Prague) and for electricity (10.17 cent/kWh vs. 40.14 cent/kWh, respectively). The announced change in summer 2022 has drastically altered the entire market situation.

Hungary's overarching strategic goals related to energy and climate, linked to a high dependence on energy imports and a focus on economic development, are detailed in the main components of the country's 'new' **National Energy Strategy 2030** (NES):

- **Focusing on the Hungarian end-user**
- **Strengthening energy security**
- **Climate-friendly transformation of the energy sector**
- **Reaping the benefits of economic development opportunities provided by energy innovations.**

These cornerstones are similar to those identified in the previous National Energy Strategy 2030 (Decision No. 77/2011, amended by Decision No. 5/2015) regarding security of supply, competitiveness, sustainability and economic growth.

It is also established that Hungary's energy strategies and policies are **linked with other policy objectives, such as social goals, environmental protection, education and labour, and rural development** (National Energy Efficiency Action Plan 2014), as reiterated in other plans and strategies (see below).

The Hungarian National Energy and Climate Plan (NECP 2020) that reports the NES and the Second National Climate Change Strategy (NCCS 2) to the EU under the Regulation on the Governance of the Energy Union and Climate Action (EU/2018/1999), redefines its energy system goals as follows:

(1) strengthen energy independence and energy security,

(2) extend the cost savings from utility price caps, and

(3) achieve decarbonisation of energy production.

A look into the details and existing policies (see also 3.3.1) shows that Hungary is – formally, at least – committed to energy saving, GHG emission reduction, renewables, and achieving sectoral targets for renovation rates. However, the **centre of gravity** of these overarching strategies (e.g., the NECP) clearly rests with **supply-side solutions**. While the plans do indeed address energy efficiency (energy efficiency installations, renovation programmes, establishing a network of energy engineers, mandatory employment of energy engineers prescribed for large companies, introduction of tax advantages for corporate energy investments, etc.), they consist mostly of stand-alone policies and measures, while demand-side measures are underrepresented. Decarbonisation plans are mostly linked to supply-side solutions (e.g., the combined use of nuclear energy and renewable energy). The **leading key priority** is to guarantee the **security of energy supply**.

Hungary's energy efficiency and climate targets are well in line with the EU framework.

The **Climate Law XLIV** was adopted in summer 2020, making Hungary the first to implement a **binding climate neutrality goal for 2050**. The Climate Law seemed to denote a change in the Hungarian climate and energy efficiency policy framework, as the Hungarian government had vetoed the EU climate target just a year beforehand. The three-page Climate Law follows a call for announcing a "climate emergency" (Hungarian Parliament 2020), a declaration originally put forward by an opposition lawmaker a year before. The Law sets out provisions that are mostly related to supply-side solutions, and systematic solutions are not evident. Provided instead are specific directions on nuclear, RES, technological investments, etc.

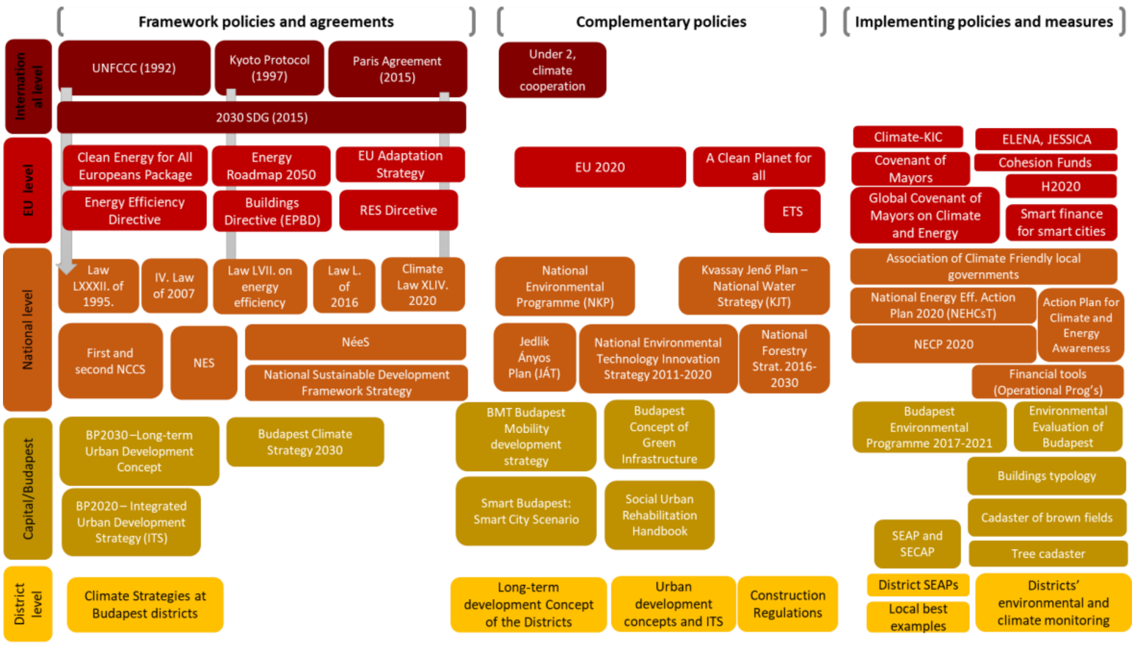
Targets set or reconfirmed include:

- Achieve a 40% reduction of GHG emissions by 2030 compared to 1990.
- Beyond 2030, final energy demand above the 2005 level must be supplied exclusively from carbon-neutral sources.

- RES should make up 21% of final energy demand by 2030.
- Achieve full climate neutrality by 2050.

According to analysts (ENEFIRST interviewees and Equilibrium Institute 2021), it is commendable that the Law defines a legally binding climate neutrality goal for 2050. However, the bulk of the challenge is left until next decade, and EE1st is not yet embedded in the document.

There is a broader system of climate and energy strategies (see Figure 12) that, in combination, have the potential to reflect the value of EE1st in solving multiple issues. Sectoral focus and temporal coverage vary (climate vs. energy, clean development vs. restoration, etc.). Almost all documents (strategies, plans, laws) are motivated by obligations contained in international (e.g., UNFCCC) or European (transposition) agreements or laws. Hungary was among the first countries to adopt the Paris Agreement and has been unequivocal in referring to it as a framework, even if implementation through real measures is falling short.



Adapted from own figure in the Budapest Development Plan 2019

Figure 12. System of national and local policies, strategies and plans

In addition to their common goals, all strategy documents state (while using different terminology) that **"the cleanest energy is unused [fossil] energy"**, even if the EE1st principle is not precisely identified. The **EE1st principle is mentioned in both the [NECP (2020)]** and the **[National Energy Strategy 2030] (NES)**.

The **[National Energy and Climate Plan]** (NECP) (*Magyarország Nemzeti Energia- és Klímaterve* (NEKT) was adopted on 20 January 2020 in compliance with the Regulation on the Governance of the Energy Union and Climate Action (EU/2018/1999). The NECP connects the links of the energy system value chain (supply, networks, demand) with those of fuels (gas, district heating, power), and is indicative of current and future integration. **EE1st is mentioned in relation to the internal energy market but without further clarification**.

The NECP states that **the introduction of the EE1st principle into everyday decision-making practice in coming years will be one of the most important measures of energy efficiency policy**. However, information on what the EE1st principle actually means is not provided. There is also no description of how EE1st might be implemented, nor does it identify sectors or types of decisions to which it might apply. Designations of responsibility and a timeline are lacking as well.

This is confirmed by the European Commission's assessment of Hungary's NECP (EC, 2020): "*The application of the 'energy efficiency first' principle is not well developed, although the importance of energy efficiency in helping reduce import dependency is recognised. Energy efficiency is also mentioned as one of the elements helping to improve energy security along with demand response*." The assessment is especially critical in the wake of claims by the power segment that it receives too little consideration in the internal market dimension. "*In view of the renewables target in electricity of 21% by 2030, the development of flexibility sources needed to integrate renewables into the system is projected. However, there is no roadmap for the implementation of required flexibility measures*." As far as consumers are concerned, the NECP does not specify timelines and targets for phasing out regulated prices. At the same time, it "*recognises the role of demand response and smart meters but does not detail specific measures or objectives*".

The **National Energy Strategy 2030** (NES) (*Nemzeti Energiastratégia* 2030 (NES), adopted in January 2020, sets a course for planned development of the Hungarian energy sector until 2030. The stated goals are "clean, smart and affordable energy". The strategy includes a detailed definition of EE1st (p.47) in line with the EU Governance Regulation: "*The energy efficiency first principle means that, before decisions are taken on energy planning, policymaking and investment, analyses will be carried out on the possibility of full or partial substitution by cost-effective, technologically, economically, and environmentally appropriate energy efficiency measures in order to achieve the overall goals of these decisions*". The Energy Strategy identifies specific potential policies and measures to implement this principle:

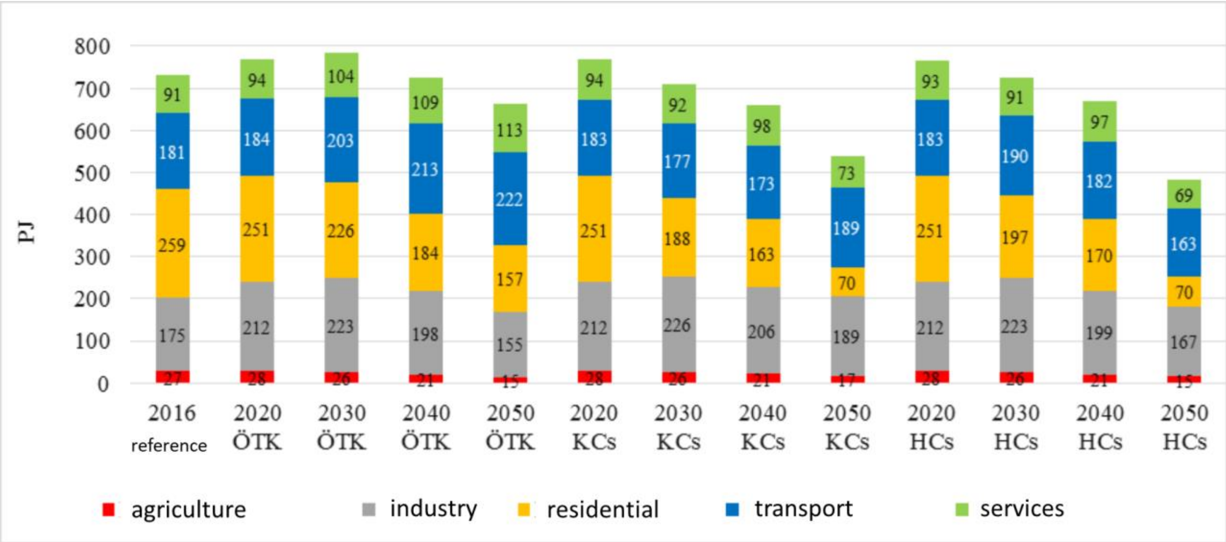
- introducing the energy efficiency obligation system (p. 49), based on EU recommendations,
- improving conditions for ESCO projects,
- strengthening advisory (the national energetic network) and management systems (p. 49),
- combining RES shares in heating and cooling, mainly by fuel switching in district heating, and improving the efficiency of the heating equipment stock (p. 45),
- introducing smart meters and exploring the feasibility of demand-side flexibility (DSF), which could reduce the need for distribution network investment (p. 25),
- electrification and its consequences for future demand flexibility, enabled by digitalisation and smart pricing (p.37),
- addressing the need to introduce an incentive regulation for network companies who will experience decreased revenue due to a lower volume of distributed energy (pp. 39, 55 and 58), and
- acknowledging that demand response and storage can reduce generation and shrink the need for network capacity (p. 54).

The **National Green Development Strategy** (NGDS) 2020-2050 (*Nemzeti Tiszta Fejlődési Stratégia-tervezet*) was adopted in September 2021. The NGDS presents an overall holistic approach. Though it does **not identify and define EE1st**, it **establishes principles for cost-benefit analysis** that would likely result in identified societal benefits, such as agricultural and pollution cost-avoidance, improved air quality, enhanced mobility, job creation, etc. (p.15). The NGDS identifies awareness raising and integrated treatment of energy issues at end-use and decision-making levels as critical elements of green development (pp. 96-97).

Hungary's official energy and climate strategies and plans indicate a clear recognition of the value of EE1st and/or otherwise integrated decision-making, planning and policymaking. Though efficiency is identified as a priority, the measures and lines of focus included in the reviewed documents do not support it in practice. Nevertheless, the NECP, NES and NGDS contain encouraging signs. The energy system impacts of recent disruptive events such as the pandemic and the Russian war in Ukraine might possibly be counteracted through the EE1st principle – for instance, by ensuring radical demand reduction, after which any necessary supply is decarbonised. While strategies have fallen short, the government has agreed to search for alternative energy sources or continued supply from Russia (Institute of Central Europe 2021).

3.1.2 Overall perspective on energy and buildings

Hungary prepared three alternative scenarios in the scope of the NGDS. A climate scenario (KCs) with the combination of efficiency and supply measures is compared to BaU and a waste-plus-climate scenario (HCs). The emissions in KCs reduce to one-tenth of current emissions in 2050 with GDP decoupling (Figure 13). Current policies will lead to reduced energy demand: 733 PJ to 662 PJ, KCs to 538 PJ, and HCs to 484 PJ. The largest identified potential is in the residential buildings sector.

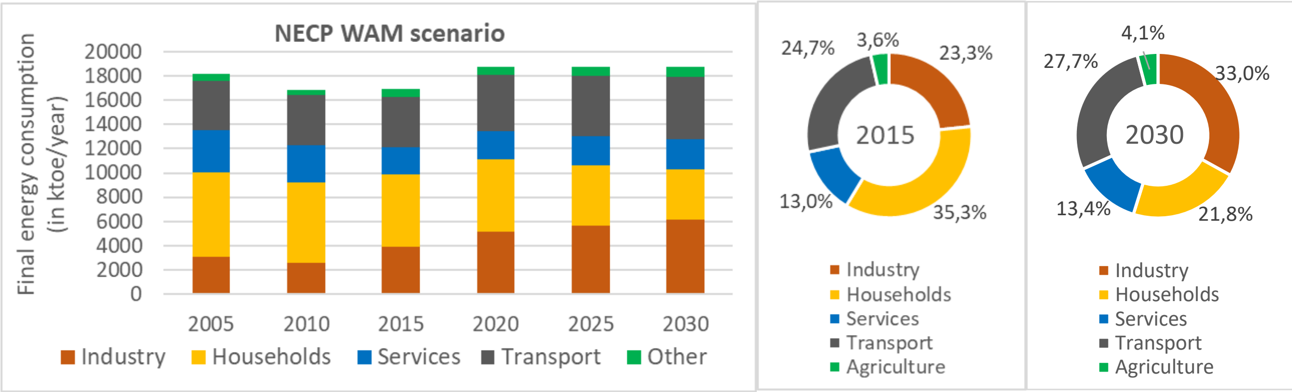


Source: NGDS (2021).

Figure 13. Final energy consumption per sector (*PJ/year*) in Hungary's KCs and HCs scenarios between 2016 and 2050, using the HU-TIMES model

Hungary hosts over 3.7 million dwellings, with a total floorspace of 274 million m². There are around 24 000 public buildings that are larger than 250 m², resulting in roughly 50 million m² of heated floorspace (LTRS 2020).

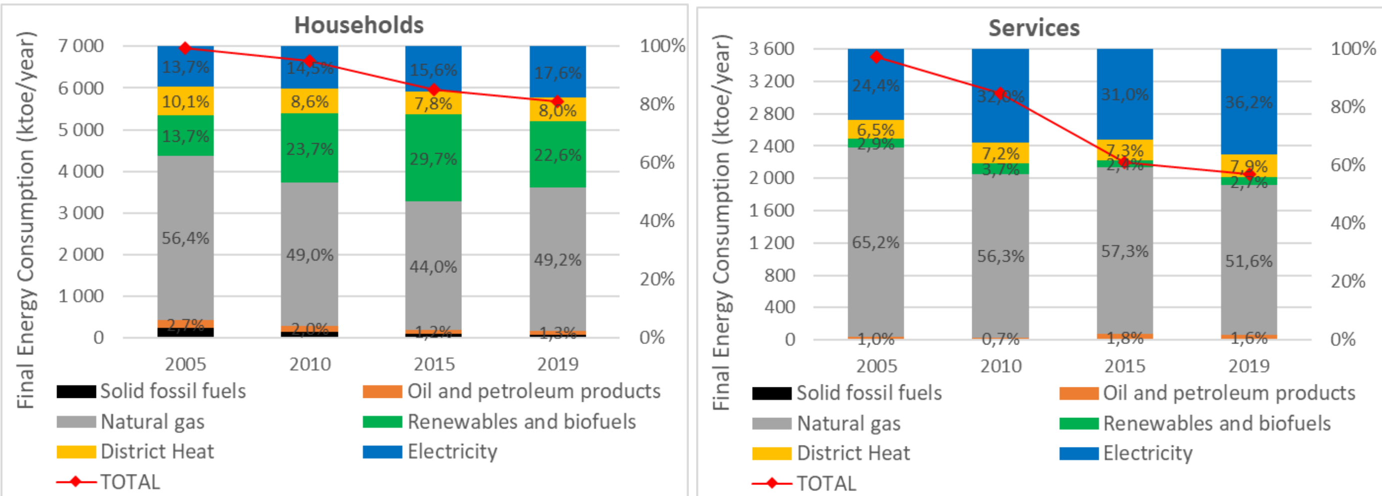
Households and services represented about 48% of Hungary's total final energy consumption in 2015 (35% and 13%, respectively). In Hungary's WAM ('With Additional Measures') scenario, the share of services is likely to remain the same in 2030 while the share for households is expected to decrease to about 22%. The WAM scenario represents an increase of 11% in total final energy consumption by 2030 compared to 2015, but the energy consumption of households would be lower by about 32%.



Source: Own graphs from data of Hungary's NECP. Statistics for 2005 to 2015 are from Eurostat, while results for 2020 to 2040 are modelled data for the scenario.

Figure 14. Final energy consumption per sector (*ktoe/year*) in Hungary's WAM scenario

Natural gas is the dominant energy source for buildings (households and services). Its share decreased significantly between 2005 and 2010 (-7 points for households and -9 points for services). This share remained about the same in 2019 compared to 2010 for households, whereas the decrease continued for services (-5 points). The share of electricity has increased for both households and services but remains low, particularly in households (less than 18% in 2019). The biomass share has increased notably in households. The share of district heating has decreased slightly in households, while increasing slightly in services.



Source: Eurostat (energy balances)

Figure 15. Hungary's final energy consumption over 2005-2019 (*ktoe/year*) in households (*left*) and services (*right*), and per energy source (%)

Hungary has a higher share of RES for heating and cooling than for electricity. However, the WAM scenario indicates that the share of RES for electricity should exceed the share for heating and cooling by 2040. Nevertheless, these RES shares would remain low compared to EU ambitions.

Table 5. Evolution of RES share in gross electricity consumption and final energy consumption for heating and cooling in Hungary's WAM scenario

RES share (%)	2005	2010	2015	2020	2025	2030	2035	2040
– in gross electricity consumption	4.4%	7.1%	7.3%	10.8%	16.4%	21.3%	25%	29%

– in final energy consumption for heating and cooling	9.9%	18.1%	21.2%	18.2%	20.7%	28.7%	27.6%	25.5%

Overall intensity improvement ([35]) was 1.6% per year from 2000 to 2018, driven by improvements in industry (2.3% per year) and services (3.6% per year), while progress was slower for the residential sector (just 0.8% per year on average between 2000 and 2018, including a total halt after 2015).

3.1.3 Overview of the building stock

Below are some key details about **Hungary's residential stock** (LTRS 2020):

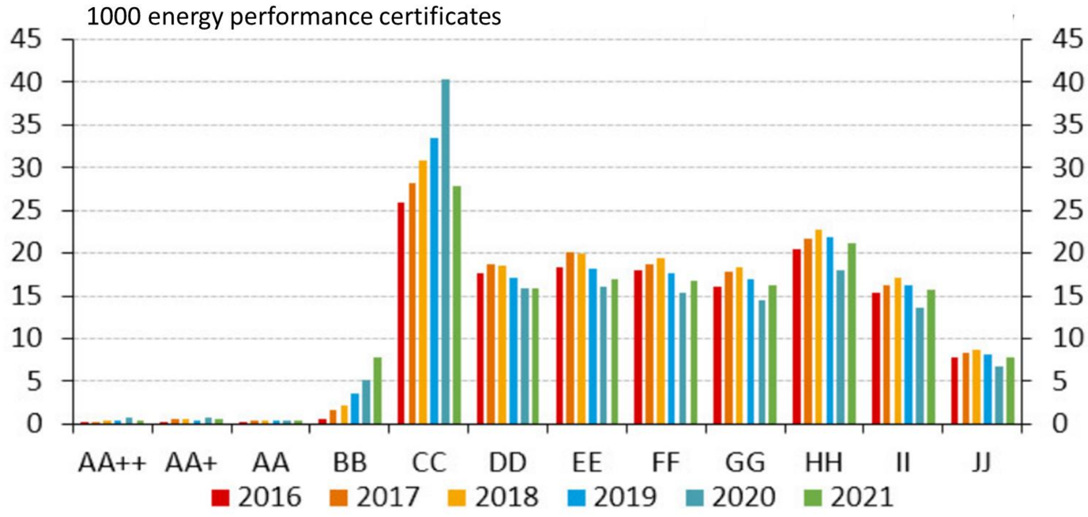
- More than 3.7 million residential dwellings, with a total floor area of almost 274 million m².
- Detached or terraced houses (1 to 3 dwellings) represent about 63% of dwellings and 73% of occupied floor area. Large condominiums (10 or more dwellings) are the second-largest share (30% of dwellings and 22% of occupied area). The rest are medium-size condominiums (4 to 9 dwellings).
- 45% of houses and 78% of condominiums were built between 1960 and 1989.

The LTRS mentions that, based on energy performance certificates and analyses of various operational programmes and surveys, the **renovation rate would be about 1% per year**. It does not, however, provide data on **whether these renovations would lead to improved energy performance**.

The **unit energy demand to heat residential buildings** (20.9 koe/m²) exceeded the EU-28 average by 37.5% (after adjustment for climate differences) in 2015, and without making significant progress compared to 2005 (21.1 koe/m²) (European Commission 2017). **Capped energy prices** from 2013 (for electricity, gas, and district heating, but not for wood and waste) curbed interest in energy efficiency upgrades related to heating and have impacted the energy supply mix. The share of gas decreased from 64% to 49% between 2000 and 2015, while the share of solid biomass (wood, waste) grew from 8% to 40% over the same period. The use of wood for heating has fallen since 2015, and gas is again more popular: their respective shares in 2018 were 32% and 56% (ODYSSEE-MURE 2022).

The quality of housing stock can be ascertained from the distribution of Energy Performance Certificates (EPCs), which are compulsory when a property is occupied, sold or rented. Within the certification system, an AA++ rating is the best in terms of energy performance, while a JJ rating is the worst. Based on more than 900 000 EPCs issued since 2016, there are significant energy quality gaps in the overall housing stock. The average consumption of residential buildings is around 235 kWh/m² per year (Sáfián 2021). As of the end of 2021, close to 65% of Hungary's building stock is below the DD level (Figure 16).

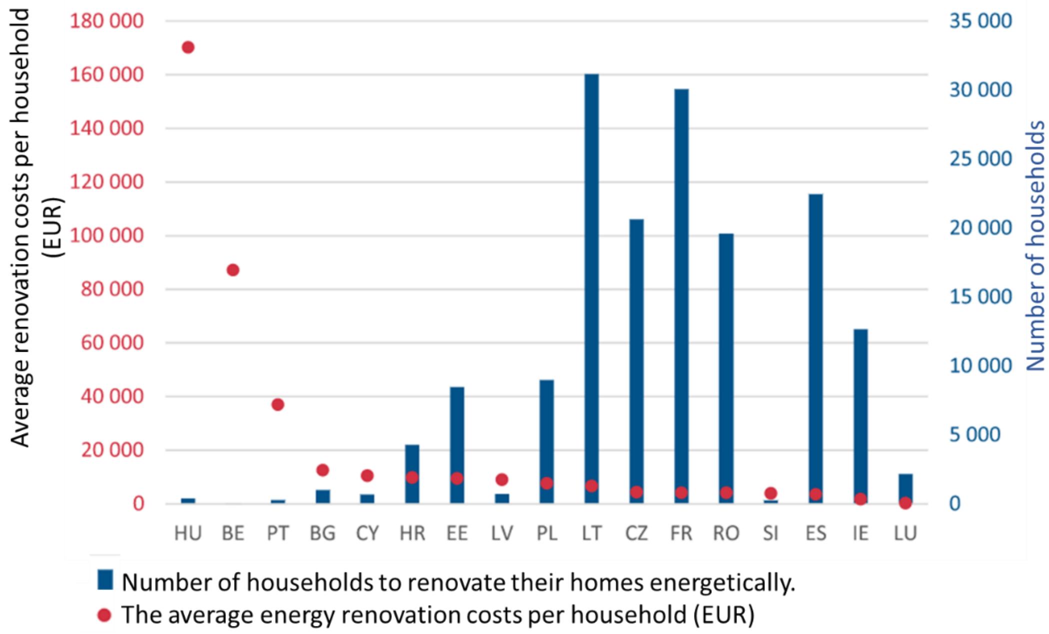
[35] ODEX by ODYSSEE-MURE. https://www.odyssee-mure.eu/publications/efficiency-trends-policies-profiles/hungary.html



Source: Sáfián 2021

Figure 16. Evolution of the distribution of Hungary's residential buildings per energy class (2016-2021)

The implementation of EE1st is based on a cost-benefit analysis of relevant measures and their associated social impacts. In Hungary, however, there is a only a small number of homes per year that carry out an energy renovation, while the cost of unit renovation is highest in the EU (Figure 17), resulting in a skewed assessment.



Source: (Sáfián 2021; European Court of Auditors, 2020)

Figure 17. Average cost per household to improve its energy rating, and number of renovated households per Member State

3.2 Governance system and interplay of institutions

Hungary has a unitary/centralised governance system in which most of the power and financial decision-making authority is concentrated at national level. The current governance system, mostly in the hands of the Prime Minister, has also been referred to as a "competitive authoritarian regime" and an "illiberal democracy" (Valdesalici 2021). The government has used both the pandemic and, in 2022, the Russian war in Ukraine to justify a declared state of emergency and rule by regulation for the last two years (Gagyi, and Gerőcs 2022). Current levels of uncertainty in policymaking and the business environment are having strong effects on long-term investment in Hungary and thus pose a challenge to EE1st implementation (see Figure 17).

Key stakeholders for policy and decision-making

The central players in terms of climate and energy policymaking are the Ministry of Innovation and Technology (MIT) and, primarily, the **Integrated State Secretariat for Energy and Climate Policy**, a group of about 15 persons ([36,,37]). These bodies are responsible for preparing energy efficiency measures, as well as for monitoring and revising regulations related to energy supply.

Strategic planning, however, is not one of their clear responsibilities: financial aspects of their decisions are assigned by and large to the Ministry of Finance. While this **presents difficulties in making a complete** assessment, deeper interaction (beyond mere authorisation, for example) between the two ministries would enable better preparation of an EE1st team.

Responsibilities at different ministries

Policymaking and implementation of efficiency measures must happen in coordination with other decision-making bodies. This is even more valid in the case of EE1st, which by definition requires collaboration with multiple entities. Decisions on building regulations (urban landscaping, building permits), on funding schemes for buildings on a social basis, on funding schemes for energy renovations/appliances, or on RES regulations and financing, are all entrusted to different bodies.

- The **Ministry of Human Resources** is responsible for the renovation of residential buildings, including large multi-apartment buildings.
- The **Minister of Finance** makes overall decisions on budgets, grants and other schemes. This already bodes well for strong collaboration with the energy team.

Implementation, adoption and complementary measures are in the hands of various authorities, banks and regulators:

- The **Hungarian Energy and Public Utility Regulatory Authority (MEKH)** is in charge of registries and cadastres of buildings and public buildings. It is also responsible for education, training and skill development. In addition, the MEKH prepares and distributes tariffs and develops calculation methodologies, including methods relevant for EE1st.
- The **Hungarian Competition Office** has the authority to impose sanctions for anti-competitive practices and can also play a key role relevant to EE1st.
- The **Hungarian National Bank** develops green financial products and provides loans, so is thus involved in implementation.

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[36] Note that this has changed since a new government assumed power in May 2022.

[37] https://cms.law/en/int/expert-guides/cms-expert-guide-to-electricity/hungary

- The **Lechner Knowledge Centre** collects energy certification for buildings in Hungary, which the **Hungarian Chamber of Engineers** checks in turn on a regular basis.
- The **Budapest and Pest County Chamber of Engineers** carries out the verification of EPCs of buildings as a statutory task.

At all points there are concerns related to capacity, effectiveness and implementation.

Energy supply side

The number of companies involved in energy supply has been cut drastically in recent years.

Even after unbundling, the state-owned and still vertically integrated **Hungarian Electricity Works Ltd. (MVM)** is the biggest player on the electricity market. In fact, MVM is the sole energy provider for residential consumers. MVM owns several generating companies, six regional distribution companies and a transmission company: properties include the Paks nuclear generating station and **Hungarian Electricity System Operator Ltd. (MAVIR)**, a transmission system operator (TSO).

Regarding the re-establishment of monopoly, the government refers to paragraph 24.A of the Competition Law to justify its claim that national strategic benefit overrides the need for competition. Thus, as of 2022, the MVM Group (Hungarian Electrical Works Private Limited Company) (*Magyar Villamos Művek Zártkörűen működő Részvénytársaság*) provides all residential electricity ([38]).

MAVIR owns and operates the transmission system. Pursuant to the Electricity Act, access to the transmission grid is granted to third parties, including traders, distribution system operators (DSOs) and end-users.

Energy demand side

There are key actors on the demand side who implement efficiency solutions, and they should be involved in decisions that involve comparing supply and demand measures. Even though the stakeholder map here is very fragmented, these players should also be involved in the EE1st decision-making process. Relevant stakeholders include:

- aggregators (who started to operate from the beginning of 2021) registered with MEKH,
- ESCOs and third parties,
- end-users and their associations,
- local governments and public bodies as end-users,
- energy communities, and
- the Hungarian Chamber of Engineers, which holds the rights to issue and monitor EPCs (the Act on Energy Efficiency CX of 2019, Section 90 assigns the Chamber with providing energy advice to businesses and the general public).

The NECP identifies further institutions and actors (p. 36), of which the following have relevance for EE1st implementation in the buildings sector: Ministry of Foreign Affairs and Foreign Trade; Construction Quality Control Non-profit Ltd.; Hungarian Chamber of Engineers; Prime Minister's Office; National Research,

[38] Regulation 139/2022 (IV.7).

Development and Innovation Office; Minister without portfolio in charge of national assets; Hungarian Atomic Energy Authority; and Minister without portfolio in charge of the design, construction and commissioning of the two new units of the Paks Nuclear Power Plant.

3.3 Policy landscape for EE1st in buildings

As described in Section 3.1.3, the buildings sector is the largest energy consumer in Hungary and thus has the largest savings potential.

Two key strategies establish the framework for the buildings policy landscape:

The National Building Energy Performance Strategy (NBEPS) (*Nemzeti Épületenergetikai Stratégia* (*NéeS*) was adopted in 2015 and transposed the EPBD. The Strategy set energy savings targets in the primary energy consumption of buildings at 49 PJ per year for 2020, and at 111 PJ per year for 2030. The savings targets to be achieved by 2020 from 2015 are presented in Table 6.

The renovation target for the floor area of central government building stock is 3% per year.

Table 6. Primary energy savings targets to be achieved by 2020 through renovation of residential and public buildings, as set out in the NBEPS

	2020 energy savings targets (PJ)	Number of residential and public buildings to be renovated by 2020 (number)	Estimated expense by 2020 (HUF bn)
Family houses	17.6	130 000	743
Industrialised multi-apartment buildings (prefabricated panels)	12.8	380 000	536
Traditional multi-apartment buildings	8.0	190 000	329
Residential buildings total	**38.4**	**700 000**	**1 608**
Public buildings	1.6	2 400	152
Total	**40.0**		**1 760**

Based on NBEPS data, the NECP estimates that the modernisation of residential building stock, the aim of which is to improve energy efficiency and facilitate a transition to efficient heating methods, could replace up to one-quarter of natural gas imports (annual natural gas consumption of ~2 billion m^3), thus linking the benefits of efficiency investments with gas infrastructure and import savings.

The Long-Term Renovation Strategy **(LTRS)** (*Hosszú Távú Épületfelújítási Stratégia*) was published in July 2021. The LTRS builds on the goals set out in the energy and climate strategies and encourages NBEPS implementation. Buildings sector-specific targets include:

- A **renovation rate of 3% per year** of all buildings by 2030 (currently at around 1% per year without information on the depth of renovations). This will reduce the total energy consumption of residential buildings and CO^2 emissions by about 20%.
- A gradually increased **renovation rate of public buildings to 5% per year**. This is expected to lead to a roughly 18% reduction in CO^2 emissions from public buildings by 2030.

3.3.1 Overview of policies relevant to EE1st

LTRS objectives are well in line overall with EE1st: **cost-effective domestic building stock by 2050** through energy efficiency, value, comfort and health-improvement measures, renewable energy utilisation and smart technologies, and reducing national primary energy use and CO_2 emissions. Several of the measures included in the LTRS lead to a comparison of demand and supply solutions.

Still, the LTRS milestones are imbalanced (as are those in the climate targets roadmap). The adopted reduction target of 20% is not ambitious enough. Reaching the 2030 goal would require deep renovation of 100-130 thousand residential buildings annually (Sáfián 2021).

The LTRS includes 35 measures and builds on existing or extended programmes, such as:

- National programmes on buildings renovation and the replacement of heating systems:
    - The Home Renovation Programme (*Otthonfelújítási Program*) offers grants to families with at least one child to expanded and/or modernise an existing home. This no longer has any relevant energy requirements.
    - Financing options for energy efficiency (*Lakástakarék-pénztári konstrukció Korszerűsítési hitelek*) provide favourable financial conditions for home renovation measures. These are provided for energy renovation and/or supply solutions, but are not well monitored.
- The Energy Efficiency Obligation Scheme (*Energiahatékonysági kötelezettségi rendszer*) was introduced in 2021 and is considered a key energy system measure alongside its potential for EE1st implementation.
- **Operational Programmes (OPs) with a main focus on energy efficiency improvement**: financed by the ESIF and Cohesion Funds (some of them coupled with the state budget), OPs are the most important measures of the 4th NEEAP.
- **Building regulations**: technical heat requirements are now 30% stricter than before. An important amendment to the decree in 2014 made the 'cost-optimal energy efficient requirement' a pre-condition for obtaining grants, either from the state budget or EU funds.
- **Residential soft loan scheme** provided by the Hungarian Development Bank: a soft loan scheme with zero interest was introduced in April 2017 to trigger energy efficient building renovations in the residential building sector. This was an effective approach and the results were monitored, but it was stopped.

Besides these main measures, the clear value of the LTRS is to identify complementary measures (MEHI 2021) that can make future EE1st-competent measures work most effectively.

Complementary measures

Other Member States often establish a committee to support implementation, such as the German Committee on Climate Change. The evaluation of applicability of the following EE1st approaches is based on other framework documents for which the government has yet to articulate a relationship with the Climate Law.

- The **National Network of Energy Managers** was established in 2017 to: exploit energy efficiency potential in public institutions (including local governments); advise SMEs and households free of charge on energy-saving methods and opportunities; help managers of public buildings in preparing mandatory energy-saving plans every five years; promote energy audits and introduce energy management systems in public institutions and SMEs; and provision help to implement energy-saving measures.

Hungary has pledged in its Recovery and Resilience Plan (RRP) to invest around EUR 454 million to support residential solar systems and electrification of heating systems in combination with solar systems. On the demand side, EUR 188 million is allocated for the construction and renovation of social housing and improvement of housing conditions, while an additional EUR 33 million is earmarked for development and promotion of community renewable energy production and use. (EC 2021b).

3.3.2 National specificities that might influence EE1st implementation

As of 2022, the buildings sector in Hungary has a limited availability of materials and construction workers, especially in the renovation sector, due to increased activity. The volume index of production in the broad construction sector grew by 39.8% from 2015 to 2020, in line with significant volume increases in the construction of buildings (58.2%) and civil engineering works (24.9%) over the same period (EC 2021b). Despite this, only a 13.6% increase in employment was observed in 2020 compared to 2010 levels.

In parallel to the rate of volume growth, the housing market saw a price index increase of 77.7% between 2015 and 2020, while the volume of transactions in the residential property market reached 15 630, exceeding the 15 000 benchmark for the first time in a decade. These increases were mostly driven by higher levels of disposable income, increased urbanisation, falling interest rates and fresh policy interventions, such as the special VAT rate and dedicated grants (EC 2021b).

3.3.3 Current situation with implementing EE1st

Challenging framework conditions

While there are many promising measures and policies that can become proper EE1st approaches, several features of the policymaking system slow or inhibit the comparison or consideration of demand and supply solutions on an equal footing, such as the following:

- Uncertainty in policy and decision-making, along with unexpected changes, creates a high-risk environment for investment and planning decisions overall – especially decisions that require delicate comparisons, as is the case with EE1st.
- The overall labour market is solid, but there are important weak points. Companies in the construction sector are finding it difficult to retain workers, and there is a high penetration of informal employment. Along these lines, productivity levels have been lower than the EU average for several reasons, including lower levels of innovation, delayed digital transformation, competition barriers combined with state interventions, and susceptibility to anti-competitive practices and corruption (EC 2022).
- Monopoly has increased on the supply side, thus limiting interest in demand-side solutions and weakening political will.
- Supporting measures are weak or non-existent (e.g., monitoring and verification of savings).
- There is no specific body responsible for implementation or mainstreaming and with powers to suggest changes of responsibility in other areas.
- Sectors that are likely to decline or transform due to the green transition currently provide jobs for nearly 4% of all workers, who might later be in need of upskilling or reskilling. Labour shortages in the energy sector could hinder the transition to climate neutrality.

EE1st could contribute to overcoming various structural challenges that have been systematically identified in the Commission assessment (EC 2022). Specifically, Hungary needs to improve its business environment and institutions, as well as address its biased taxation and fiscal risks, to foster a green transition. EE1st can help lead the way to these solutions because of the shared responsibility involved.

Integrated planning for EE1st

Energy system planning and development is currently siloed. Responsibility for gas infrastructure, energy security, and buildings energy lies separately with different ministries and departments. EE1st interviewees have expressed the view that this provides a deeper rationale for establishing collaboration on decision-making across the whole energy system and beyond. At present, even financial decisions are taken separately from teams in charge of planning. This either causes the system to fail (e.g., grants have been announced that later had no budget, or the budget was gone within a few hours and the call had to be closed) or to be very costly (e.g., large network developments are carried out when demand reduction would be cheaper).

In an ideal system, all policies (not just energy policy) would take demand/efficiency perspectives into account. Cross-sectoral monitoring would take place on a regular basis, and compliance checks might also be required prior to the introduction of any decision or policy.

The **Integrated State Secretariat for Energy and Climate Policy** team within the Ministry of Innovation and Technology (MIT) ([39]), or the Managing Authority, are examples of where such a hub could be placed. The latter already holds a similar role in other areas and could thus be trained and integrated into the process.

Building codes and regulations

Regulations have been a major part of Hungarian energy policy, and building codes could play a key role helping the country to reach its decarbonisation targets. Traditionally, the construction industry has had well-trained planners, implementers and appropriate financing solutions. However, competition between supply measures (different renewable source alternatives, district heating and traditional supply solutions) and demand measures (efficiency improvements, sufficiency solutions) has dominated the agenda in recent decades. Furthermore, relevant regulations and their implementation – as well as the buildings sector itself – have been seriously downgraded. Definitions in the building codes are driven by EPBD requirements but are geared to minimum compliance. For example, Hungary postponed the introduction of nZEB requirements from 1 January 2018 to 30 June 2022 (BPIE 2021), and the defined nZEB level of around 100 kWh/m^2 per year sits well above the EU benchmark (BPIE 2021). Finally, the building codes establish efficiency levels and RES integration levels separately.

Operationalising EE1st through passive-level building codes would first and foremost contribute to much greater energy savings and faster decarbonisation, simply because the requirements are stricter by tenfold. In addition, a ‘whole building’ approach could further boost cost-effectiveness and adaptability, as efficiency and generation measures would be evaluated on an equal footing at the building level.

Supporting policies exist in Hungary that could further improve the impacts and cost-effectiveness of a passive-level standard. Most of these would require some adaptation. Energy performance certificates are used as required and could support the evaluation and monitoring of investments. Financial policies would need to be reformed, mostly to include requirements to monitor energy performance. A combination of grants, credit lines, guarantees – all of which are already available in the country for different types of construction projects – would assist the move to passive-level requirements while using the least amount of public funding. In addition, recently launched one-stop shops (such as Renopont) and energy information centres could help eliminate existing technical, informational and hurdle-related barriers.

The current system locks-in low-energy performance by design, and this results in long-term costs, lower comfort levels and an expanded set of social problems. The impacts of poorly developed building codes are

[39] The Ministry and team have been restructured during the writing of the report, but this does not change the overall message.

exacerbated by centrally determined energy prices for the residential sector, which discourages energy investments and extends payback times artificially, especially when fossil-fuel prices are skyrocketing.

Integrating the 'fabric first' approach in funding schemes

Hungary has an active construction industry, both in terms of new buildings and renovations, and is boosted in large by three key policies: (1) There are several competing programmes that subsidise building construction and renovation. For example, the CSOK programme for families offers HUF 1.5-10 million (EUR 4 000-27 000) in non-refundable grants and combined preferential credits. The scheme used to include energy performance requirements but these were not monitored and were finally removed altogether. The programme is by definition a 'social policy' but is designed so that the richest families reap the benefits (MEHI 2021). (2) 'Green Homes for All' is a mixed-subsidy, credit and guarantee scheme that focuses on heating equipment exchange, insulation, renewable integration, exchange of old home appliances, etc. (3) The offer of tax relief for construction materials was introduced as a recovery measure during the pandemic.

The primary concern about these programmes is that there is no reliable way to evaluate energy savings before and/or after implementation. While these programmes have been identified as the most suitable for implementation of the 'fabric first' approach, they should be strengthened through an evaluation, validation and monitoring element. Specific programme requirements should be defined so as to achieve an integrated balance between efficiency and supply measures.

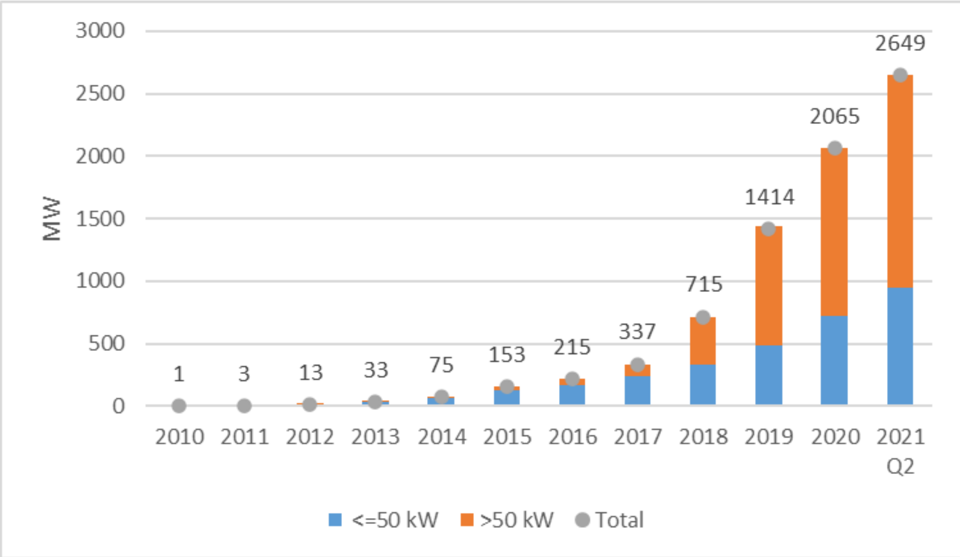
There are some supporting policies and framework conditions that could enable such a transition. In September 2021, the National Bank announced a green mortgage bond purchase programme (MNB 2021) that could be earmarked to support projects and programmes leading to overall social benefits. These programmes, which are shown reach up to 20% of all buildings per year (MEHI (2021), could be leveraged to motivate Hungarian tenants, both in the residential and non-residential sectors.

Complementary measures

- The LTRS includes the introduction of **the Building Renovation Monitoring System (ÉMOR)** (p. 26) to verify the achievement and redesign of the policy.

3.4 Policy landscape for EE1st in the power sector

The power sector in Hungary faces multiple challenges and uncertainties. Generation capacity will change in the next decade, as the country's only lignite plant closes in 2025 and the lifetime of the Paks nuclear plant expires between 2032 and 2035. Replacement plans include a new 500 MW CCGT (combined cycle gas turbine) at the site of the lignite plant and two new nuclear blocks, each with a capacity of 1 200 MW (Paks 2). The NECP warns that permitting uncertainties could cloud the viability of commercial operations of Paks2 by 2030 – regardless of investment, which is already quite delayed. The Hungarian government assumes considerable EU funding for the new gas power plant but, again, the European politics around investing EU money in gas infrastructure is still evolving. Also, Hungary's RFF plan is not yet approved. The major trend regarding renewables is the recent boom in PV generation, albeit from a low baseline (Figure 18). Behind this change is the introduction of a new, auction-based renewable support regime (from 2017) for larger units (especially now that that national energy policy has practically ruled out wind development), and a net metering regime is in place until 2023 for small-scale PV, coupled with non-refundable support. The targeted PV capacity for 2030 is 6 500 MW, which means putting into operation those units which have been granted support via any of these schemes.



Source: Hungarian Energy and Public Utility Regulatory Authority (HEPURA)[40], 2021

Figure 18. PV capacity in Hungary (end of period)

The need for power system flexibility increases with the increasing share of PV capacity, even if the CCGT is in place by 2025. The NRA claims that system flexibility limits PV deployment, not power grid capacity (HEPURA, 2021). Storage is in the pilot phase only and includes a few DSO/retailer projects (EON, Alteo, ELMU).

Consumers are not engaged as 'power system resources' and they do not consider themselves to be as such. All residential consumers and most SMEs are eligible for regulated retail prices under the so-called universal service regime, under which the fixed, non-time-differentiated electricity price is increasingly below cost. This not only creates looming financial gaps and losses for retailers, it also weakens the price signal for energy efficiency investment and demand response. Consumers are unaware of the cost they impose on the power system and of how they can contribute to operating a lower-cost system.

Even though flexibility is a key demand-side resource for the power system, improving the efficiency of electricity use is equally important. The EEOS was introduced from January 2021 but is not yet functional. The EEOS could mobilise Hungary's energy efficiency potential, but quality of monitoring and verification remain open questions.

3.4.1 Overview of legislation and strategic documents relevant to EE1st

The National Energy and Climate Plan (**NECP**) is Hungary's key horizontal energy strategy document across the value chain (supply, networks, demand) and across fuels (gas, district heating, power). As such, it is well positioned to show how – or if – national energy strategy and planning is built on the EE1st principle. At the same time, Member States need to report on various sections and questions that deal with energy efficiency and flexibility. The Hungarian NECP (p. 188) states that the introduction of the EE1st principle into everyday decision-making practice in coming years will be one of the most important measures of energy efficiency policy. However, detailed information on these interlinkages and the EE1st principle is not provided.

[40] Presentation of Attila Bagi, XII. Szolár Konferencia, MNNSZ, 17 November 2021 (not available online).

This is confirmed by the European Commission's assessment of Hungary's NECP (EC, 2020): "*The application of the 'energy efficiency first' principle is not well developed, although the importance of energy efficiency in helping reduce import dependency is recognised. Energy efficiency is also mentioned as one of the elements helping to improve energy security along with demand response.*" The assessment is especially critical in the wake of claims by the power segment that it receives too little consideration in the internal market dimension. "*In view of the renewables target in electricity of 21% by 2030, the development of flexibility sources needed to integrate renewables into the system is projected. However, there is no roadmap for the implementation of required flexibility measures*." As far as consumers are concerned, the NECP does not specify timelines and targets for phasing out regulated prices. At the same time, it "*recognises the role of demand response and smart meters but does not detail specific measures or objectives*".

The **Energy Strategy**, developed in 2019 on the basis of the NECP, sets the course for development of the Hungarian energy sector up to 2030. It includes a detailed definition of EE1st in line with European legislation (p. 74). The Energy Strategy lists various potential policy measures to help implement the principle, but mostly as plans for the future. These include:

- introducing smart meters and exploring the future feasibility of demand-side flexibility, which could reduce the need for distribution network investment (p. 25),
- electrification and its consequences and the role of demand flexibility enabled by digitalisation and smart pricing in the future (p37);
- addressing the need to introduce an incentive regulation for network companies who will experience decreased revenue due to a lower volume of distributed energy (pp. 39, 55 and 58), and
- acknowledging that demand response and storage can reduce generation and needed network capacity (p. 54).

The **2007 Electricity Law** ([41]) is the national legal framework for the Hungarian power sector. It was amended in 2020 and 2021 to transpose the recast Electricity Directive (2019/944). Accordingly:

- It defines new terms in the 'Clean Energy for All' package, such as 'aggregators', 'active consumers', 'demand-side management' and 'dynamic energy tariff'.
- It requires demand-side flexibility, energy efficiency and storage to be considered in network development plans, at both transmission and distribution levels (Article 24/A).
- It requires DSOs to plan, define and procure their flexibility needs (Article 29).
- Flexibility procurement must be non-discriminatory and market-based, and in line with the least-cost principle (Article 32).
- DSOs must report annually to the NRA on the procured amount, and also provide an assessment of the flexibility market and its potential development options (Article 32/B).
- Consumers have the right to choose an aggregator without the consent of the supplier and/or the body responsible for balancing but must inform them (Article 66/D).
- Aggregators can aggregate market-participants from different balancing groups
- It defines aggregators' financial reliability for the unbalances caused (Art 66/D)
- Energy efficiency and demand-side flexibility must be considered in setting network tariffs, most notably the cost-savings achieved, including avoided network investments (Article 142).

[41] Law LXXXVI, 2007.

The Electricity Law thereby transposes relevant requirements of the CEP that are essential for EE1st implementation in the power sector.

Regarding demand-side flexibility, the implementing codes (*Üzemi Szabályzat, Elosztói Szabályzat* and *Kereskedelmi Szabályzat*) of the Electricity Law were amended in 2021 or are under revision. Whereas the Commercial Code (*Kereskedelmi Szabályzat*) only refers to demand-side flexibility, the 15th amendment of the Distribution Network Code (*Elosztói Szabályzat*) defines:

- framework rules on market-based flexibility procurement by DSOs,
- non-market based redispatch options for generators, storage and demand connected to the distribution network (Chapter 6),
- coordination between the TSO and DSO when the same unit offers flexibility to both operators, and
- rules of product definition and accreditation for flexibility suppliers (Annex 26).

This amendment is a transposition of the recast Electricity Directive (EU) 2019/944) and its related Regulation (EU) 2019/943). The substantive justification (apart from the legal requirement) is to provide additional options for DSOs with the aim of connecting the soaring number of prospective PV generators applying for network connection.

The Network Code (*Üzemi Szabályzat*) has been amended in terms of network planning rules. It now requires the network company to "*consider various investment alternatives, assess them against engineering and economic criteria, and chose the preferred one based on the 'least cost principle'* " (4.3.1 (E). There is no explicit reference to the consideration of demand-side resource options as an alternative to network capacity buildout, so this is much up to interpretation. The transparency of planning has improved, as the NRA and general public can now access the assessed alternatives. Due to rapidly growing PV capacities, the 2020 electricity network plan refers to "innovative" grid solutions such as high-temperature conductors and static VAR compensators ([42]).

Realising the need to strengthen the toolkit to realise the 2030 energy efficiency goal, the government introduced an **energy efficiency obligation scheme (EEOS)** from 2021. Implemented in the majority of Member States, the EEOS is the only policy in Europe that directly mandates energy companies (whether involved in energy supply or energy distribution) to invest in energy efficiency (Fawcett et al. 2019). There is a wide range of obligated parties, including electricity and gas retailers, universal service providers, and transport fuel retailers serving final consumers. Energy savings targets are set on the basis of annual energy sales. Targets increase over time and reach their maximum in 2024-2027 (0.5%). Savings can be achieved both through actions and investment by obligated parties or by third parties in a future secondary market. Savings can be claimed based on a standard catalogue or on individual energy audits of investments/interventions. Savings can be achieved through any energy carrier for any obligated party. The NRA is responsible for monitoring, verification and sanctioning. The optional waiver fee for implementing the energy savings target is HUF 50 000 (EUR 126) per year. The penalty for failing to meet the savings target is HUF 70 000 per year. Funds are to be used to improve energy efficiency in vulnerable households. Obligated parties have received a derogation to comply with their 2021 savings target by the end of 2022 (671/2021 Government decree).

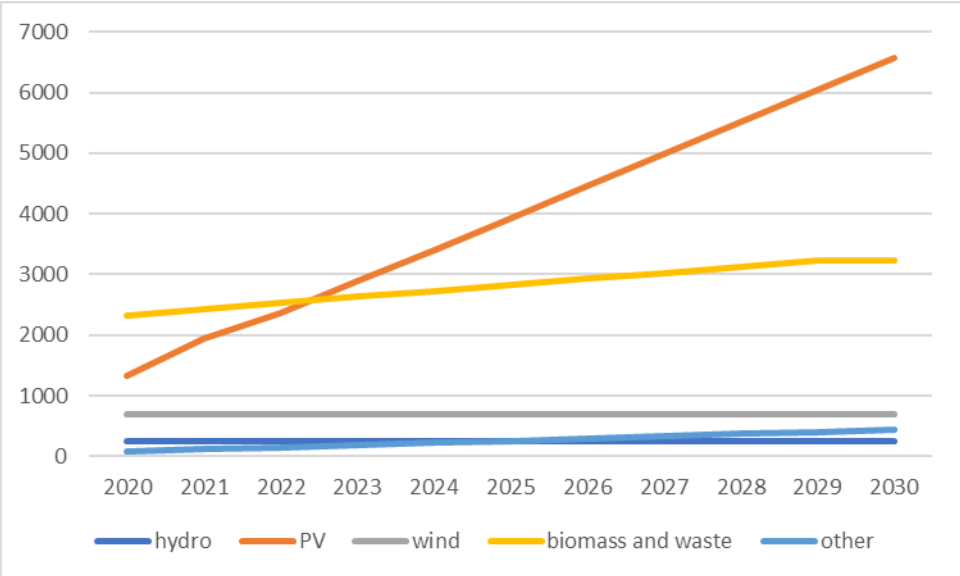
[42] Volt-Ampere Reactive (solution to handle reactive power).

3.4.2 National specificities that might influence the implementation of EE1st

Certain national parameters can highlight the importance of improving flexibility of the power system and integrating demand-related potential.

- **(Variable) RES-E share and forecast**

A growing share of variable renewables in the electricity supply signals the need to increase the flexibility potential of the power system so it can integrate new units efficiently and without considerable curtailment. Hungary plans to increase its share of renewables in gross final electricity consumption from 10.8% in 2020 to 21.3% in 2030. This doubling of RES-E is mainly due to an increase in variable generation (PV in this case) (Figure 19).



Source: NECP of Hungary

Figure 19. RES-E forecast per technology (*GWh*)

- **EV and HP penetration and forecast**

Electric vehicles (EVs) and heat pumps (HPs) are key indicators of electrification pathways and ambitions. These assets, together with a greater penetration of air conditioners (ACs) for cooling, bring additional load and affect power system equilibrium. On the other hand, if integrated in a smart way, they are important sources of flexibility.

EV and HP penetration levels are relatively low in Hungary. Only around 0.5% of the car fleet was electric in 2021, but EVs accounted for a 6% share of new car purchases. The HP market is quite undeveloped as well, but a similar take-off is expected due to nZEB rules requiring a 25% renewable share in the energy use of buildings (in effect from 2021). This will make HPs the prime choice for new buildings.

The penetration of these assets is likely to be concentrated in larger urban areas. The Power System Network Development Plan, 2021 foresees 21 000-34 000 HPs, 440 000-540 000 ACs, and 40 000-100 000 EVs in Budapest by 2030. This additional load will already impact network operation in the central region.

- **Retail energy pricing**

Residential and 'commercial and industrial' consumers are key flexibility resources for the power system. Apart from being able to sell their flexibility potential (via aggregators) to the various power markets, they also align their consumption patterns according to price signal exposure. The consumer share of dynamic time-of-use (ToU) tariffs indicates the extent to which these resources are being mobilised.

In Hungary, many consumers with electric water heaters have been traditionally on a night/day tariff for decades. However, ToU pricing is virtually non-existent in the residential segment due to the lack of smart meters and regulated prices (now widely below-cost). This is a key barrier for retailers looking to offer competitive, dynamic retail prices on the Hungarian market. As the regulated price is a politically eminent issue, it is yet to be when Hungary reduce eligibility to the vulnerably social groups as required by the EU legislation.

3.4.3 Current situation with implementing EE1st

Both the current need for and availability of flexibility is low in Hungary. However, demand for flexibility is expected to increase due to high PV ambition. Integrated PV installation is expanding rapidly, albeit from a low baseline, due to net metering (and its eventual phaseout) and non-refundable financial support from the State. Flexible asset availability is likely to stay at modest levels: even though the government provides financial support for EV purchases, the penetration rate is likely to lag behind the rest of Europe. Electrification of heating is limited to new buildings only. Network development is seen as fundamental to integrating 6 000-6 500 MW of PV by 2030 and 12 GW by 2040. This includes connecting PV, at various voltage levels, to transmission and distribution networks. Alternative solutions seem to be confined to the smarting of grids via improved control and monitoring capabilities. There is no mention at present of investment into energy efficiency or demand flexibility via network companies. The first call for the TSO to support network investment to facilitate integration of increased renewable feed-in was issued in 2022.

Consumers are used to flat-rate tariffs in general, even though consumers with electric water heaters have used the night/day tariff option for decades. A lower rate is offered in exchange for direct DSO control. The regulated tariff option is a key barrier to implicit (price-based) demand response, as it crowds out alternative tariff offers that are more dynamic. Electricity bills are usually smaller than heating (gas) bills, so consumers are less incentivised to invest in energy efficient use of electricity, while spending more on heating- and building insulation. There is no price mechanism to convey the value of flexibility and energy efficiency in the form of bill savings.

Relevant rules of the recast Electricity Directive ((EU) 2019/944) are being transposed. The most recent public consultation on aggregators determined the following:

- Even though virtual power plants (VPPs) have operated for several years in Hungary – aggregating (on a voluntary basis) small power plants and selling their capacity on the ancillary services market – there is also a need for mixed aggregation.
- Only three or four of 26 licenced aggregators are independent third-party actors. The majority are suppliers/BRPs.
- As of 1 January 2021, aggregators are allowed on the automatic frequency restoration reserve (aFFR) ([43]) while, as of 1 March 2021, only aggregating producer units are allowed on both the aFFR and the manual frequency restoration reserve (mFFR), with demand and producers aggregated separately. The timeline for allowing an unlimited aggregator mandate has not been set.

Flexibility products have yet to be defined, and their definition is key for an inclusive and technologically neutral flexibility market. A ‘too large’ bid size or ‘too long’ availability requirement (six hours at present) would

[43] aFFR (automatic frequency restoration reserve) and mFFR (manual frequency restoration reserve) are balancing services used by the TSO to maintain system balance.

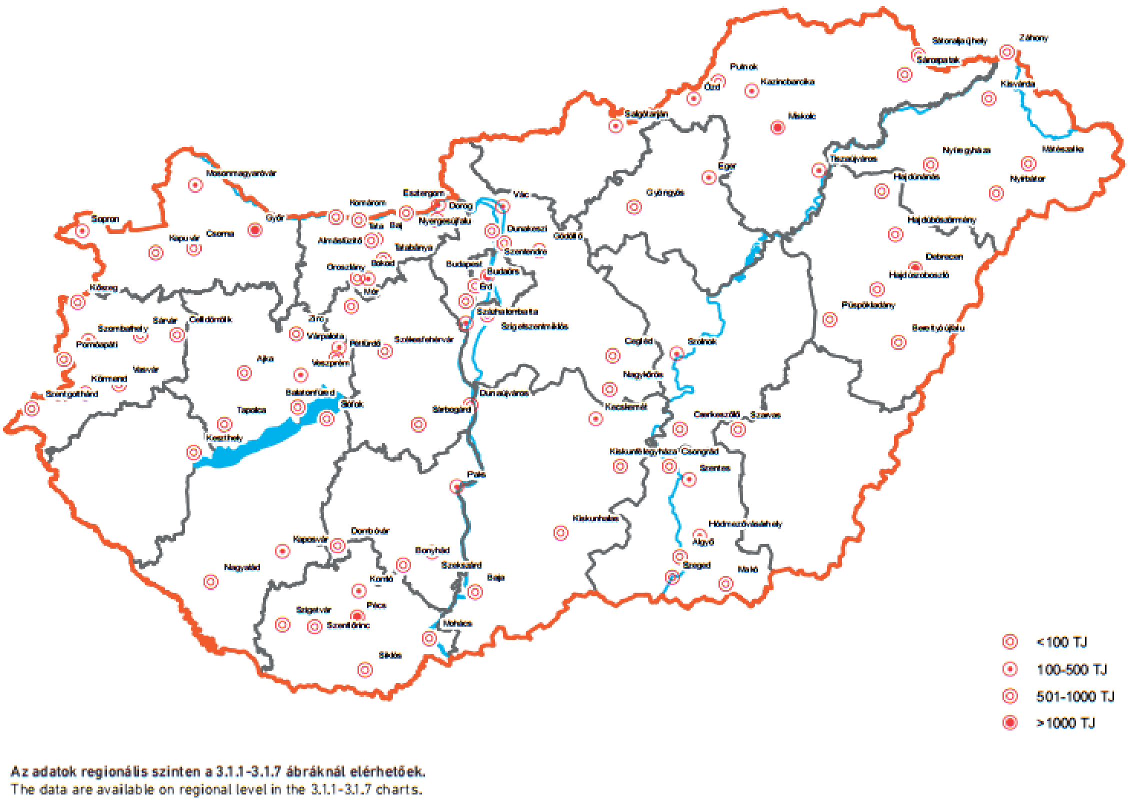
rule out demand and storage for these markets, as they cannot pre-qualify with these conditions. Purchasing flexibility services is very new for DSOs and they are a bit reluctant to engage. On the other hand, they see the need for new solutions due to rapidly increasing PV generation, which challenges grid reliability. NRA officials expect consumers to integrate with these markets in the next 2-3 years.

EE1st is only known as a motto and all the issues discussed here are not necessarily resonant with the public. Hungary is just beginning this process and the NRA is looking elsewhere for best practices.

Approval of the Hungarys' RFF is still pending. The draft plan includes a financial request for "classical and innovative power network development" (HUF 103 billion / EUR 3.2 million, with 50% support intensity), whereas planned support for smart metering has been withdrawn and PV deployment support has been reduced considerably ([44]).

3.5 Policy landscape for EE1st in district heating

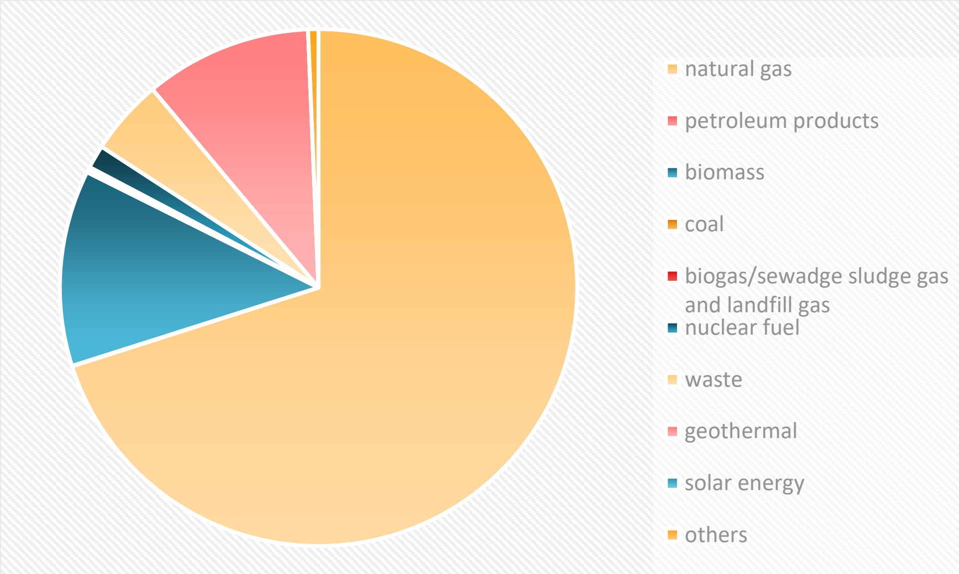
Hungary has a considerably large district heating (DH) sector. It served approximately 670 000-680 000 consumers between 2015 and 2020, with minor fluctuations, the vast majority (660 000) being residential consumers. A total of 217 district heating systems are spread across urban areas countrywide (Figure 20). The majority are fuelled by natural gas (Figure 21). Several systems switched to geothermal in the last decade due to the availability of public/EU investment grants.



Source: MEKH/MATÁSZSZ, 2021 (data of the Hungarian district heating sector 2020)

Figure 20. Settlements supplied with district heating

[44] https://www.portfolio.hu/gazdasag/20210605/a-naperomuvek-miatt-oriasi-fejlesztesek-jonnek-a-magyar-villamosenergia-rendszerben-486560



Source: MEKH/MATÁSZSZ, 2021

Figure 21. Energy consumption by district heat producers (2020)

Network loss has been between 12-13% since 2015, with no considerable improvement.

3.5.1 Overview of policies relevant to EE1st

The **NECP** foresees a 15% increase in DH capacity by 2030, coupled with a fuel shift. The goal is to reduce the share of natural gas to below 50% and reach a 60% renewables share. The latter aim translates into a doubling of the current RES heat supply capacity, which is unrealistic because it is based purely on the existing business case of DH producers and requires public financial support. The goal is to divert the entire DH sector to qualify for 'efficient DH/DC' as defined by EU law. It also refers to the need to develop the necessary legal and economic conditions for building out smaller DH systems – next to the existing urban systems – based on local renewables resources. Importantly, the government plans first to revise the current price regulation of the entire DH sector and then establish the necessary conditions for a competitive heat supply market.

The **Energy Strategy**, developed in 2019 on the basis of the NECP, sets the course for development of the Hungarian energy sector up to 2030. Apart from including a detailed definition of EE1st in line with European legislation (p. 74), it does not discuss the relevance of the principle for the district heating sector.

The **Law on District Heating** does not incorporate the EE1st concept or refer to policy approaches that could facilitate its implementation in the DH sector, such as the use of waste heat or access of third-party heat suppliers. The 'price regulation framework' is defined in this piece of legislation.

The planned **Green District Heating Strategy**, also referred to in the NECP, has yet to be developed. Key elements that have been mentioned officially include:

- increasing the share of renewables (up to 60%), including the use of geothermal energy, biomass, waste and biogas,
- improving temperature-control and measurement instruments in DH-supplied units,
- establishing a Geothermal Risk Fund to reduce exploration risk,
- developing a District Heating Programme,

- using waste in heat generation, and
- introducing DH regulation conducive to innovation.

The preparation of an 'integrated district heating plan' for each DH area is a precondition for public financial support. Plans must include:

- Demand projections
- Modernisation of buildings supplied by DH
- DH market expansion options
- Fuel-switch possibilities amenable to local conditions
- Modernisation of existing DH systems
- Quantification of GHG, final energy reduction and associated impacts on the share of renewables
- Social cost-benefit analysis.

The **Electricity Law** requires that DSO annual reports must include – every four years – integration options for district heating and cooling systems in terms of providing flexibility, including their technological possibilities and cost-effectiveness (Article 32B).

3.5.2 National specificities that might influence the implementation of EE1st

- **Heat providers of many different sizes and with different ownership**

The DH sector in Hungary is highly diverse. Differences in ownership and size results in unequal leverage to modernise systems. This is due, for example, to unequal opportunities to attract private financing for investment projects.

- **Technological state of DH systems**

Hungarian DH systems belong to the 'third generation': they operate at high flow temperature (100 °C) based on a single heat supply (usually natural gas, but can be oil, biomass or waste heat) where heat is transported via a paired or point-to-point pipeline (one transporting water forward and one backward). This does not facilitate a coupling of DH with the power system; nor does it facilitate integration of multiple heat sources (ambient heat, waste heat, etc.).

- **Cross-subsidised DH sector with artificially low end-user prices**

Various classical barriers (lack of access to capital and/or available information) and below-cost end-user prices are diverting investments in buildings energy efficiency away from optimal levels. At present, electricity consumers are cross-subsidising the entire DH sector via a dedicated levy.

- **Missing regional level governance**

National regulation focuses exclusively on price regulation. All other issues are managed at local level. An absence at regional level is not problem per se but can act as a barrier when planning beyond local level.

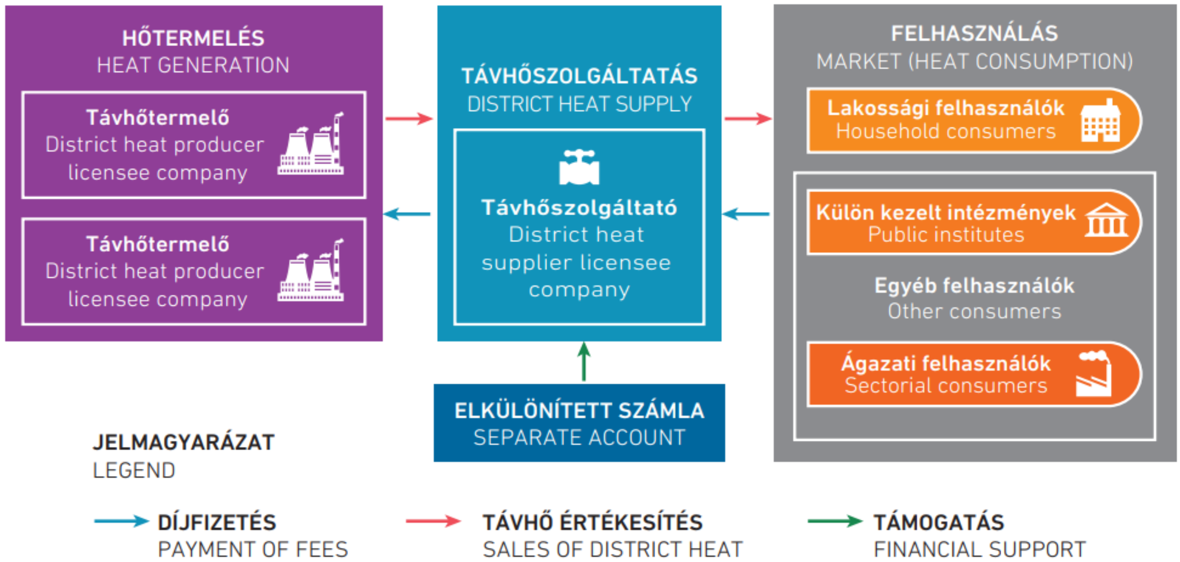
3.5.3 Current situation with implementing EE1st

The legislative and policy development process on DH remains unfinished in Hungary. Alongside the incomplete Green DH Strategy, a DH Action Plan – meant to be the satellite Action Plan for the Energy Strategy – was started in 2012-13 but never finished. Neither the EE1st principle nor demand-side options are included in the current legislative and policy documents. Moreover, the NECP presumes a DH demand increase of 15% by 2030, and at the same time targets energy efficiency for buildings in which the integration of a considerable volume of additional users is likewise presumed, but without clear evidence.

- **Price regulation**

Price regulation is a key barrier to creating a competitive, increasingly clean and efficient district heating sector in Hungary. As price control applies to both heat supply price and the end-user/heat service price in Hungary, no one has a vested interest in modernising DH. Ageing infrastructure increasingly causes reliability problems. This is a concern for DH companies, even without having to provide a 'quality of service' element.

The cross-financing of regulated end-user heat prices was exempted until 2022 under the EU's *de minimis* rule. There are no public plans on how to reform the price regime. This is an especially urgent issue to address, as the 'separate account' used for cross-subsidisation would need to be doubled to cover the extremely high fuel costs of heat suppliers (Figure 22).



Source: MEKH/MATÁSZSZ, 2021

Figure 22. Model of district heat supply

A DH company is a regulated company like a power DSO: NRAs potentially could trigger some changes in the investment decisions. Now, however, permitted revenue is decided on a case-by-case basis each year for each DH company. The remuneration scheme is a cost-plus regime with a 2% margin based on gross asset value. This rate is not only an ex-ante profit margin, it has an ex-post profit cap as well. Higher profit can only be retained by the DH company if it is invested in system- or cost efficiency (REKK, 2019).

Price control reform needs to include a longer price control period (currently just one year) to allow for planning, as well as an incentivising regulation that allows revenue to be kept and applied to operating more efficiently.

- **Integrated planning**

There is no requirement to integrate demand-side into DH investment decisions, and no coordination between DH modernisation and building renovation at system level. A key concern of DH companies for years has been reduced heat demand due to users leaving the DH sector. Consumers with viable alternatives (for example, a local boiler operated by a third party for a whole block of estates) have already left. The only demand-related improvement to the DH system is that most DH flats are equipped with cost allocators (cheaper than individual metering). While a better option than before, these are still not fully cost-reflective.

There is one solid example of combining end-use reduction and DH system modernisation: the city of Kecskemét. The city increased end-use efficiency via building modernisation, connected new users to the existing system to counterbalance demand loss, and planned the integration of a biomass heat source as well. The successful implementation required close cooperation between the DH company and the local government. The parties collectively secured financing resources (EU) and helped end-users with fund application and renovation. The DH company increased its market share and modernised the network itself, and the local government now has a stock of higher-value real estate.

As most DH companies are owned and are under direct management by the local government, integrated heat and building stock planning could be implemented relatively easily.

- **Third-party access**

Hungarian DH systems are based on single heat suppliers. Third-party access would bring in competition and should probably be included in the DH law, but this will require a circular heat network structure. The DH company of Budapest (Főtáv) is building a new, ringed network with the goal of creating competition among the various gas-based heat suppliers. This option, however, is only viable for large cities. Even where waste heat is available and technically suitable through a very small investment, the transaction cost for waste heat providers (unregulated private companies) obtaining the mandatory DH license from the NRA prohibits such opportunities.

Funding opportunities are key for DH companies, and funding for end-use efficiency and supply investment should be coordinated. A modern, 'fifth generation' DH system (such as the one planned in Mórahalom) allows third-party access to renewable sources and coupling with the power system via heat storage – but this requires investment support.

4 SPAIN

4.1 Overview of the energy sector in relation to EE1st

4.1.1 General framework and targets

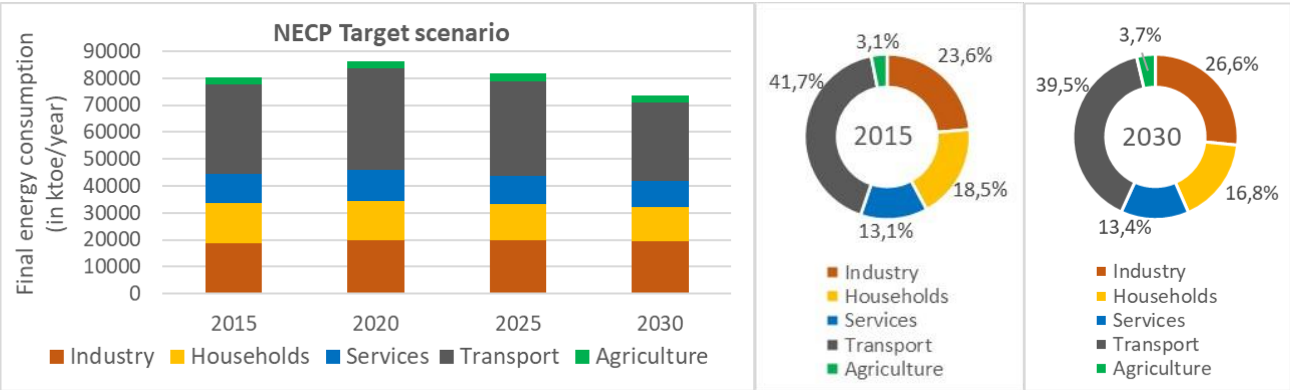
Three main strategic plans shape Spain's framework for energy policies and, more specifically, energy efficiency in buildings. They provide the background for considering opportunities to implement EE1st:

- The ELP 2050 (Long-Term Strategy for a Modern, Competitive and Climate-Neutral Spanish Economy in 2050), approved in November 2020, is the strategic planning instrument that establishes the long-term objectives of energy saving and emissions for all economic activities, including the buildings sector. Some of its overarching objectives for 2050 are:
    - achieving carbon neutrality (carbon sinks to absorb around 128% of total emissions),
    - producing 100% of electricity with RES (by quadrupling the amount of installed RES production power compared to 2020),
    - RES to make up 97% of national final energy consumption, and
    - importing only 13% of all energy consumed.

- The **ERESEE 2020** (Spanish Long-Term Renovation Strategy for Buildings), last updated in June 2020, formally develops the section of the ELP 2050 concerning buildings. Regarding the residential sector, these are the main objectives for 2050:
  - reducing final energy use by 37.3% compared to 2020 levels,
  - electrification of energy consumption, aiming at a value of 81.4%, and
  - reducing carbon emissions by 98.8% compared to 2020, which means an almost total decarbonisation of the sector by 2050.
- The **PNIEC 2021-2030** ([45]) (National Integrated Energy and Climate Plan 2021-2030) defines, among others, a specific pathway (based on current technology and knowledge) to achieve renovation objectives between 2021 and 2030. The plan's modelling basis derives from the ERESEE's data and hypothesis to create several renovation scenarios for the buildings sector for the 2021-2030 and 2031-2050 periods.

4.1.2 Overall perspective on energy and buildings

Buildings (differentiating between households and the service sector) represented 30.2% of Spain's total final energy consumption in the 2010-2019 period (18.7% and 11.5%, respectively), and 63.2% of total electricity consumption ([46]). In the target scenario presented in the PNIEC 2021-2030, by 2030 this share would remain about the same for services, while decreasing to 16.8% for households. This scenario aims at an 8% reduction in total final energy consumption in 2030 compared to 2015 (while the trend was upward to 2019). The households sector is expected to achieve 37% of this reduction (10% for the services sector).



Source: Own graphs from data of PNIEC 2021-2030 (Spain's NECP) (Table A.54)

Figure 23. Final energy consumption per sector (*ktoe/year*) in Spain's target scenario

In the last 15 years, electricity has remained the main energy source in households (more than 42% in 2019) and even more so in services (60% in 2019). A significant decrease in the share of oil products has been observed in both sectors: from 28.6% to 16.3% in households and from 26.0% to 11.7% in services.

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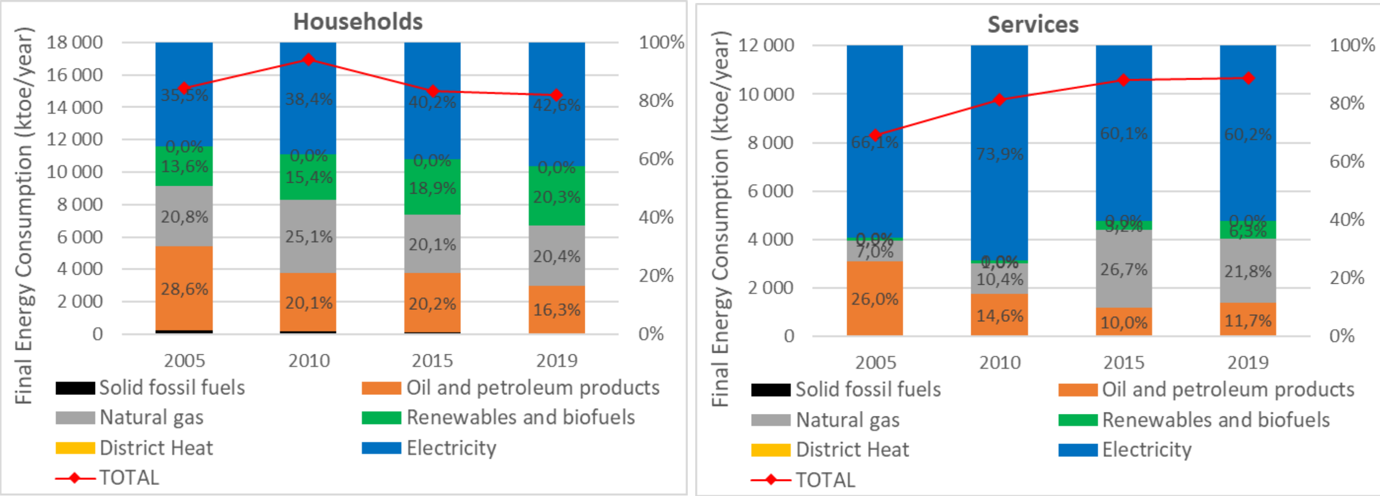
[45] This is Spain's NECP.

[46] On Spain's energy balance, see also: https://sieeweb.idae.es/consumofinal/bal.asp?txt=Consumo%20de%20energ%EDa%20final&tipbal=s&rep=1

The direct use of fossil fuels represented about 37% of households' final energy consumption in 2019 (not considering fossil fuels used for electricity supply). District heating (DH) is thus far negligible in the national energy balance.



Source: [Eurostat]

Figure 24. Spain's final energy consumption over 2005-2019 (*ktoe/year*) in households (*left*) and services (*right*), and per energy source (%)

While it was expected that the share of RES in gross electricity consumption would be about 42% in 2020, it was only 18% of final energy consumption for heating and cooling. The target scenario presented in the PNIEC 2021-2030 aims at doubling the RES share for electricity and multiplying by 1.7 the RES share for heating and cooling. Reduced final energy consumption, more specifically the consumption of fossil fuels, will also contribute to increasing these shares.

Table 7. Evolution of RES share in electricity generation and final consumption of energy for heating and cooling in Spain's target scenario

RES share (%)	2015	2020	2025	2030
– in electricity generation	37%	42%	64%	86%
– in final energy consumption for heating and cooling	17%	18%	25%	31%

Source: PNIEC 2021-2030 (Spain's NECP) (Table A.14 on RES share in heating and cooling, and Table A.17 on RES share in electricity generation)

4.1.3 Overview of the building stock

The Spanish building stock is analysed in depth in the first section of the [ERESEE 2020 document], which features a selection of the most relevant metrics and draws from other relevant sources (such as the Hotmaps project database). This section provides a brief but complete overview of the country's building stock, distinguishing residential and non-residential buildings.

4.1.3.1 Residential buildings

The following key figures from the ERESEE 2020 (from around 2018) provide an overview of residential stock:

- 25.7 million dwellings in total (corresponding to around 3.4 billion m^2) but 35% are secondary or unoccupied houses or main homes without a heating system. There are thus **16.6 million permanently inhabited (main residence) dwellings with heating systems**.

The following figures concern these 16.6 million dwellings but the shares are similar for secondary, unoccupied or without-heating dwellings:

- **44% were built between 1981 and 2007** and a further 34% were built between 1961 and 1980. Dwellings built before 1960 represent less than 17% of the total stock.
- **67% are in multi-family buildings** and mostly in buildings with more than three floors (8.7 million dwellings, 52%). Single-family buildings account for just 33%.
- **77% are owner-occupied**, a figure in line with other Mediterranean countries: 18% are in the rental sector ([47]).

The high share of condominiums may create a barrier to building renovations (more complex decision-making). At the same time, a simplified decision-making process represents an opportunity for a significant increase through large-scale renovation projects.

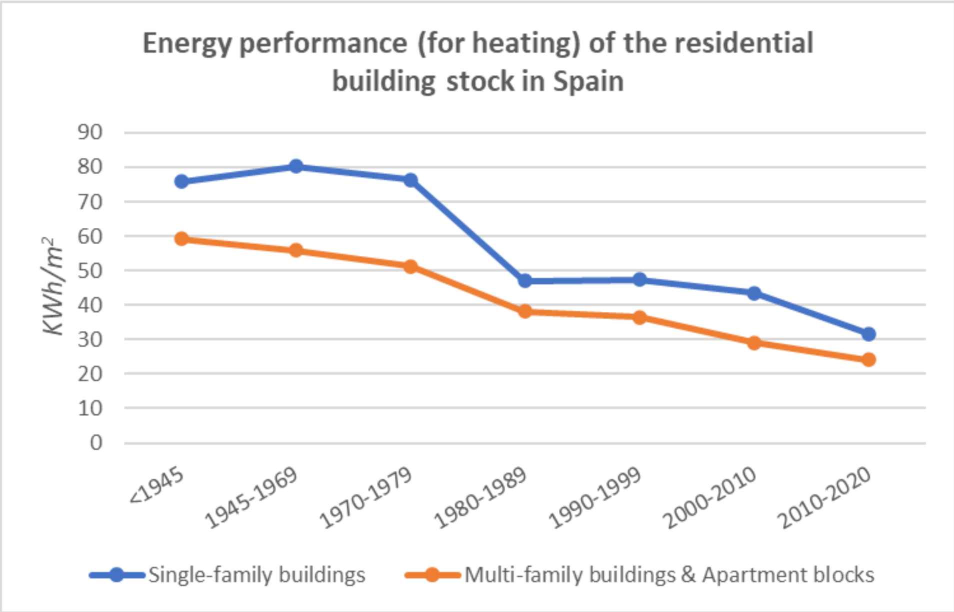
The dwellings stock is relatively young due to economic growth from the 1980s to 2007 ([48]). The 1997-2007 period saw record construction rates due to a speculative property bubble, which in turn brought a construction crisis.

The first thermal insulation requirements were adopted in 1969 but they were not strict (mostly fulfilled through the installation of cavity walls). The first building regulation to include significant energy requirements (especially regarding thermal insulation) came into force in 1980. This regulation was then revised in 1999, with new requirements approved in 2006 that delivered energy efficiency improvements of between 25% and 35%. The regulation has since then been revised several times (see section 4.3.1.4 for more details about the current regulation).

The effects of building regulations on the energy performance of dwellings can be seen in Figure 25, which shows specific heat demand (kWh/m²/year) for single-family houses and multi-family buildings. There was notable improvement between the 1970s and 1980s (around 38% for single-family houses and 20% for multi-family and apartment blocks) due to the entry into force of the new building regulation in 1980. The slower decreasing trend is also in line with the subsequent tightening of energy requirements.

[47] The remaining 5% correspond to another other type of tenure made available free of charge or for a price by another household, company, etc. The Hotmaps database provides further details about the shares per tenure type: social housing comprises 17% of apartment blocks (of more than three floors), while privately rented dwellings represent 12% single-family or small multi-family buildings with three or fewer floors.

[48] The second-biggest period of construction in Spain was the so-called ‘Francoist property cycle’ (1960-1975).

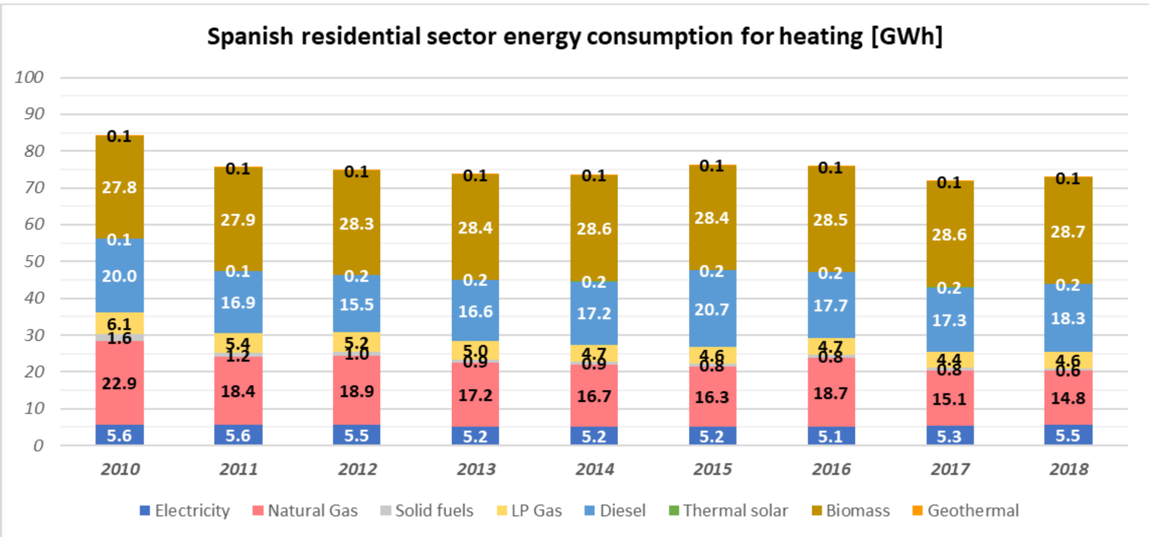


Source: Hotmaps

Figure 25. Energy performance of residential buildings in Spain in terms of specific heat demand (*kWh/m²/year*) according to building type and construction period

The average values shown in Figure 25 hide large geographical and climatic-zone differences.

Regarding energy consumption for heating, a breakdown by carriers ([49]) is presented in Figure 26:



Source: MITECO, IDAE and INE

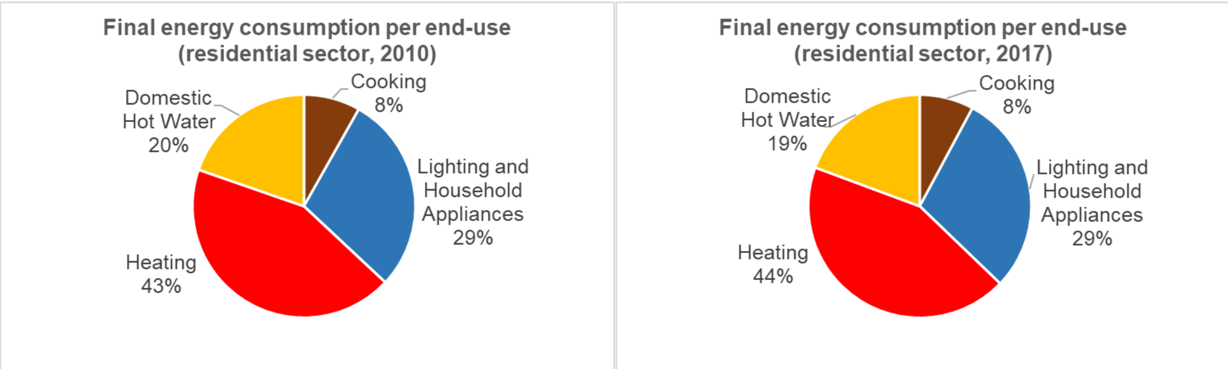
Figure 26. Spanish residential sector energy consumption for heating, per energy source (*GWh*)

[49] In this graph, biomass also includes charcoal.

The Spanish residential building stock still relies heavily on the direct use ([50]) of fossil fuels ([51]), which jointly accounted for 52% of heating consumption in 2018. However, a stable though arguably mild trend of reduction in total energy consumption (up to 13.4% in the period analysed) can be observed.

Biomass is the most prevalent energy source for space heating by a considerable margin (39% in 2018, against 25% for diesel), and its use (both in relative and absolute terms) has slowly but steadily increased in the last decade. Diesel (heating oil) has undergone slight ups and downs. Natural gas, which by 2010 was the second-largest energy carrier (27%), gradually decreased to 20% in 2018, below the share of heating oil. A similar though milder trend applies to LPG, while the share of electricity has remained stable, with a slight increase in relative terms by about 1%. Finally, as part of the 'solid fuels' category, the use of coal (though a marginal carrier from the beginning of the period analysed), has fallen remarkably (by around 62.5%).

The distribution of final energy consumption per main end-use remained stable in the last decade, despite variations in total final energy consumption: heating represents about 44%, lighting and appliances ([52]) 29%, domestic hot water 19%, and cooking 8%.



Source: from data of ERESEE 2020

Figure 27. Distribution of final energy consumption of residential buildings per main end-use in 2010 (*left*) and 2017 (*right*)

As is frequently the case regarding the energy performance of buildings, there can be large differences according to region and climatic zone.

4.1.3.2 Non-residential sector

The following key figures provide an overview of Spain's non-residential building stock (data from the ERESEE 2020 from around 2017, and excluding Basque Country and Navarre):

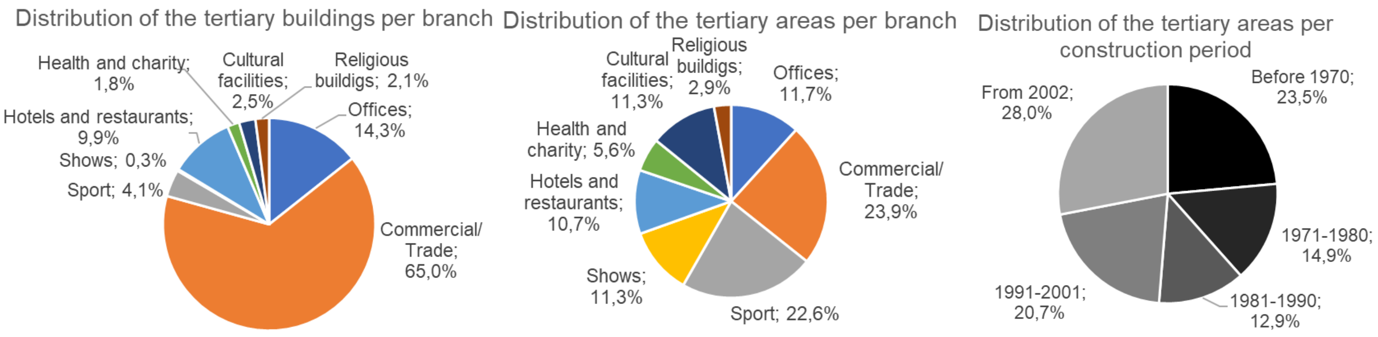
- There are 12.3 million non-residential buildings in total, 68% of which are storage and parking facilities; 17% are tertiary buildings and 14% are industrial buildings.

[50] This is, without considering the share of electricity produced from fossil fuels.

[51] The 'solid fuels' category, though including coal, also considers some other wood-derived fuels, so the category has not been included for calculating this percentage. In any case, its share is rather negligible.

[52] This category also includes cooling appliances. According to the EREESE 2020, cooling consumption was still very low (about 1% of the total for residential buildings), despite 30% of Spanish households (5.7 million) having some type of AC system (mostly in the Mediterranean climatic zone).

* **Tertiary buildings** represent about **13% of total floorspace (m²) ** built in Spain, but account for **42% of energy consumption from buildings**.
* Commercial (trade) buildings represent about two-thirds of the 2.1 million tertiary buildings, but less than one-fourth of tertiary building area. Sport facilities claim the second-largest share of area (23%). Most of the remaining area is fairly evenly distributed between offices, exhibition facilities, cultural facilities, and hotels and restaurants (each around 11-12%), with a smaller share for health facilities (6%).
* Spain's tertiary buildings are of **rather recent vintage**: about half the tertiary area has been built since 1990 (see Figure 28). However, as with residential buildings, construction rates for non-residential buildings have dropped significantly in the last ten years, particularly the trade sector, with around 79% fewer m² built compared to the 2000-2010 period (which included a slight boom in construction rates).

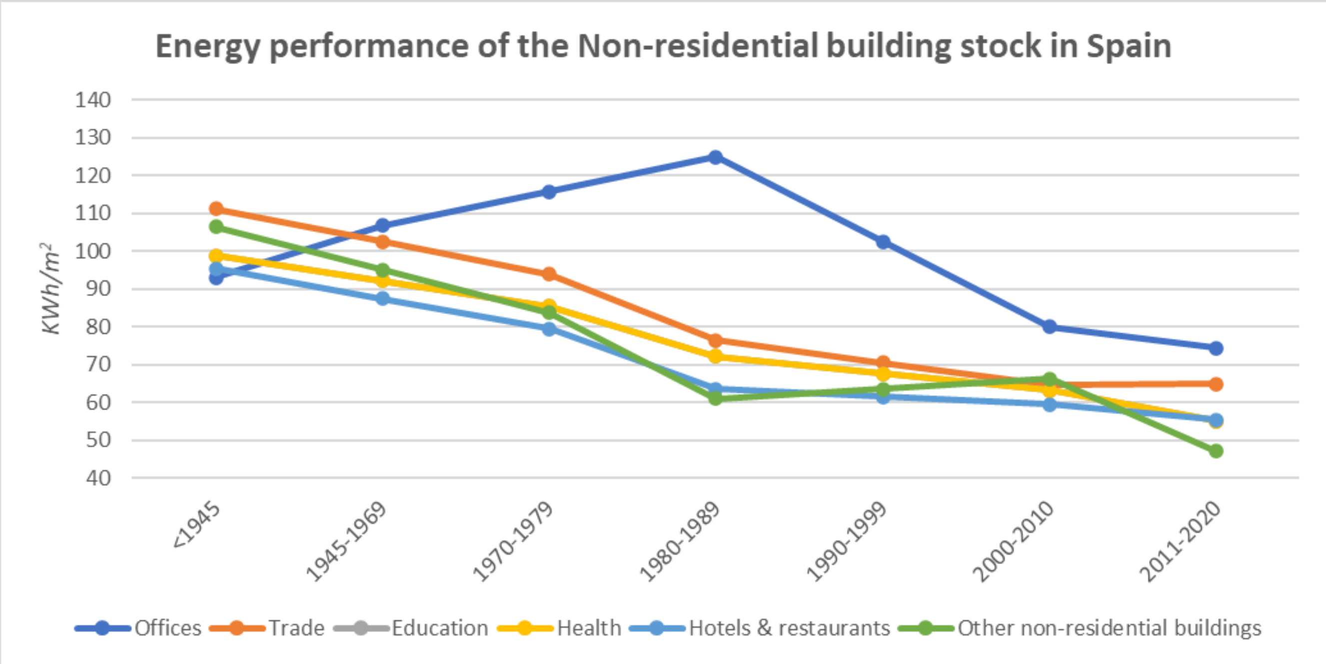


Source: Own graphs from data of the ERESEE 2020

Figure 28. Distribution of tertiary buildings per branch (*left*), tertiary areas per branch (*centre*) and per construction period (*right*)

Figure 29 provides an overview of average energy performance per branch and construction period in terms of useful energy demand per m² ([53]):

[53] Education and health facilities have the same performance values according to the data consulted, and they overlap in the graph.



Source: [Hotmaps]

Figure 29. Energy performance of non-residential buildings in Spain per use and construction period as useful energy demand for heating (*kWh/m²*)

The energy performance of non-residential buildings in Spain has improved gradually over time across all sectors with the exception of office buildings, for which improvements were quite significant in the 1980s ([54]). Among all categories, offices still lag behind, although it can be argued that the entire non-residential building sector has much room for improvement when compared to the residential sector. Tertiary buildings consume 41% of final energy used in buildings while comprising just 17% of the total building stock surface area. This means that non-residential buildings consume 3.4 times more energy per m^2 on average than residential buildings.

4.2 Governance system and interplay of institutions

In Spain, the **Autonomous Communities** (*Comunidades Autónomas*, NUTS2) governments have **exclusive competences concerning urban planning and housing**, according to Article 148.1 of the Spanish Constitution. For example, they bear the main responsibility for allocating public funds to final users in renovation programmes.

With this in mind, the main strategic document at national level concerning the renovation of the building stock (ERESEE 2020, see section 4.3.1.2 for more details) identifies the **need for regional strategies** to be developed and adopted in line with both the territorial singularities of each region (not only regarding their building stock, but more broadly at a social and economic level) and national long-term objectives aimed at deep decarbonisation of buildings. The national government has responded by taking an active stance to

[54] The increase can be linked to the massive influx of the personal computer in offices. This led to a redesign of working spaces that was not very (if at all) optimised in terms of energy conservation. (Evolución de los lugares de trabajo. De la oficina tradicional a los nuevos espacios de coworking, Universitat Politècnica de València).

effectively encourage the Autonomous Communities to develop their own strategic planning tools in concert with these goals, and always within the framework of their competences.

One such example is Article 3 of the 2013-2016 State Plan for the Promotion of Housing Rental, Building Rehabilitation and Urban Regeneration and Renovation, which established that the Collaboration Agreements signed with the Autonomous Communities must include a global Strategic Plan proposed by each Autonomous Community related to the execution of different programmes within the Plan – or, at the very least, an estimate of the number of actions to be financed annually.

However, the development of these Strategic Plans and the importance given to them by the Autonomous Communities is **quite uneven**, as not many Communities have taken the initiative to develop real strategic planning for rehabilitation and regeneration within their jurisdictions. Efforts in this direction are thus very much needed to **strengthen coordination at an inter-administrative level, both vertically and horizontally**. In this sense, the PNIEC 2021-2030 already contemplates measures such as periodical meetings of the **Interministerial Commission on Climate Change and Energy Transition**, and promotion of collaboration with Autonomous Regions through the **Climate Change Policy Coordination Commission**. These measures help to identify the interrelation of the PNIEC with regional policies while seeking to obtain the full involvement of each sphere of government to achieve national objectives. Moreover, Spain's NECP also mentions that coordination between various public administrations should be strengthened through a new **National System of Energy and Climate Policies, Measures and Projections**, whose role will be to meet reporting obligations, especially at EU and international levels (UNFCCC), by monitoring and centralising the information contained in various sectoral plans and policies.

Regarding compliance of the buildings sector with technical aspects, Spain is quite centralised, having developed a series of documents on national application. Examples include the Building Code (*Código Técnico de la Edificación*, known as CTE, see section 4.3.1.4) and the Regulations of Thermal Systems in Buildings (*Reglamento de las Instalaciones Térmicas de los Edificios*, RITE), which is referred to in the CTE.

4.3 Policy landscape for EE1st in buildings

Three overarching strategic documents and their mutual relationships are outlined here to help explain the Spanish approach to EE1st. They are then analysed more in-depth in subsection 4.3.1, along with other documents relevant to EE1st implementation.

The main strategic document dealing with the energy efficiency of Spain's building stock is the **National Long-Term Renovation Strategy**, **ERESEE** (*Estrategia a largo plazo para la Rehabilitación Energética en el Sector de la Edificación en España*) ([55]). It was last updated in June 2020 (ERESEE 2020) to comply with every part of the EPBD as amended in 2018.

In turn, the ERESEE content is in the framework of the **ELP 2050** (*Estrategia a Largo Plazo para una Economía Española Moderna, Competitiva y Climáticamente Neutra en 2050*), which is the strategic planning instrument that establishes **long-term objectives** in Spain for energy saving and carbon neutrality for all economic activities, including the buildings sector. The Spanish government approved this document on 3 November 2020. The ERESEE is the document that formally develops the section of the strategy concerning buildings, as stated in Annex section C.3.4.2 of the ELP 2050. This is done **in compliance with**

[5555] For a summary of the Spanish context for energy renovation of buildings, see de Arriba Segurado, 2021.

the EE1st principle (as explicitly mentioned in section 6.3 of the ELP 2050 and established in section 7.1 of the ERESEE).

The ELP 2050 strongly relies on another document, the **National Energy and Climate Plan**, which was prepared in line with the Governance Regulation of the Energy Union ((EU) 2018/1999). Referred to as the **PNIEC 2021-2030** (*Plan Nacional Integrado de Energía y Clima 2021-2030*), this document defines a specific pathway (based on current technology and knowledge) to achieve climate and energy goals set for 2030, including renovation objectives between 2021 and 2030. The modelling basis of the PNIEC feeds on ERESEE data and hypothesis to create several renovation scenarios to estimate the evolution of both the 2021-2030 and 2031-2050 periods for the building sector. As required by the Governance Regulation (Article 15 (1), the PNIEC will be updated every ten years and revised at the middle of the validity period. Compliance of the PNIEC 2021-2030 with the EE1st principle is explicitly mentioned in section 2.2.1, and its ongoing consistency with the ERESEE is guaranteed, as specified in Annex H, section 9.

4.3.1 Overview of policies relevant to EE1st

Seven key documents are considered relevant and comprehensive in the context of implementing EE1st in the buildings sector in Spain. These involve not only national long-term and mid-term strategies and plans (such as the overarching trio just described), but also laws, technical regulations and public financing programmes.

4.3.1.1 ELP 2050

The ELP 2050 (main document and annexes) is the overarching strategy to which all other relevant documents are subordinate. It can basically a hypernym of both the PNIEC and the ERESEE 2020, as they serve as instruments for its development in greater detail in their respective categories: temporal (PNIEC) and sectoral (ERESEE 2020).

The ELP 2050 makes use of the PNIEC modelling basis, considering **four different scenarios**:

- PNIEC trend scenario: This predicts progress on decarbonisation within the policy framework already set by the end of 2019. It would not achieve the 2030 objectives in the ELP 2050 document.
- PNIEC objective scenario: This takes into consideration the progress of measures planned in the PNIEC 2021-2030 to achieve objectives set for 2030 in the ELP 2050.
- ELP 2050 trend scenario: This predicts progress on decarbonisation within the policy framework already set by the end of 2030 by the PNIEC. It would not achieve the 2050 objectives.
- ELP 2050 objective scenario: This considers the evolution of decarbonisation by applying the measures set in the same document for the 2031-2050 period with the aim of achieving said objectives.

Focusing on the buildings sector, the ELP 2050 refers to the ERESEE 2020 for the development of its premises, highlighting a series of technologies to drive the attainment of decarbonisation and goals related to reduced consumption, divided into **four categories**:

- Digitalisation, behaviour, and management
- Technological solutions to achieve reduced energy demand (including thermal insulation)
- Thermal RES
- Electrification (including RES for self-consumption).

4.3.1.2 ERESEE 2020

The Spanish Long-Term Renovation Strategy (*Estrategia a largo plazo para la Rehabilitación Energética en el Sector de la Edificación en España*) is structured in three parts: diagnosis, objectives, and implementation.

The **diagnosis** component develops an analysis of all the technical, political and financial parameters that are required to serve as input data for determining subsequent **objectives** in line with the ELP 2050, and are developed in detail based on the results of PNIEC projections.

These objectives are intended to be met through a **series of rehabilitation 'menus'** (sets of measures), designed both for residential buildings (differentiating between envelope, DHW and heating, and additionally dedicating a separate subsection to homes in energy poverty) and non-residential buildings (differentiating between the private and public sectors). These menus are then aggregated in different ways and under different hypotheses to build complete renovation scenarios. The **implementation** component defines a series of measures and policies, as well as tracking indicators, to meet scenario outcomes.

The main established objectives for the building stock in terms of energy consumption and CO_2 emissions are summarised below, distinguishing between the residential and non-residential sectors:

- **Energy consumption reduction objectives**
  - *Residential sector*

Table 8. Final energy consumption for the residential sector (excluding non-energetic uses) for the ELP objective scenario (*GWh*)

	2020	2030	2040	2050
Fossil fuels	72 448	47 465	21 995	0
Electricity	68 823	64 403	78 561	88 110
RES	31 148	34 157	23 627	20 155
Total	***172 419***	***146 025***	***124 183***	***108 265***

Source: ERESEE 2020

In terms of energy efficiency, this estimate considers an overall reduction of 64 154 GWh in final energy use by 2050, equivalent to a reduction of 37.3% compared to consumption in 2020. The savings breakdown would be 41.1% between 2020 and 2030, 34.1% between 2030 and 2040, and 24.8% between 2040 and 2050. The use of fossil fuels would cease by 2050 (carbon neutrality goal). Electrification of demand (81.4% of total consumption is expected to be electrical by 2050), mentioned in the ELP 2050, is made evident.

  - *Non-residential sector*

Table 9. Final energy consumption for the non-residential sector (excluding non-energetic uses) for the ELP objective scenario (*GWh*)

	2020	2030	2040	2050
Fossil fuels	53 763	37 572	8 385	0
Electricity	75 379	72 201	76 987	77 306
RES	2 715	5 016	6 331	7 157
Total	***131 857***	***114 789***	***91 703***	***84 463***

Source: ERESEE 2020

The final energy consumption target set for 2050 (-47,395 GWh) is equivalent to a reduction of 36% compared to consumption in 2020. This reduction would be intense for the first ten years (36% between 2020 and 2030), peak between 2030 and 2040 (49%), and slow to 15% between 2040 and 2050. Electrification of the non-residential sector (demand by 2050 is expected to represent 91.5% of the total) is even larger than for the residential sector.

- **Objectives to reduce carbon emissions**
  - *Residential sector*

Table 10. Residential sector CO_2 emissions for the ELP objective scenario (*kt*)

2020	2030	2040	2050
17 044	10 725	4 854	201

Source: ERESEE 2020

The ELP 2050 data adapted to the household path ([56]) forecasts reduced emissions by 98.8% compared to 2020, which means almost total decarbonisation by 2050 ([57]).

Apart from the objectives defined above, the measures and policies suggested for compliance with set objectives stand out as a main strategy outcome, as they strive for correct implementation in all areas. Related objectives, clustered in 11 different sets called 'structural axes', are summarised here:

1. **Promotion of sectoral, vertical and horizontal coordination**: The objective of this axis is to strengthen or create, where appropriate, the administrative structures necessary to develop and promote the ERESEE at national, regional and municipal levels. This involves articulating the necessary coordination mechanisms at sectoral level (between different ministerial departments), vertically (between the different public institutions involved in strategy implementation), and horizontally (considering other key actors in the buildings refurbishment sector).

2. **Regulatory development and administrative measures favouring energy renovation:** This axis aims to promote development of the existing regulatory framework related to buildings refurbishment and energy efficiency, as well as to provide instruments and tools to municipalities for the implementation of urban renewal actions. These measures include improving IT solutions to apply for administrative permits, limiting certain inadequate sources of consumption (like façade illuminations at night), and promoting the installation of automatic systems in the tertiary and industry sectors to optimise energy use.

3. **Renovation of public administration buildings and other exemplary measures:** To extend the requirement laid down in Article 5 of Directive 2012/27/EU – according to which 3% of total surface area of buildings with heating and/or cooling systems owned and occupied by the General State Administration must be renovated annually – it is necessary to increase this percentage and extend its application to buildings not listed in the current inventory. Another proposal is to extend this commitment to buildings belonging to other public administrations.

4. **Public financing measures:** The purpose of this axis is to continue with public aid programmes commissioned in recent years and to resolve identified aspects that allow room for improvement. To this end, some new actions have been established (opening a network of one-stop shops), and the consideration of general criteria is recommended when defining new financing programmes or reforming or continuing existing ones.

5. **Measures for the promotion and mobilisation of private financing:** This set of measures aims to encourage the mobilisation of private funding by removing barriers that currently prevent their large-

[56] Data considered by the *Ministerio de Transporte, Movilidad y Agenda urbana* (MITMA).

[57] Projected reduced carbon emissions are not provided for the non-residential sector

scale deployment. These include the creation of a guarantee fund to cover defaults, as well as encouraging public-private collaborative endeavours, etc.

6. **Fight against energy poverty:** This axis incorporates measures contemplated in the National Strategy against Energy Poverty 2019-2024 (*Estrategia Nacional contra la Pobreza Energética 2019-2024*) that are directly related to energy rehabilitation. These include creating administrative structures to address energy poverty and engaging with different public administrations to increase knowledge about the topic.

7. **Measures for the deployment of a new energy model in the buildings sector:** The objectives here are to contribute to the deployment of a new energy model in the buildings sector in coordination with sectoral objectives related to energy and climate. Relevant measures include reforming the regulatory framework for domestic energy uses, promoting bioclimatic architecture, implementing community-owned renewable energy installations, and improving the current regime of energy performance certificates.

8. **Measures for the activation and aggregation of demand:** These measures can contribute to activating demand, facilitating decision-making and financing for owners, and searching for synergies between energy rehabilitation and compulsory conservation works. They also promote the aggregation of demand at building and neighbourhood levels. Other measures involve revising the horizontal property law to facilitate decision-making (already implemented as of October 2021) ([58]) or analysing the potential development of building renovation passports.

9. **Supply-side measures: professionalisation, modernised rehabilitation, education and training:** The main objective of these measures is to ride the current wave of new and modernised professional services and to address building renovation as a 'well-rounded service'. These measures include expanding academic opportunities in universities and technical schools regarding energy renovation of buildings, as well as developing technical guides to support decarbonisation.

10. **Society and information / Citizenship engagement:** The aims of this axis are to promote cultural change among citizens, awaken greater social awareness of energy savings, build up maintenance and renovation capacities, and spark urban regeneration in towns and cities. Moreover, the measures included in this axis aim to effectively disseminate (in a more technical sense) pioneering or innovative experiences in the field of buildings renovation and urban regeneration that can be replicated elsewhere. These goals are to be achieved through communication campaigns and by supporting technical forums that enable the exchange of ideas and experiences related to energy efficiency in buildings and urban renovation.

11. **Development of statistics, indicators and monitoring:** The goal of the measures in this axis is to address the current lack of knowledge about real energy consumption in Spain's residential sector (and thus to adequately promote energy and renovation policies), as well as to develop monitoring indicators for publicly funded programmes to facilitate the proper evaluation of public policies. These measures include conducting surveys on the penetration of different heating/cooling technologies in the building stock, and investing in research related to living conditions, comfort, indoor air quality, etc.

[58] https://www.boe.es/diario_boe/txt.php?id=BOE-A-2021-16230

4.3.1.3 PNIEC 2021-2030

The PNIEC 2021-2030 (*Plan Nacional Integrado de Energía y Clima 2021-2030*), **Spain's National Energy and Climate Plan**, is prepared in line with the Governance Regulation of the Energy Union ((EU) 2018/1999). It defines the objectives for reducing GHG emissions, increasing renewable energy penetration, and improving energy efficiency across every sector of the Spanish economy for the 2021-2030 period. An interesting point of the PNIEC is that scenario assessments **consider the opportunities and benefits related to employment, health and the environment**, while minimising transition costs in the most carbon-intensive sectors.

In line with the Governance Regulation template, PNIEC objectives and action lines are structured according to the five dimensions of the Energy Union: Decarbonisation; Energy efficiency; Energy security; Internal energy market; and Research, innovation, and competitiveness.

Concerning the energy efficiency dimension, four objectives are explicitly defined for the buildings sector, all of which are linked to energy renovation ([59]):

- For private buildings:
  - Improve the thermal envelope of 1.2 million dwellings (equivalent to 120 000 dwellings per year on average).
  - Renovate heating and domestic hot water (DHW) systems at a rate of 300 000 dwellings per year on average.
- For public buildings:
  - Energy renovation of the public building stock of the General State Administration above the 3% target derived from Article 5 of the Energy Efficiency Directive (equivalent to 300 000 m^2 per year).
  - Energy renovation of 3% of built and air-conditioned floor area of the Autonomous and Local Administrations.

Measures and action mechanisms suggested to achieve these goals include the following:

- Residential sector, 1st measure: '**Improving energy efficiency of the building stock'** involves the following action mechanisms:
  - **Taxation:** Internalising the externalities of improving EE in buildings.
  - **Legislative measures**: Transposing EU Directives on new EE and RES requirements into national legislation and revising the Horizontal Property Law so that homeowner associations (HOAs) can gain access to private financing.
  - **Public support programmes:** Launching non-refundable grants and wide-reaching financing programmes for energy renovation of existing buildings and urban regeneration.

[59] The objectives of energy consumption and reduced building stock emissions are mentioned in the ERESEE (see section 4.3.1.2).

- **Fostering private financing:** Creating financing programmes in collaboration with private entities (aimed at HOAs).
- **Training**: Upskilling of agents involved in the energy refurbishment process, as well as EE training at financial institutions.
- **Information and communication:** Issuing guides and manuals, strengthening interprofessional collaboration on EE, organising forums and launching communication campaigns.

- Residential sector, 2nd measure: **'Renovation of energy systems'**, through:

  - **Voluntary agreements**: Signing agreements with market stakeholders on household appliances to coordinate information campaigns.
  - **Training:** Preparing courses on EE in household appliances (aimed at retailers and consumers).
  - **Information and communication:** Making updated information on energy labelling available on public websites, organising campaigns, encouraging the purchase of better-performing energy efficient appliances.

- Tertiary (non-residential) sector, 1st measure: **'Improving energy efficiency of the building stock'**, with the help of:

  - **Legislative measures**: Extending the mandate derived from Article 5 of Directive 2012/27/EU to all public administrations.
  - **Public support programmes**: Introducing non-refundable grants and financing programmes to improve energy performance ratings (aimed at service buildings).
  - **Training**: Upskilling of agents involved in energy renovations and financial institutions.
  - **Information and communication:** Issuing guides and manuals, organising professional forums and preparing communication campaigns on EE for different tertiary sectors.

- Tertiary (non-residential) sector, 2nd measure: **'Energy efficiency in refrigeration equipment and large air-conditioning installations in the tertiary sector and public infrastructures'**, by offering non-refundable grants and financing for this type of equipment and infrastructure. Regarding actions related to publicly owned infrastructures, these programmes will also provide necessary technical assistance on the definition of technical specifications and public procurement.

4.3.1.4 CTE-DB-HE

The Technical Building Code (*Código Técnico de la Edificación*, CTE) is the set of core regulations that establishes the technical-legislative framework for safety and habitability in which buildings must be constructed. This is a set of general requirements, applied nationally, that must be complied with in the construction of any building whatsoever. Subject to periodic updates, the CTE underwent its last major overhaul in December 2019.

The requirements cover all phases of a building project, from the design phase to construction of the building itself, as well as any subsequent maintenance and upkeep. It is a **performance-based standard** that dictates the essential requirements of building construction. Divided into six different categories, each is addressed individually in the so-called 'basic documents' (*Documentos Básicos*), each of which has its own code.

The basic document related to energy efficiency is the **CTE-DB-HE for energy savings**, which covers six criteria: Limitation of energy consumption (CTE-DB-HE0); Conditions for the control of energy demand (CTE-DB-HE1); Conditions for thermal systems (CTE-DB-HE2); Conditions for lighting systems (CTE-DB-HE3); Minimum contribution of renewable energy to meet DHW demand (CTE-DB-HE4); and Minimum electricity generation (CTE-DB-HE5).

The last update from December 2019 (which entered into force in September 2020) was Spain's introduction to the **nearly Zero-Energy Building** (**nZEB**) concept. Any building that complies with the current requirements set in the CTE-DB-HE0 is considered an nZEB. These requirements are **adapted to the country's different climatic regions** and consist of maximum limits for total and non-renewable primary energy consumption levels on the basis of kWh/m^2 per year. Thermal insulation requirements featured in the CTE-DB-HE1 differ depending on the climatic zone.

4.3.1.5 Agenda Urbana Española (AUE)

The Spanish Urban Agenda (*Agenda Urbana Española,* AUE) is a strategic and non-binding document that aims to enable local authorities (at municipal level), through an understanding of AUE principles, to obtain their own tailored action plans. The plan defines ten strategic objectives that encompass all aspects (social, economic, environmental, etc.) linked to urban development, as well as 291 action lines to help tackle an assortment of challenges. Each of these ten strategic objectives has its own PDF file publicly available on the official AUE website.

The AUE is part of the current government programme and frames a series of cross-cutting and integrated measures, thus representing a complete 'national urban policy'. This is the result of a broad participatory process in which Spanish municipalities play a fundamental role. The Agenda is aligned with international agreements and objectives, and also contains criteria and objectives designed to inform public policies on sustainable and integrated rural and urban development.

AUE implementation is ongoing, partly through actions included in its own action plan and which are the responsibility of the General State Administration, and partly by promoting the preparation of municipal action plans in accordance with the established methodology and within the framework of the aforementioned ten strategic objectives. Two of these objectives stand out because of their relation to ENEFIRST principles:

– Strategic objective 2: **'Avoid urban sprawl and revitalise the existing city'** defines six specific objectives:

- Define an urban model that promotes compactness, urban balance and the provision of basic services.
- Ensure functional complexity and diversity of use.
- Ensure good quality and universal accessibility for public spaces.
- Improve the urban environment and reduce pollution.
- Boost urban regeneration.
- Improve the quality and sustainability of buildings.

– Strategic objective 3: **'Prevent and reduce the impacts of climate change and improve resilience'** defines three specific objectives:

- Adapt the territorial and urban model to the effects of climate change and achieve progress in preventing climate change.
- Reduce greenhouse emissions.
- Strengthen resilience to climate change.

4.3.1.6 Funding programmes for energy efficiency in buildings

Several public administration-sponsored renovation programmes have already been implemented, either as an exclusive goal or as part of multi-objective initiatives. The most relevant are summarised here.

4.3.1.6.1 Spain's recovery and resilience plan (NextGenerationEU)

With up to EUR 140 billion of EU funds to be gradually transferred, the measures considered in this plan ([60]) encompass 30 components that aim to realise actions along four directive lines (called 'domains'). These are: Green transition; Digital transformation; Gender equality; Social and territorial cohesion.

Component 2, known as the 'Building renovation and urban regeneration plan', concerns buildings and is linked to the EE1st principle. An estimated EUR 6.82 billion has been allocated for measures within this component, along with EUR 4.55 billion in private financing (accounting for 40% of the total).

Component 2 has a dual objective:

– The first is to activate a renovation sector in Spain that can accelerate decarbonisation and improve the quality and comfort of the building stock through the construction of buildings for social rental housing, which is currently insufficient. This is in response to the urgent need of the Spanish population for decent and affordable housing, with a special focus on the most vulnerable sectors of society. This is an important step towards improving social resilience and ensuring a fairer and more inclusive recovery.

– The second objective concerns the field of rehabilitation. The aim here is to generate a substantial increase in the rate of renovation of the building stock with models that, due to their technical and financial viability, can be sustained over the medium- and long term. If successful, PNIEC objectives would be met in advance and within the framework of the ERESEE 2020.

Likewise, the renovation of the housing and building stock demonstrates a commitment to comprehensive approaches so that the improvement of energy efficiency and integration of renewable energy sources is accompanied by improvements in habitability, accessibility, conservation, safety of use and digitalisation of buildings. To this end, the entire action plan of the Spanish Urban Agenda (AUE) will be implemented in towns and cities, with the promotion of urban rehabilitation and regeneration as a key element in the reactivation of the construction and real estate sectors. These sectors have great potential because of the age and conservation requirements of the building stock, in addition to their capacity to decarbonise the economy by triggering innovation in financial instruments, job creation and social cohesion.

[60] See also the Royal Decree 853/2021 from 5 October 2021 on the regulation of aid programmes for residential rehabilitation and social housing in the Recovery, Transformation and Resilience Plan.

Component 2 programmes include a series of reforms and investments ([61]) that provide a framework of support at different scales, from territorial to building level, as well as intervention at the building and housing levels. All this will take place both in metropolitan and in rural areas while also taking social rental housing needs into account. The Component includes a response to the challenges of climate change, the need to mitigate energy poverty, and the call to provide decent housing for the most vulnerable groups. The Component also aims to tackle the demographic challenge of depopulation, paying special attention to low-population areas. This entire scope of efforts is based on concerted action and inter-administrative collaboration, and involves interventions concerning public and privately owned buildings.

Component 2 proposes the distribution of funds from among a series of investment programmes, as shown in Table 11.

Table 11. Different programmes and investment options under Component 2 of Spain's recovery and resilience plan

Component 2 programme name	Public investment [EUR mln]	% of total
Housing rehabilitation programme for economic and social recovery in residential environments	3 420	50.1%
Programme for the construction of social rental housing in energy efficient buildings	1 000	14.7%
Buildings Energy Rehabilitation Programme *(Programa de Rehabilitación Energética de Edificios,* PREE*)*	300	4.4%
Regeneration programme and demographic challenge	1 000	14.7%
Programme to promote the rehabilitation of public buildings (*Programa de impulso a la rehabilitación de edificios públicos,* PIREP*)*	1 080	15.8%
Aid programme for the development of pilot projects of local action plans in the Spanish Urban Agenda (AUE)	20	0.3%
TOTAL	**6 820**	**100%**

Source: Spain's recovery and resilience plan

[61] https://www.mitma.gob.es/ministerio/proyectos-singulares/prtr/vivienda-y-agenda-urbana/componentes

4.3.1.6.2 Plan Estatal de Vivienda 2018-2021

The State Housing Plan 2018-2021 ([62]) (*Plan Estatal de Vivienda 2018-2021*), promoted by the Ministry of Transport, Mobility, and Urban Agenda (MITMA), consists of ten different programmes, two of which (with a budget of roughly EUR 442 million) align with the ENEFIRST principle. These are:

- Programme for the promotion of energy efficiency and sustainability in housing
- Programme for the promotion of urban and rural regeneration and renovation

The purpose of the first programme is to finance, both in urban and rural areas, the financing of energy efficiency and sustainability improvement works, with a special focus on works related to the building envelope of collective residential buildings, including their dwellings, as well as single-family houses.

The purpose of the second programme is to finance the joint execution of: refurbishing works on buildings and dwellings (including single-family dwellings); urbanisation or redevelopment of public spaces; and, where appropriate, the construction of buildings or dwellings to replace demolished ones within previously defined areas of action (urban or rural regeneration areas). This includes cases of substandard housing and shantytowns, although in this case the construction of buildings and dwellings will be based on resident cohabitation units and their characteristics (not involving the substitution of other demolished buildings or dwellings). The primary aim is to encourage social inclusion through the provision of decent housing in an inclusive context.

The competences for housing belong exclusively to the Autonomous Communities ([63]) (NUTS 2 regions of Spain). Funds for the development of housing plans are forwarded from the central administration to the regional governments.

State housing plans are drawn up in Spain almost every four years. A new State Housing Plan ([64]) is under development to cover the 2022-2025 period, with the majority of funds for implementation expected to come from the resilience programme. Contrary to the 2018-2021 plan, none of the 12 programmes envisaged considers grants for the renovation of the building stock outside the substandard housing sphere. This feature has drawn pointed criticism from some regional governments, such as the government in Galicia ([65]), where climate conditions infer an energy demand for heating that is higher than the national average.

4.3.2 National specificities that might influence the implementation of EE1st

One explanation for the apparent lack of enthusiasm from the Spanish National administration concerning the implementation of energy efficiency in buildings (particularly those aiming to reduce cooling and heating demand) is that the country, together with other Mediterranean nations, is among those with the lowest energy consumption in the residential sector. In fact, Spain's share of energy consumption in the residential sector is the lowest in the EU. According to data from the NEEAP 2017-2020 (referring to 2014 figures), the building sector in Spain represented just 29.7% of total final energy demand in Spain, compared to the EU average of 38.5%. Also, Spain's share of heating in total residential sector consumption is 43% compared to the EU average of 64.4%. Differences in climate and population distribution (most of the Spanish population

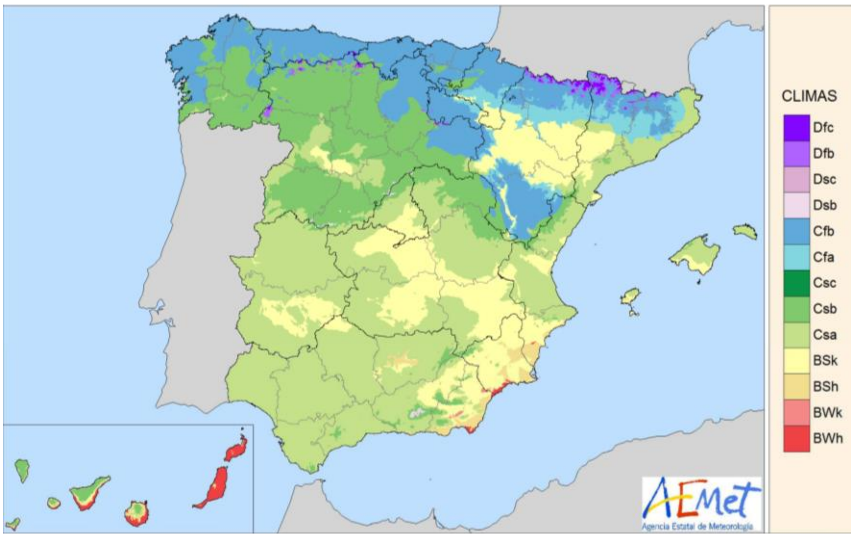
[62] On the timing of the new Plan, see : https://www.mitma.gob.es/el-ministerio/sala-de-prensa/noticias/mie-09122020-1745

[63] https://www.congreso.es/entradap/l12p/e12/e_0127797_n_000.pdf

[64] https://www.mitma.es/recursos_mfom/audienciainfopublica/recursos/pev_22-25_16-06-212.pdf

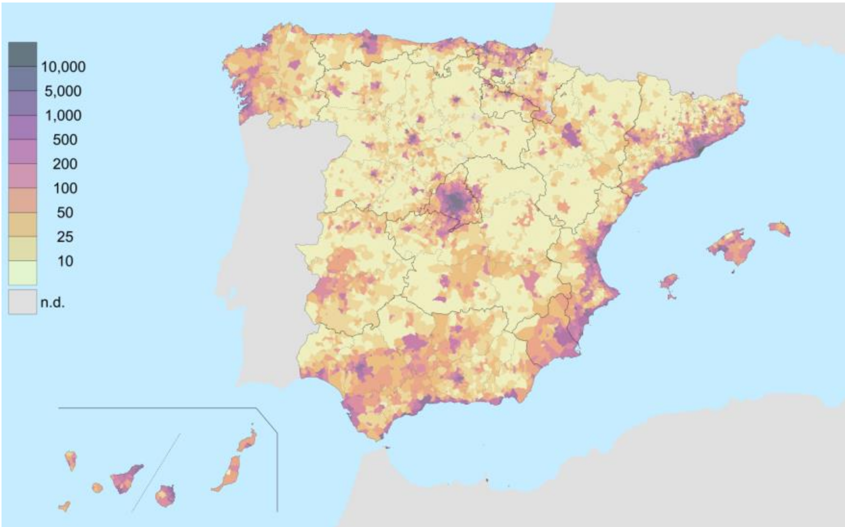
[65] https://www.xunta.gal/hemeroteca/-/nova/128300/xunta-advirte-que-novo-plan-estatal-vivenda-costas-rehabilitacion-conservacion?langId=es_ES

lives in climatic zones with mild winters) are certainly key factors behind these numbers, as Figure 30 and Figure 31 show.



Source: Spain's State Meteorological Agency (AEMET)

Figure 30. Köppen-Geiger climate classification for Spain (1981-2010)



Source: Spain's National Statistics Institute (INE)

Figure 31. Population density in Spain (2019)

These facts help explain the minimal presence of district energy networks in Spain. The few that exist were generally built in the framework of experimental projects, with strong support for their construction from the public administration. Due to generally low energy demand, they have not been very attractive from a cost-efficiency perspective, as energy density is small and transport losses are magnified. Another reason is that their installation in already densely populated urban areas has proved costly and complicated from a technical/logistical point of view (every building has its own individual/block system already in place). The reasons for their lack of popularity in new areas of lower density are the same. Therefore, most of the measures promoted by the Spanish government have focused on envelope-insulation interventions in the building stock. This approach is much simpler in technical terms than embarking on large-scale implementation of district networks. Given the prospects for the massive electrification of building energy consumption proposed in the ERESEE, district networks in Spain are not likely to acquire as much relevance as in other Member States. On the other hand, the NECP has underscored the potential of district networks to help decarbonise heating within the buildings sector (see section 4.5).

As shown in Figure 22, Spain is the most climate-diverse country in Europe, and among the ten most climate-diverse countries in the world ([66]). Added to this is the fact that exclusive competences for housing and urban development are held by the Regions, which makes the application of energy efficiency measures across the country highly dependant on interinstitutional cooperation and strategic planning tailored to regional needs. This in itself represents an important challenge at the political level. Priorities for different governments tend to diverge widely around this topic.

Notwithstanding the challenges that potential discrepancies and stagnation can pose, the wide margins given to Autonomous Communities to design their own strategies offers a huge opportunity for energy renovation programmes to better adapt to local conditions. This in turn can result in a more effective implementation of EE1st measures across the entire country.

4.3.3 Current situation with implementing EE1st

Based on received input from the interviewees, a series of issues around EE1st and building performance and their potential solutions have been identified:

- **On the Building Code (*Código Técnico de la Edificación*, *CTE*):** The energy consumption limit figures defined in the CTE-DB-HE0 (the sub-document defining the energy consumption limitation of buildings, described in section 4.3.1.4) are established for total and non-renewable primary energy/m^2 and are thus subject to conversion coefficients from final energy values, the definitions of which are based on the characteristics of different fuels and, to a certain extent, arbitrary (giving rise to political interference). The case is even more pronounced for electricity, where the contribution of different sources of production to the mix varies constantly: this undoubtedly allows for a misrepresentation of actual energy performance. It is possible, for example, for a single non-refurbished building to generate different figures for non-renewable primary energy consumption, depending on the coefficient values in force when measurement takes place. Some of these coefficients are highly controversial. Biomass, for example, has a conversion coefficient from final to primary non-renewable energy of 0.034, making its designation as 'clean energy' rather questionable ([67]). Final energy demand (kWh/m^2/year) should also be considered as a parameter so as to favour non-consumption of energy (the cornerstone of EE1st measures), rather than by allowing any 'renewable' energy source whatsoever to cover former fossil energy use at no cost (especially when it increases the total consumption of energy). The over-dimensioning of RES installations has a negative overall environmental impact.

- **On energy performance certificates (EPCs):** Energy performance certificates in Spain ([68]) are based on non-renewable primary energy consumption (as well as CO_2 emissions), so there is no strong correlation between this form of non-renewable consumption and household energy bills, as

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[66] https://www.aemet.es/documentos/es/conocermas/recursos_en_linea/publicaciones_y_estudios/publicaciones/Atlas-climatologico/Atlas.pdf

[67] https://www.science.org/doi/10.1126/science.aat2305

[68] https://energia.gob.es/desarrollo/EficienciaEnergetica/CertificacionEnergetica/DocumentosReconocidos/Paginas/documentosreconocidos.aspx

conversion factors are involved. Current EPCs in Spain, which were updated in June 2021 ([69]), should include at least one indicator of final energy consumption, as this is what effectively ends up determining the amount of the bill. This would help raise public awareness by making clear the correlation between the rating obtained by a building in the certificate and the associated energy costs. It is contradictory that a building can get a 'good' energy rating despite increasing its energy consumption, such as changing a heating installation to biomass, which has a very low conversion coefficient into non-renewable primary energy – or by expanding an on-site PV power installation without doing anything else to reduce the building's energy consumption.

- **Concerning the use of NextGenerationEU funds**: Energy rehabilitation actions that achieve a minimum 30% reduction in primary energy consumption ([70]) but not final energy consumption (or possibly involving an indicator that is a combination of both) are eligible for subsidies within the framework of Spain's recovery and resilience plan (see Table 11). If most renovations achieve only the minimum threshold of 30% of primary energy consumption, a great opportunity to lower demand over the long term will be missed. As light/medium/deep retrofitting have yet to be defined at European or national level, there is no standardised way to determine any basis for financial support. At least one indicator related to final energy consumption should be considered, or some parameter more in line with the EE1st principle.

- **Regarding implementation of time-of-use (ToU) tariffs:** In the context of the electrification of energy consumption, the fixed terms of electricity bills have increased following the introduction of these types of tariffs in Spain ([71,72]), thus shrinking the margin for consumer savings. This is discouraging, as it makes investments to reduce such consumption less attractive by prolonging the payback period.

On a broader scale, a series of current challenges and potentially effective approaches for implementing EE1st in Spain have also been identified:

- **Strengthen public awareness of EE1st measures in all areas:** The latest move to update electricity consumption tariffication (which establishes off-peak, flat, and peak tariff periods) is a step in the right direction, as the purpose is to avoid over-sizing the electricity grid (encouraging consumption during off-peak hours and doing the opposite during peak hours). However, the underlying reasons behind this measure have not been well explained to the public. An air of mistrust around the tariff ([73,74]) is damaging the image of sustainability policies in general, and this does not help in getting the public to adopt a proactive stance towards the "sustainable revolution" to come. The aim of communication efforts should be to prevent misconceptions. Citizens should be made aware of their own importance in the transition to a less carbon-intensive socio-economic model, and consequently become more actively involved. Public demand is a driver for accelerated change, as all sectors of the economy always seek to satisfy their demands, adapting as necessary. This also applies to the political sector,

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69 https://www.certificadosenergeticos.com/contenido-minimo-del-certificado-energetico

70 https://www.boe.es/diario_boe/txt.php?id=BOE-A-2021-16233 See Art. 14.

71 https://www.boe.es/diario_boe/txt.php?id=BOE-A-2021-4565

72 https://www.boe.es/diario_boe/txt.php?id=BOE-A-2020-1066

73 https://prnoticias.com/2021/07/12/appino-hacer-la-colada-por-la-noche-no-ha-incidido-en-las-nuevas-tarifas-de-la-luz/

74 https://www.sigmados.com/encuesta-el-mundo-sigma-dos-el-583-cree-que-las-nuevas-tarifas-electricas-afectaran-a-su-factura/

where the incentive to act comes from social pressure. Society must be made aware of the tangible benefits of more sustainable housing in terms of quality of life and reduced environmental impacts.

- **Anticipating the renovation wave:** One potential obstacle that the renovation sector faces is a lack of capacity. There is some risk in Spain that the anticipated 'avalanche' of energy renovations will not occur because the sector is unprepared, both in terms of aptitude (lack of technical training adequate to the requirements) and size (insufficient labour force in the sector, which is especially challenging in the context of a demographic crisis). The key role of vocational training at all levels (white-collar and blue-collar workers) cannot be overstated, and sustainability training must be promoted across the board to public institutions (vocational schools, universities) and professional associations alike. To anchor the EE1st principle to all professional sectors, sustainability ([75]) should be a part of the core curricula subjects in university courses and vocational training programmes, as opposed to optional. Detailed job training plans are also essential. Plans targeting working professionals who want to retrain or update their skills can help ensure that the sector's entire workforce is comprehensively covered, both now and in future.

- **Lack of transversality concerning potential of multiple benefits of buildings renovation**: The negative impacts on health of living in buildings with inadequate indoor conditions ([76]) should be addressed in a cross-cutting way. It should be made legally possible to compel renovation of a dwelling on the basis of diagnostics that confirm poor indoor air conditions. There is much work to do to enhance coordination between seemingly distant sectors in the professional spectrum, and a more holistic approach is needed. One solution could be the establishment of multidisciplinary teams capable of exchanging advanced knowledge across diverse fields. These teams could help identify and develop synergies leading to a solid and fully fledged legislative framework that puts the well-being of occupants first. A proper holistic integration of the concepts of energy performance and indoor air conditions of buildings could help in determining the priority of interventions and lead to overall success.

- **Ensure proper coordination and transversality of all public instances to guarantee compliance with long-term objectives**: The roles of different branches and levels of the public administration in the implementation of policies should be defined to maximise the positive impacts of all work to be carried out. This relies on several factors, including having respect for the country's regional diversity (which helps in tailoring commitments to meet unique conditions). Another decisive factor is to take a holistic approach that seeks the involvement of every element of the public administration: engagement at horizontal level (to take advantage of expertise at every branch of the public administration); and engagement at vertical level (to reinforce information exchange between national, regional and local platforms). The approach concerning financing and implementation should imitate a top-down structure, where regional governments prepare their own strategies in line with the national LTRS while also involving municipalities in the process. This in turn will promote actions and ensure the proper implementation of all works taking place within a given jurisdiction. The public administration can play an exemplary role in demonstrating the feasibility and benefits of renovating public buildings, and this will trigger a spill-over effect into private buildings.

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[75] Defined as "*meeting the needs of the present without compromising the ability of future generations to meet their own needs*". From the UN Brundtland commission report, 1987: http://www.un-documents.net/our-common-future.pdf

[76] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5707925/

- **Generalise and enhance the role of one-stop shops to unleash their potential:** One-stop shops not only advise citizens on economic savings to be obtained by carrying out renovations, but also provide information on the multiple benefits to be derived from energy rehabilitation (indoor comfort, for example). These are powerful incentives, especially in cases of energy poverty. Potential economic savings are not always the strongest selling point, but improved home-life conditions can be a strong motivation to undertake refurbishment works. Other approaches that transcend energy and economics can also be integrated in some way when addressing interventions: accessibility, health and indoor comfort all have a significant impact on the daily life of building occupants.

- **Make private investment in improving buildings more attractive to foster renovation rates:** From a financial point of view, energy renovations attract little interest, and even less in countries where energy demand is not particularly high due to climate. Accessibility, healthiness and indoor comfort are, however, of great importance to users, and their inclusion in renovation projects has proved a strong stimulus for their promotion and acceptance. The insertion of these aspects in renovation projects as a 'necessary cost' can leverage the uptake of works, as building users generally value the implementation of these interventions highly enough to relegate economic considerations to the background. It is therefore possible to view an entire renovation as an investment on a deeper dimension (one which has a direct impact on quality of life). On the other hand, the increase in value of a property that undergoes a 'quality of life' intervention generates positive but unequal enthusiasm between external investors and owner-occupiers. Public policies and incentives could thus promote overall home improvement with enhanced energy performance embedded as part of the renovation. The scope of eligible costs for such an incentive could be defined according to policy objectives, together with minimum energy performance requirements and/or bonus grants to promote higher ambition regarding energy performance. Another key to accelerating the pace of renovation in Spain is to facilitate the implementation of renovation works in a more staggered manner. This is closely linked to the role that the 'digital building book' or 'renovation passport' can play ([77]).

- **Improve flexibility on how renovation works can be performed to make regulatory compliance easier and access to funding more attainable:** Property ownership in Spain is usually very fragmented (for example, a company that owns a section of an office block), and partial refurbishments of buildings are the typical norm. This being the case, the current way that financial aid is articulated should be reconsidered. 'Global' rehabilitation strategies should be enabled for buildings (especially those more atomized due to co-ownership) from the superposition of different works on a smaller scale, so as to encourage action on the different parts of the building in a more approachable and attractive way for owners (each one acting first on what is most interesting for them). Applications for smaller subsidies would be simpler, and a greater amount of subsidies could be granted from the same fund. A good first experience with rehabilitation serves as a powerful incentive to undertake subsequent works, but it is still important to instil confidence on the part of owners regarding the effective availability of funds to partially or fully subsidise these reforms in order to not discourage or undermine ongoing or future rehabilitation activities. New regulations should address the concern of how to legally assure the completion of these sets of reforms so the desired effects are achieved. This will help guarantee that works carried out in later renovations will comply with renovation passports and guarantee proper maintenance. At present, the CTE does not consider this last point. It is therefore advisable to strengthen the legislative framework to better control the

[77] These documents are still being developed.

direction taken by the renovation processes, especially when they are carried out in a staggered manner or as a concatenation of small interventions. A typical example is an intervention that aims to replace all the windows of a building after some owners have already done this individually on their own. Any permission for owners to embark on renovations in their apartments should be regulated so that the 'harmony and performance of the ensemble' is not compromised if a 'global' intervention takes place later. A certification process could serve as a possible coordination mechanism.

4.4 Policy landscape for EE1st in the power sector

As in most EU countries, Spain's power sector background for the coming years is strongly influenced by two major trends: (1) an increased share of RES in electricity generation, and (2) electrification of energy end-uses – especially heating and vehicles, both of which have an impact on electricity demand from buildings.

Spain adopted higher **2030 targets** than those set at EU level for the **development of RES**. Regarding RES, Spain aims to achieve:

- a share of 42% of gross final energy consumption compared to about 18% in 2019 and 22% in 2020 (based on Eurostat), while the 2020 target was 20.8%, and
- **74% of electricity generation** ([78]) compared to about 37% in 2019 and 43% in 2020 (based on Eurostat), while the 2020 target was 39% (as set in the RES plan PER 2011-2020).

The NECP does not announce a ban of coal plants but forecasts that coal plants will no longer be used by 2030 at the latest, as they will no longer be competitive (due mainly to ETS or regulations on other emissions). It was already expected that nine of the 15 coal plants (about 8 GW) in operation in 2019 would be closed by 2021. Four out of the seven nuclear plants are planned to be retired by 2030 (from 7.4 to 3.2 GW). The NECP does **not plan any new capacity for gas plants**: reduced coal and nuclear capacities are to be compensated for by increased RES capacities, mostly wind (from an expected 28 GW in 2020 to 50 GW in 2030) and solar (from an expected 9.1 GW and 2.3 GW in 2020 to 39.2 and 7.3 GW in 2030 for solar PV and solar thermoelectric, respectively). The existing 26.6 GW of CCGT (combined cycle gas turbines) provides the basis for back-up capacity to integrate a higher share of RES, to be complemented with an additional 6 GW of **storage** (3.5 GW from hydro/pumping stations, in addition to the current 3.3 GW; and 2.5 GW from batteries, hydrogen or other technologies compared to almost none currently), together with promoting **flexibility** and **demand-side management**.

Spain's NECP highlights the role of RES, particularly solar and wind energy ([79]), in achieving greater self-sufficiency and national energy security and reducing fossil fuel imports. The NECP also notes that this increased share of RES will also be achieved thanks to energy efficiency and reduced final energy consumption. Still, the RES target for electricity will require **more than double the current electricity generation from RES** (from 10.2 Mtoe in 2021 to 21.8 Mtoe in 2030).

Concerning **electrification**, two main objectives offer some insight into the changes expected:

- a planned increase in energy production from **heat pumps** from 629 ktoe in 2021 to 3,523 ktoe by 2030 (i.e., multiplied by 5.6), and

[78] 74% is presented as direct share of RES in electricity generation. This share is equivalent to 86% when using the methodology defined in EU Directive 2018/2001.

[79] In 2018, wind power was already delivering more than 18% of the electricity generated in Spain.

- reaching 5 million **electric vehicles** by 2030 (28% of the total vehicle stock).

The NECP notes that these trends will **change the model of electricity supply substantially**, evolving from a centralised generation system based on 'base' and 'peak' with predominantly 'passive' demand, to a new model where generation variability must be managed using large-scale storage within the generation systems themselves or separate from them, as well as demand-side management and flexibility to **adapt demand to supply**.

Moreover, the **security of electricity supply** has always been a central issue for Spain's power sector due to its peninsular location. Security of supply is therefore the top priority assigned to electricity system operators. This is covered in dedicated annexes to the NECP (based on findings from REE [*Red Eléctrica de España*], Spain's sole TSO) to make sure that the planned generation mix can guarantee security of supply even in the most demanding conditions (and, where wind and solar power are concerned, in unfavourable weather conditions). The NECP thus mentions the need to **reinforce and expand electricity networks** of transmission and distribution.

The projected total of investment needed for networks and electrification is EUR 58.6 billion. This is roughly one-quarter (24%) of total investment needed to achieve NECP objectives for the 2021-2030 period (EUR 241.4 billion).

Implementing the **EE1st principle** is essential to making needed changes in Spain's power sector. The first step is to **reduce overall final energy consumption** (thus reducing the need for new generation and shrinking the amount of network investment). The second is to **increase demand-side flexibility** (thus enabling the integration of a higher RES share while reducing needs for storage and back-up capacity). The NEAP measure 1.3 on adapting the grid to integrate a higher RES share notes that developing flexibility of the electricity system with demand-side management and storage will be as important as grid investments. The NECP then points out that "*improved system flexibility makes it possible to achieve renewable energy generation objectives set out in this NECP without increasing the capacity of natural gas combined cycles as a backup technology*".

This applies at both national and local level, as pointed in the NECP (p. 83): "*Depending on the characteristics of the geographical areas, the rapid changes in consumption and generation dynamics can pose challenges for the management of distribution networks. In this sense, use by the distributors of services that may be offered by the distributed energy resources in their area emerges as a possible cost-efficient alternative to solve network congestion or other challenges at local level*". The NECP then mentions examples of demand-side resources, including energy efficiency systems, charging systems for electric vehicles and other energy services.

4.4.1 Overview of policies relevant to EE1st

Power sector measures relevant to EE1st are mostly related to the objective of increasing the share of RES for electricity. Another major measure involving energy suppliers and relevant to EE1st is the Energy Efficiency Obligation Scheme (see section 4.4.1.4).

Spain's strategy to achieve its target for electricity generation from RES is structured along three main axes: (1) promotion of large generation projects (mainly through auctions); (2) deployment of distributed RES for own consumption; and (3) measures to integrate renewables into the electricity system and market. The third axis includes most of the actions foreseen to develop demand-side management (see 4.4.1.3). Recent developments in the domain of electricity tariffs should also contribute to this end (see 4.4.1.5).

4.4.1.1 Measures for large-scale RES and demand-side management are not linked

The NECP notes that the **involvement of the Autonomous Communities** will be essential to the development of **large generation projects**, as they are responsible for spatial planning and rules for environmental protection. They also implement the subsidy schemes for RES-powered heating and cooling (including heat pumps)[80] and off-grid electricity generation. Increasing the flexibility and interconnection of the electricity system is clearly identified as essential to integrating large-scale RES projects on the grid in an optimised way. However, existing schemes to develop large-scale RES projects (mostly through auctions or calls for tenders) have no direct link or interaction with possible measures on the demand-side. These axes are developed in parallel.

4.4.1.2 Deployment of RES for own use presents opportunities to jointly consider supply and demand options, and this should be promoted

The NECP concludes that the deployment of RES for own use is almost non-existent because a series of **regulatory barriers** have crippled its economic viability. This was addressed recently in Royal Decree 244/2019, which regulates the administrative, technical and economic conditions for own consumption of electricity (dealing with administrative processes, tariffs and charges for self-generated energy, and economic compensation for surpluses fed into the grid).

The NECP also mentions the promotion of **local energy communities**, and more generally the proactive role of citizens in making the energy transition. Getting the benefits of RES projects to citizens more directly will increase social acceptance (for large projects) and spark involvement (RES for own use). For example, an annual quota will be reserved for **participatory citizen projects** in calls for tenders for new RES capacities. The model of shared own consumption is one suggested way to mitigate conditions of vulnerability and energy poverty (by considering multiple impacts). A related aspect noted in the NECP is the right for consumers to **access to their own energy consumption data** in a quick and understandable way.

The NECP concludes that "*own consumption with renewables brings energy generation closer to its consumption and, therefore, reduces losses, increases the involvement of consumers in the management of their energy, and reduces the territorial impact of renewables production*" ([81]). While drawing a link between own consumption and demand-side management, the NECP does not mention actions or specific provisions that would favour projects to jointly consider RES for own use and demand-side management.

4.4.1.3 Actions planned to overcome barriers to the development of demand-side management

The measures presented in the **NECP** to facilitate higher integration of RES in the electricity system start with **measure 1.2 on demand-side management, storage and flexibility**. This measure foresees a comprehensive set of actions to overcome current barriers in this field (see details below). The responsible bodies for this measure include the Ministry of Ecological Transition and Demographic Challenge (MITECO – the ministry in charge of energy), the Institute for the Diversification and Saving of Energy (IDAE – Spain's energy agency), REE (Spain's TSO for electricity), DSOs, EV-recharge infrastructure operators, the Regions (Autonomous Communities), and sectoral associations.

[80] Most often as part of buildings renovation programmes (see section 4.3.1.6).

[81] On the benefits and cost-effectiveness of household photovoltaic self-consumption in Spain, see Gallego-Castillo et al. 2021; Roldán Fernández et al. 2021.

As a starting point, the rollout of **smart meters** appears to be a **prerequisite** for providing consumers with the information needed to adapt consumption habits to market signals.

The first action highlighted is the development of a **regulatory and legislative framework for demand-side management**:

- to determine **technical requirements** for participants offering energy from renewable sources, for energy storage managers, and for providers of demand-response services, so they can all participate in existing and developing markets, and
- to ensure the participation of small consumers by allowing the **development of aggregators** – especially independent aggregators – and guaranteeing their right to enter the electricity market. The NECP highlights the need to **allocate clear roles and responsibilities for electricity companies and customers**, which will enable the exchange of and access to data on an equal and non-discriminatory basis while protecting relevant information. It will also establish a mechanism for resolving disputes between those providing aggregation services and other market participants, including responsibility for deviations.

A legal framework that allows independent aggregators (other than energy suppliers) has indeed been missing in Spain. Only one scheme to date has allowed demand-side resources to compete with supply-side resources for balancing and ancillary services: the REE-managed 'interruptibility' system for the electro-intensive industry ([82]). This scheme does not allow the participation of aggregators, which makes it impossible to develop demand-response services for buildings, the exception being dynamic pricing by energy suppliers ([83]).

A first step in the development of a much-needed legal framework was taken by the Spanish National Markets and Competition Commission (CNMC) with its publication in the Spanish Official Journal (BOE) of Disposition 18423 (December 2019). This legal text allowed all consumers, either individually or through an aggregator, to participate in balancing services. Afterwards, the Spanish transmission system operator (REE), had to propose terms and conditions for balancing service providers and settlement agents. According to smartEN (2022), Spain now has major potential to develop its flexibility market, even if the regulatory progress is slow. Spain is thus considered to possess an emerging flexibility market with a promising future ([84]).

Another action focuses on **managing distributed energy resources on local markets**. It aims to develop a legal framework to enable and **encourage DSOs to acquire flexibility and balancing services** from distributed generation suppliers of demand response or energy storage as a cost-efficient alternative to more conventional network management mechanisms.

The basis for this action is the **IREMEL project** carried out by IDAE and OMIE ([85]). This project analysed potential and needs associated with the integration of distributed energy resources on local electricity markets. IREMEL objectives are: to design prototypes of operating schemes for local markets; to analyse conditions that enable prosumers (producer-consumers) to continuously manage energy produced or

[82] The cost-effectiveness of demand-side management from large industries is demonstrated by Roldán Fernandez et al., (2016). Beyond the context of large industries, Roldán Fernández et al. also recommend considering the cost-effectiveness of promoting plans to replace inefficient equipment and implementing real-time tariffs.

[83] See https://www.magnuscmd.com/spain-towards-the-famous-demand-aggregator/

[84] See González Galván, 2019 for a more detailed analysis of the potential for demand-side management in the residential sector (through dynamic pricing and appliance replacement).

[85] OMIE is the Spanish electricity market operator that manages day-ahead and intraday electricity markets on the Iberian Peninsula.

consumed based on existing price signals, either directly or through aggregators; and to demonstrate the viability of new technologies that facilitate the management of distributed resources and their presence on local markets. IREMEL paves the way for **pilot projects** on demand-side management and storage.

Another approach considered in measure 1.2 is the development of **dynamic pricing** to provide consumers with real-time price signals. The NECP acknowledges that this would require the identification and removal of the legal and administrative barriers that make it difficult (disproportionate fees or administrative charges) for 'prosumers' to choose when to consume, store or sell on the market the electricity they generate, or to participate in all electricity markets. A **new electricity tariff** was implemented in June 2021 (see section 4.4.1.5).

Measure 1.2 also mentions the need to conduct an **information and awareness-raising campaign** for consumers and to introduce **training programmes for building professionals** (developers, installers, architects) to integrate demand-side management measures (smart meters, automation systems, EV charging systems) in the design of new buildings and in the operation and renovation of existing ones.

The NECP also acknowledges that "*the current administrative approval processes may make it difficult to develop demand management*". It then proposes to develop a **one-stop shop** that would act as an intermediary to **make the administrative processes easier** for applicants involved in demand-side management or RES integration into the electricity system.

Meanwhile, **measure 1.3** on **adaptation of the grid** to integrate a higher share of RES does not always link with measures on the demand side. In particular, the foreseen adaptation of electricity transmission and distribution **network planning** focuses mostly on an adaptation approach that assumes the forecasted development of renewable generation through the strengthening or creation of transmission nodes and the development of interconnections. The action does not refer to expected trends related to reducing final energy consumption and developing demand-side management. What is foreseen instead is the need to accommodate a greater use of electricity (development of high-speed rail infrastructure or an influx of electric vehicles).

Network digitalisation will likely bring benefits on both sides: optimised supply management and new opportunities to develop demand-side management and related services for consumers. For these benefits to materialise, measure 1.3 refers to **remuneration schemes for regulated electricity distribution and transmission activities** that should be designed to promote progress in digitalisation, innovation and alternative solutions to network investments. These include demand-side resources, which requires acknowledgement of a greater level of interaction between network operators and users in the context of greater penetration of distributed energy resources.

4.4.1.4 An EEOS that obliges energy suppliers to contribute to the National Energy Efficiency Fund

Law 18/2014 of 15 October 2014, which sanctioned urgent measures for growth, competitiveness and efficiency, has established an **Energy Efficiency Obligation Scheme** (EEOS), as well as the National Energy Efficiency Fund (NEEF). In practice, the EEOS requires energy suppliers of electricity and natural gas and wholesale retailers of oil products and LPG ([86]) to pay a **contribution to the NEEF** in proportion to

[86] In 2019, 359 obligated parties were subject to this obligation. The three largest suppliers represented 40% of contributions (for more details about this EEOS, see ENSMOV, 2020).

energy sales. Overall, total contributions from energy companies to the NEEF amounted to more than EUR 200 million per year from 2015 to 2019 (ENSMOV 2020).

In essence, the EEOS implements the EE1st principle by requiring energy companies to develop energy efficiency activities or to contribute to funding energy efficiency activities, as is the case in Spain. This makes energy companies prioritise funding or investments in energy efficiency to the extent that they comply with relevant obligations. Companies themselves do not need to compare supply-side and demand-side options: this is part of the process that the public authority uses to set targets (assessing potential cost-effectiveness of energy savings, for example). The EEOS is thus a kind of mandatory implementation of the EE1st principle.

The Spanish EEOS is more specific than others. Up to now, obligated parties only had one option to comply with their obligation (contributing to the NEEF). This obligation has been set according to an energy savings target that corresponds with the share of energy savings needed from the EEOS to complement the energy savings Spain needs to achieve its target as per EED Article 7. It is then transcribed into a funding obligation based on the average cost of achieving energy savings as assessed by NEEF programmes.

This approach affords clear visibility on the funding available from the EEOS to the NEEF. The NEEF programmes are clearly advantageous compared to funding sources with variable annual allocations (the State budget, for example).

The drawback is that it is difficult to guarantee that the energy savings target will be met: average costs of achieving energy savings may vary, or participation in NEEF programmes may be lower than expected. The Spanish EEOS is currently being amended to allow energy companies to run programmes.

4.4.1.5 Recent developments in electricity tariffs

From 1 June 2021, a new electricity tariff has been implemented with three differentiated time slots: peak time during weekdays / intermediate time during weekdays / off-peak time during nights and weekends and national holidays ([87]). The new tariff enables consumers to choose between two time slots with distinctly different power demands: ‘peak+intermediate’ or ‘off-peak’. The new tariff replaces previous tariffs that were regulated. Consumers under market tariffs can ask their supplier to switch to the new equivalent tariff, which suppliers must make available to their customers.

The tariff is designed to generate bill savings for consumers ([88]) while better fitting electricity demand to supply constraints. It is also a means to promote self-consumption and smart-charging of EVs (with the possibility of subscribing to either of two distinct power demands). Consumers can use an app to get informed and receive notifications about how the tariff evolves ([89]).

The legal basis for the new tariff is Royal Decree-Law 1/2019 (January 2019), which was adopted in compliance with EU legislation on electricity markets and, more specifically, provisions related to network

[87] https://www.ree.es/es/sala-de-prensa/actualidad/nota-de-prensa/2021/05/red-electrica-publica-los-precios-de-la-nueva-tarifa-pequeno-consumidor

[88] According to the CNMC, the new tariff would reduce electricity bills for the roughly 19 million consumers on prior average pricing (without time differentiation), but would increase bills for the roughly 10 million consumers already on some type of time differentiation.

[89] https://www.ree.es/es/actividades/operacion-del-sistema-electrico/redos-app-operador-sistema

tariffs ([90]). The framework for the new tariff was then prepared and approved by the Ministry of Ecological Transition and its regulatory body (CNMC) ([91]), with Royal Decree 148/2021 establishing a new calculation methodology for network charges. Finally, Ministerial Order TED/371/2021 established the new network tariff. For consumers on the regulated tariff, the Spanish TSO (REE) publishes updated tariffs per timeslot for each following day ([92]). Differences in the tariff per time slot are related to network charges (both fixed and variable components).

According to the Spanish Consumer Organisation (OCU) ([93]), the new tariff results in a smaller fixed rate (compared to the power subscription) and a higher variable rate (related to electricity consumed). This provides an incentive for saving electricity during peak hours.

At the same time, the major overall increases in electricity prices observed in Spain, as in other EU countries since mid-2021, have changed the context. The Spanish government was forced to take measures to limit the impact of the energy crisis on consumers ([94]). This has significantly reduced the price difference according to time slot and thereby curbed the incentive for consumers to adapt their time of use.

4.4.2 National specificities that might influence the implementation of EE1st

Spain's peninsular location at one end of the European network offers **limited possibilities for interconnection** (only with France and Portugal). The country's current interconnection rate is less than 5% of installed national generation capacity, and it is the only Member State with an interconnection rate below the expired 2020 target of 10%. Connected solely to France to provide access to the European grid, Spain's actual interconnection rate is just 2.8%. Spain can be considered an "**electric island**", as pointed in the NECP. This makes **security of electricity supply** critical, and this is a **priority both for DSOs and Spain's lone TSO**, **REE**, which manages more than 44 000 km of transmission lines, including on Spain's remote islands.

This dynamic also explains Spain's priority to establish new power sector interconnections with Portugal (3 GW) and France (currently 8 GW compared to 2.8 GW). These new interconnections are perceived as essential for better integration of production from RES, especially from wind power.

Having a single TSO for the whole country favours coordinated planning and optimised operation of the transmission network. REE is indeed the central actor in charge of overall security of electricity supply.

Spain still needs to clarify the financial specifics of its electricity tariff, as the receipt of large debts from the previous feed-in tariff for RES ended in 2013. The NECP foresees the payment of annuities to recover the deficit from previous financial years, ending in 2028.

Another specificity is the high reliance of Spain's **non-mainland islands** on fossil fuels to generate electricity. The substitution of fossil fuel plants with RES on the islands will also require increasing interconnection

[90] The European Commission asked Spain to mandate that a part of network charges be set by an independent regulator (CNMC) not subject to government intervention. The objective was to ensure the transparency of network tariffs and reflect actual costs (that is, higher charges on electricity consumption generating higher network costs).

[91] https://www.cnmc.es/la-nueva-factura-de-la-luz

[92] More information is available at: https://www.esios.ree.es/es/pvpc

[93] https://www.ocu.org/vivienda-y-energia/gas-luz/informe/nuevas-tarifas-acceso

[94] Royal Decree-Law 17/2021, September 2021.

between islands where possible. This problem could be mitigated by reducing final energy consumption, increasing demand-side flexibility, and – especially – improving energy efficiency.

4.4.3 Current situation with implementing EE1st

Overall, the NECP provides an overview of the main barriers in front of demand-side management and flexibility when it comes to developing alternatives to supply-side investments. Measure 1.2 proposes a rather **comprehensive approach**, with a mix of legislative and regulatory developments, pilot projects, incentives to consumers (through dynamic pricing), information and training. The approach also considers the entire chain of actors (public authorities, energy companies, aggregators, building professionals, consumers). However, **actual incentives for energy companies** to make use of or engage in demand-side management schemes **remain unclear**.

The foreseen development of legal frameworks could support implementation of the EE1st principle, depending on the way cost-efficiency would be assessed, and providing that new legal provisions are enforced with clear monitoring by the national regulatory authority.

Current and future challenges for Spain's power sector means that the country needs to invest in grid flexibility and develop demand-side management. The development of demand-side management (including energy efficiency and demand response) could limit the need for grid investments. This still requires changes in the regulatory framework and in stakeholder practice, from energy companies to energy consumers. There is also the need to develop new market players, especially aggregators.

In parallel, the change adopted in 2019 regarding responsibilities for setting network tariffs established a more important role for the regulatory body (CNMC). This resulted in a new design of network tariffs that aimed to better reflect network costs pegged to time-of-use (with three time slots for consumption charges and two time slots for power charges). However, the energy crisis and resulting increases in overall electricity prices led to governmental measures that reduced the differences between time slots, thus negating any possible impact of the new network tariff on the load curve.

4.5 Policy landscape for EE1st in district heating

Final energy consumption from district heating and cooling in Spain was about 42.5 ktoe in 2017, or roughly 0.15% of final heating and cooling consumption (about 29 Mtoe) ([95]). This negligible share of district heating and cooling may be explained by overall lower heating needs compared to the rest of Europe (with significant differences between Spanish regions).

This does not, however, eliminate potential for developing district heating and cooling in Spain. Existing potential is assessed in the Report on Urban District Heating and Cooling in Spanish Cities, prepared in collaboration with the Ministry of Agriculture, Food and Environment. The NECP notes that measures are being considered to enable and support the development of district heating and cooling using renewable energy sources. District heating and cooling is indeed identified as a solution for developing RES heat and

[95] Data reported by Spain relative to EED Article 24(6).

achieving carbon neutrality, especially regarding developing renewable energy communities. Potential for district heating and cooling is thus expected to grow significantly between now and 2030.

4.5.1 Overview of policies relevant to EE1st

Policies to develop district heating and cooling in Spain were limited until recently. NECP measure 1.6 on the framework for developing thermal renewable energies mentions mechanisms under consideration to promote district heating and cooling (the first three of those listed below are related to EED requirements):

- Regularly collect and update information on district heating and cooling networks, whether or not they meet the EED definition of 'efficient district heating and cooling'.
- Ensure that final consumers are provided with information about the networks to which they are connected, especially regarding efficiency and RES share.
- Evaluate potential for district heating and cooling and ensure that cost-benefit analyses are conducted for new urban development projects.
- Develop renewable energy communities linked to district heating and cooling, while including technical training at municipal level.
- Perform legislative analysis on the implementation of measures for potential users.

Measure 1.6 also includes the preparation of an assessment of potential energy from renewable sources and the use of waste heat and cold and other uses, as required by EED Article 14. This assessment, meant to be completed by the end of 2020, should help in identifying any potential to develop district heating and cooling schemes that place a value on waste heat.

The NECP notes in its introduction that the promotion of high-efficiency co-generation and urban heating and cooling networks has been part of a comprehensive strategy to achieve energy efficiency in cities.

The priority given to investments related to energy transition in the EU Recovery and Resilience Facility provides an opportunity for Spain to develop new schemes that could assist the development of district heating and cooling. The Spanish Ministry for Ecological Transition (MITECO) has recently adopted **two support frameworks** to help develop RES heat generation related to district heating and cooling, in line Spain's recovery and resilience plan funded by NextGenerationEU. These frameworks will be managed by the IDAE, the Spanish energy agency attached to the MITECO.

The first framework, derived from the Royal Decree 1124/2021 adopted in December 2021, is for **small projects** (smaller than 1 MW) and open until the end of 2023. The initial framework budget is EUR 150 million. This framework can support, but is not limited to, development of **micro-district heating and/or cooling networks** supplied with RES, with a focus on rural areas (including a bonus grant rate for rural areas). Grant schemes are established and managed by the Regions (Autonomous Communities) under the supervision of IDEA ([96]). The Regions may thus define complementary criteria. For example, they can link the development of micro-networks to implementation of building renovations in the same areas, thus establishing a link with the 'Building renovation and urban regeneration plan' (see section 4.3.1.6). However, the timelines of these different frameworks (building renovation and RES heat) are different, and a likely

[96] https://www.idae.es/index.php/ayudas-y-financiacion/para-la-implantacion-de-instalaciones-de-energias-renovables-termicas-en

outcome is the preparation of projects for implementation as soon as possible. Therefore, an ‘emergency’ context would discourage coordination between the different schemes.

The second framework is for **large projects** (larger than 1 MW) and was launched with a public hearing in May 2022. It lays the groundwork for calls for projects with an initial budget of EUR 100 million that aim to develop new district heating cooling networks supplied by RES, or to expand existing similar networks ([97]). It will run until the end of 2025. Calls will be directly managed by the IDAE. The objective is to attract roughly EUR 230 million in investment for new installed capacities for RES heat of more than 320 MW (compared to 42.5 kW of district heating and cooling in operation in 2017).

Project selection includes criteria related to efficiency of the DHC network, as well as “positive impacts in areas of Just Transition and Demographic Challenge”. The primary objective of the calls remains the development of RES heat as a contribution to achieving climate neutrality by 2050. This approach also takes on a social perspective by focusing on the **value of multiple impacts**, not just on the amount of RES heat produced. The proposed Royal Decree refers to the following complementary objectives: structuring territory and developing rural areas, reducing the importance of fossil fuel imports, promoting sustainable economic activities in a context of economic recovery, and improving air quality.

The launch of this framework for large projects follows a call for ‘expressions of interest’ made in 2021 concerning projects related to RES heat, not limited to district heating and cooling. Several projects on district heating and cooling were submitted, which demonstrates clear stakeholder interest and real potential to develop district heating and cooling in Spain.

4.5.2 National specificities that could influence the implementation of EE1st

The development of district heating and cooling is still at an early stage in Spain. District heating and cooling projects are perceived as complex in terms of administrative, technical and operational aspects. This might explain why other options to develop RES heat (based on individual heating systems, for example) are preferable, especially when the objective is to promote a rapid decrease in fossil fuel imports.

While most ongoing projects on district heating and cooling might be about developing new networks, it might be easier to consider buildings in collaboration with local planners. The overall objective of developing district heating and cooling is to increase the use of RES heat, which is an argument in favour of using high-efficiency technologies (using low heat temperature, for example) to make it easier to achieve 100% RES heat supply for these new networks.

Another issue to address is the distribution of roles at national and regional level. The national government sets the regulations and the overall frameworks, while the Autonomous Communities are often in charge of implementing support schemes and are in direct contact with local authorities – the key actors involved in district heating and cooling. Nevertheless, the upcoming support scheme for large district heating and cooling will be managed in a centralised manner by the IDAE. The Autonomous Communities can still play an important role in this scheme by submitting to the IDAE a report explaining how projects submitted from their region will contribute to regional objectives and plans.

[97] https://www.miteco.gob.es/es/prensa/ultimas-noticias/el-miteco-lanza-a-audiencia-pública-una-línea-de-100-millones-para-redes-de-calor-y-frío-a-partir-de-energías-renovables/tcm:30-540865

4.5.3 Current situation with implementing EE1st

District heating and cooling is still an emerging sector in Spain but is likely to grow in the coming years. It is a priority objective of the Spanish government to develop RES heat and achieve carbon neutrality. As such, the primary objective related to district heating and cooling is to increase RES heat production. The interaction of buildings energy performance with district heating and cooling has yet to be explored in current national plans. Likewise, there is no explicit reference to demand-side resources in the form of end-use energy efficiency or thermal demand response in buildings.

Spain's NECP clearly identifies the development of district heating and cooling in rural areas as a means of economic support, especially in areas that are challenged demographically. The ministry in charge of energy is indeed the Ministry for Ecological Transition and Demographic Challenge. Promoting a fair and inclusive transition is therefore one of the major objectives of Spain's energy policies.

The approach to developing district heating and cooling is thus in line with considering multiple impacts. Moreover, such investments are necessarily planned on at least a mid-term time perspective. Combined with the need to comply with EED requirements on cost-benefit analysis for district heating and cooling projects, the approach might create favourable conditions for EE1st implementation. This might be achieved by linking the local planning of district heating and cooling projects with the implementation of buildings renovation programmes implemented by the Autonomous Communities, who can in turn coordinate with municipalities to identify synergies with district heating and cooling projects.

While the first priority might be to quickly develop district heating and cooling projects, identifying synergies with buildings renovation programmes might involve added time and complexities.

The emerging district heating and cooling sector creates an opportunity to learn from other countries with greater experience in this field. Related regulations can be designed to favour EE1st approaches for integrated district heating planning and operation, third-party network access, and planning for integrated heat and buildings renovation.

5 CONCLUSION

When analysing the policies of the three countries in this report, it appears that **most of the policies are not designed around the EE1st principle**. There are some that 'accidentally fit' (the KfW programmes in Germany, for example) but have not been designed for this purpose. The main renovation programmes now tend to include criteria or requirements that favour projects achieving higher energy performance and/or combining action types (as with PREE, Spain's renovation programme), but few are explicitly designed to bear in mind their possible impacts on energy supply systems. This can be partly explained because **EE1st is still a new concept** (the European Commission published the relevant guidelines in September 2021).

Moreover, **the current energy crisis in Europe urges policy makers to pursue greater short-term impacts**, to counter the energy crisis and reduce fossil fuels' imports from Russia as well as to speed up GHG reductions, as pointed out in the latest IPCC reports. This can favour action types that are easier to scale up quickly and immediately boost security of supply, such as replacing heating systems that use fossil fuels. While making the switch to renewable heating systems is paramount, it nonetheless creates a **dilemma vis-à-vis the EE1st principle, which requires a more holistic approach** (the switch should be accompanied by the renovation of the building envelope and resizing of heating systems).

Making EE1st a reality indeed requires a **systemic approach** to policymaking that goes beyond the classic portfolio of energy efficiency policy: this means integrated planning and investment decisions, and a **joint consideration of supply-side and demand-side** resources. The debate around EE1st should embrace policies that are often seen from a supply perspective, such as market design, regulations and incentives for network operators, heat roadmaps, etc. (ENEFIRST, 2021c). Reciprocally, classic energy efficiency policies (e.g. renovation programmes, building codes) could have a greater impact if designed to bear in mind their potential impacts on the supply-side. Their funding could then better reflect the benefits they bring to society.

As shown by this analysis of Germany, Hungary, and Spain, **introducing EE1st as an overarching principle is not sufficient** to secure its execution: implementation needs to be carefully planned, and adjustments to decision-making, governance structures and investment frameworks need to be introduced across all areas, including building policies, the power sector, climate action, governance systems, policy targets, etc. Implementing EE1st is **not necessarily about adopting new policies**: it is instead **primarily about ensuring that existing policies are in line with the EE1st principle**.

Germany and Hungary are well illustrating this: despite a variety of strategic documents and processes that recognise EE1st as a core principle (for example, the Energy Efficiency Strategy for Buildings prepared to help introduce the EE1st principle into Germany's governance structure in 2015), the principle is not yet fully operationalised. While the role of energy efficiency is well acknowledged in the overall strategies, policy discussions on decarbonisation tend to focus on or prioritise fuel switching. Most policies are developed through sectoral approaches and fail to consider the broader picture, which in turn narrows the scope of costs and benefits.

At the same time, **some existing incentives might contradict the EE1st principle**, such as revenues for municipalities when they award gas concessions (Germany), or strongly subsidised energy prices for a large share of consumers (Hungary).

The analyses of Germany and Spain both show the importance of the indicator(s) used to set the main energy requirements, either for buildings regulations or in the design of financial incentives. **Prioritising indicators set in 'primary energy' or 'carbon content' can steer a bias** towards fuel switching over reducing final energy demand. This can result in higher total energy system costs and present greater challenges to achieving a 100% RES supply because of the need to meet higher demand.

National and local specificities, including **complex governance structures** (Spain, Germany), must be taken into consideration to avoid unsuitable 'one size fits all' approaches that will not grasp and address the complexity of a system originally designed to serve different needs and secure supply first. Whatever the governance structure in a country, successful cooperation and integrated approaches depend on having clear definitions of principle roles at each level of jurisdiction.

While an initial effort is required to **map gaps and areas of intervention**, mainstreaming EE1st decisions can improve overall decision-making, leading in turn to better-integrated and cheaper solutions, better cooperation and higher levels of optimisation. A more **collaborative decision-making environment** can also lead to a better integration of demand management, bring added value (co-benefits) to investment decisions and policy portfolios, and lead to an increased legitimacy of the energy transition policies in the long term.

A starting point is to ensure that the **overall national energy planning** clearly **acknowledges the interactions between supply and demand**, considering fairly the potentials on the demand-side with a long-term perspective. The time frame should be in line with **long-term decisions** on major energy infrastructure. The main energy policies should then be examined to make sure they are in line with the pathway(s) defined in overall energy planning, while at the same time looking at possible impacts on both supply and demand and the associated range of costs and benefits.

As seen in Germany and Spain, the **increase in the share of RES** in the energy supply represents an **opportunity for more integration** in energy planning, policies, and investment decisions. It requires major changes in the way to plan and operate energy systems, implying very large investments. A pitfall would be to continue the current practices considering that security of supply means investments in energy infrastructures, only expanding their usual scope (generation, transmission and distribution) to include storage. An opportunity to implement EE1st is thus to **make demand-side resources recognised as part of the solutions to secure that energy supply can meet a manageable demand**

The development of pilot projects testing the potential for **demand-side flexibility** (Germany, Spain) shows that such opportunities are being explored. Going beyond pilot projects to wider implementation will require revising regulatory frameworks, cost allocations, and incentives for network and market operators. **Energy regulators** thus have a **major role to play**. This is also true in countries like Hungary, which is late in developing RES but also where regulators can take advantage of experience from policy front-runners to establish good framework conditions for providing demand-side flexibility and competitive alternatives to network or storage investments.

Pricing electricity use is a key to mobilising user flexibility. The challenge today is to balance the need for reducing price risk for consumers while still pricing energy based on system conditions. Spain adopted a new grid tariff in June 2021 but the energy crisis occurring soon afterwards narrowed the price difference between time periods, which weakened price signals.

Another opportunity for more integration can be found in adapting, upgrading and developing **district heating and cooling networks**. A reduced and more flexible demand for heat can **make it easier to increase the share of RES supply** in district heating and cooling, or to develop these networks directly with 100% RES supply (as promoted in Spain). This can overcome the initial barrier that a lower heat demand means less revenues for district heating companies. Another approach is to compensate for lower heat demand from already connected buildings through a **network extension** to newly connected buildings (as done in Germany).

Local front-runner projects can point the way forward. The local government in Kecskemét (Hungary) cooperated closely with its district heating company to carry out a combined modernisation of buildings and the district heating system. Notably, this took place in conditions where the existing national regulatory framework is focused mostly on short-term price control, which usually leads to underinvestment. Making good use of EU funding was a key factor in overcoming this barrier.

This illustrates the importance of **aligning national, regional and municipal energy planning**. Consultation processes can offer opportunities for multi-level coordination. There are some challenges in practice, however, such as differences in the decision timelines related to the various political mandates involved, conflicting priorities, and imbalances in power relations. Similarly, the **coordination between different fields of intervention** (between heat planning and buildings renovation programmes, for example) at the same governance level can be challenging for similar or other reasons (e.g. difficulties in or lack of communication between units working in different fields). Progressive harmonisation and integration of planning timelines (as with the NECP process at national level), development of joint data management and processing facilities, and the increasing necessity to consider the interactions between demand and supply when the share of RES increases, can help to go forward on the way to multi-level and cross-cutting integrated planning.

Even with good policies and regulations in place, EE1st implementation cannot take place if the skills needed are not well anticipated. This requires careful planning. The development of energy efficiency and RES already implies plans to ensure sufficient professional capacity in each sector. The implementation of EE1st requires complementary, and especially cross-cutting, skills as well – from combining different models (for integrated energy modelling) to coordinating building trades (for deep renovation dealing with both building envelope and heating system).

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GERMANY

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ACRONYMS AND ABREVIATIONS

aFFR	Automatic Frequency Restoration Reserve
APEE	Germany’s Energy Efficiency Incentive Programme
AUE	Spain’s Urban Agenda
AVBFernwärmeV	Germany's Ordinance on General Conditions for the Supply of District Heating
BAFA	Federal Office for Economic Affairs and Export Control
BBSR	Germany's Federal Office for Buildings and Regional Planning
BEG	Germany's Federal Funding for Efficient Buildings
BKartA	Germany's Federal Cartel Office
BNetzA	Germany’s Regulatory Office for Electricity, Gas, Telecom, Post & Railway Markets
BOE	Spain’s Official Journal
CCGT	Combined Cycle Gas Turbine
CHP	Combined Heat and Power
CNMC	Spain’s National Markets and Competition Commission
CTE	Spain’s Technical Building Code
dena	Germany’s Energy Agency
DG ENER	European Commission’s Directorate-General for Energy
DH	District Heating
DSF	Demand-Side Flexibility
DSO	Distribution System Operator
EBN	Germany’s Programme: Energy Advice for Non-Res Buildings, Plants & Systems
EBW	Germany’s Programme: Energy Advice for Residential Buildings
EC	European Commission
EE1st	Energy Efficiency First
EED	Energy Efficiency Directive
EEG-Umlage	Renewable Energy Law surcharge
EEOS	Energy Efficiency Obligation Scheme
EEWärmeG	Germany's Renewable Energy Heat Act
ELP 2050	Long-erm Strategy for a Climate Neutral Spanish Economy in 2050
EnEV	Germany's Energy Savings Regulation
EnWG	Germany's Energy Law
EPBD	Energy Performance of Buildings Directive
EPC	Energy Performance Certificate
ERESEE 2020	Spain’s Long-Term Renovation Strategy for Buildings

ESG	Germany’s Energy Efficiency in Buildings Strategy
ETS	Emissions Trading System
EU	European Union
EV	Electric Vehicle
FiT	Feed-in Tariff
geea	Germany’s Alliance for Energy Efficiency in buildings
GEG	Germany’s Buildings Energy Act
GHG	Greenhouse Gases
GWB	Germany's Competition Law
HeizkostenV	Germany's Ordinance on Heating Cost Account
HOA	Homeowner Association
HP	Heat Pump
IDAE	Spain’s Institute for Diversification and Saving of Energy
IPCC	Intergovernmental Panel on Climate Change
IT	Information Technology
KfW	Germany's Development Bank
MEHI	Hungarian Energy Efficiency Institute
MEKH	Hungary’s Energy and Public Utility Regulatory Authority
mFFR	Manual Frequency Restoration Reserve
MIT	Hungary’s Ministry of Innovation and Technology
MITECO	Spain’s Ministry of Ecological Transition
MITMA	Spain’s Ministry of Transport, Mobility and Urban Agenda
MS	Member States
MsbG	Germany's Act on Metering
MVM	Hungarian Electricity Works Ltd.
NAPE	National Action Plan for Energy Efficiency
NECP	National Energy and Climate Plan
NEEF	National Energy Efficiency Fund
NRA	National Regulatory Authority
NUTS	European Union's Nomenclature of Territorial Units for Statistics
OCU	Spain’s Consumer Organisation
OMIE	Spain’s Electricity Market Operator
PNIEC 2021-2030	Spain’s National Integrated Energy and Climate Plan 2021-2030
PV	Photovoltaic
REE	Spain’s Transmission System Operator

RES	Renewable Energy Sources
RES-E	Electricity from Renewable Energy Sources
SME	Small and Medium-Sized Enterprise
ToU	Time-of-Use
TPA	Third-Party Administrator
TSO	Transmission System Operator
UBA	Germany's Central Environmental Authority
VAR	Volt-Ampere Reactive
VPP	Virtual Power Plan