Enhancing Turkey's policy framework for energy efficiency of buildings, and recommendations for the way forward based on international experiences

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Summary

Turkey's building sector's energy demand is growing rapidly, at a rate of 4.4% on average, effectively rendering it the one sector with the largest energy consumption among all end-use sectors, representing around one third of the country's total final energy consumption. The sector's energy demand is characterised by a high share of gas and electricity use, with these two accounting for two-thirds of the sector's total energy demand. Turkey has put forward a comprehensive policy package over a period approaching two decades, covering various facets of buildings' energy demand. The National Energy Efficiency Action Plan (NEEAP) released in 2018 is an important step forward; however, several gaps need to be addressed in the existing policy framework concerning the building sector, to accelerate the transition to a low-carbon one. In this study we review a number of policies that are currently in place in Turkey, namely Energy Efficiency Law (2007); Energy Efficiency Regulation (2011); Energy Efficiency Strategy (2012); TS 825 (2008, and the draft version of the revision of the same document dated 2013); National Energy Efficiency Action Plan (2017); Buildings Energy Performance Regulation (2017); and the Green Buildings Regulation (2017).

Even though the existing policy framework is well developed in terms of energy efficient technologies, the review identified a number of issues overlooked: the growing demand for cooling and the potential of renewable energy technologies (and thereby the synergies with energy efficiency) are not fully addressed, and should be developed further, to create a market and to ensure their application in buildings. One major issue area stands out as overlooked concerns green buildings –how they are defined and the availability of specific policies that can accelerate their uptake–. At the time of writing this report, the institutional deficit that stems from the lack of a dedicated agency working on energy efficiency was regarded as a key issue where such an agency could help coordinate and harmonise the efforts of all stakeholders, support various relevant departments within the public sector with specialist know how, and contribute to the effective dissemination of information. It would also help enhance the buildings of the public sector as front runners of energy efficiency. The newly established Department of Energy Efficiency and Environment under the Ministry of Energy and Natural Resources is a key step forward in closing this institutional gap. Quantitative targets and performance indicators, measurement methods, and the reporting and revision of these indicators could benefit from solid and more robust definitions.

Filling these gaps would go a long way in accelerating energy efficiency improvements in Turkey's building sector. International models for such policies provide inspiration on ways to close these policy gaps, through, among others, efforts for potential financing mechanisms, approaches to renovating public buildings and multi-family buildings, standards and compliance mechanisms for driving nearly zero-energy buildings (and the definition of these buildings), and new business models linking innovation and industrialisation.

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List of Abbreviations

BOTAŞ	Boru Hatları İle Petrol Taşıma A.Ş.
BRE	Building Research Establishment
BREEAM	BRE's Environmental Assessment Method
CO_2	carbon dioxide
EPC	Energy Performance Contracting
EPCs	Energy Performance Certificates
ESCOs	Energy Service Companies
EU	European Union
G20	the Group of Twenty
GDP	gross domestic product
IGBC	Indian Green Building Council
KPI	Key Performance Indicator
LEED	Leadership in Energy and Environmental Design
LHV	lower heating value
Mtce	million tonnes of coal equivalent
Mtoe	million tonnes of oil equivalent
NEEAP	National Energy Efficiency Action Plan
^{o}C	degrees Celsius
OECD	the Organisation for Economic Co-operation and Development
USGBC	U.S. Green Building Council

1. Introduction

As of the end of 2016, Turkey's total final energy consumption has reached 105 million tonnes of oil equivalent (Mtoe). One third of this total was consumed by buildings (residential, commercial and public), representing a demand figure amounting to 33 Mtoe (EİGM, 2017). Thus, the building sector's share in Turkey's total final energy consumption is equivalent to that of the manufacturing industry. Total demand for energy in buildings is expected to rise further with high rates of urbanization and population growth. In order to limit the rise in the sector's energy demand, the government has put in place a number of energy efficiency targets and policy mechanisms to achieve these targets. As part of the series of polices the government has put in place over the past decade, the National Energy Efficiency Action Plan (NEEAP) was officially announced at the end of March 2018. The NEEAP puts forward a concrete technology and investment strategy regarding energy efficiency in buildings, among other sectors of the energy system. The following specific lines of action have been highlighted for improving the energy efficiency of Turkey's building sector.

Line of Action	Timeline
Identify and share best practices regarding materials and technology in the construction sector	The guide will be prepared in 2017 and 2018. The portal will be completed and be functional by 2019.
Create a database for building energy consumption data	Work will be undertaken in 2018 and 2019 to determine the scope of the database and infrastructure. The building inventory work will start in 2020.
Set energy saving targets for public buildings	Savings targets will be identified in 2017 and 2018; and the monitoring of saving results will start in 2018.
Improve energy efficiency of municipal services	Financing effectiveness will be improved, and the conduct of audits and implementation of measures will start in 2018. By the year 2023, the program will be scaled up to include metropolitan municipalities as well.
Rehabilitate existing buildings and improve energy efficiency	The appropriate method will be identified, and the necessary legislative framework will be developed in 2017 and 2018. The method will be implemented in 2019, along with the monitoring of results.
Promote central and district heating & cooling systems	Technical and legislative work will be undertaken in 2018. The implementation will begin in 2020 with mass housing complexes, depending on economic feasibility. From 2020 to 2022, the program will be scaled up to cover any mass housing complexes to be built. Inquiries will be made to extend the program so as to cover existing high-potential mass housing complexes, by the end of 2023.
Increase the energy performance certificate ownership rate among existing buildings	Necessary legislative framework will be developed in 2017 and 2018. Sanctions on inefficient buildings will be considered as an option from 2021 on.
Promote sustainable green buildings and sustainable settlements	The legislative framework will be developed in 2018 and 2019; and the implementation will start in 2020.
Promote energy efficiency in new buildings	2018 will see administrative and technical work undertaken and appropriate method identified. From 2019 on, the identified method will be implemented.
Improve energy performance of existing public buildings	The work on the technical and administrative infrastructure will be completed in 2018. The implementation will begin in 2019.

Scale up the use of renewable energy and cogeneration systems in buildings	The technical and administrative groundwork will be completed in 2018, followed by actual implementation.
Fund energy efficiency audit programmes for SME buildings	The technical and administrative work will be completed in 2018, followed by the implementation stage.

These actions cover a wide range of areas, including technology, finance, policy, awareness and capacity building. On the implementation front, existing policy instruments will be used. However new instruments will also be required. Particularly for the design of new policy instruments, understanding the gaps and limitations of existing ones will be of paramount importance. Several analyses have already been carried out assessing the current policies in Turkey and identifying their shortcomings (MWH, 2015; NIRAS, 2015). In this working paper, we add value to existing analyses by analyzing all policies that are currently in place in the light of indicators enabling comparisons, and providing simple recommendations about how these shortcomings can be remedied, based on a review of international experiences. The scope of the review often goes beyond the analysis of policies, to discuss gaps in financing, quality infrastructure, awareness etc. where relevant.

This paper is organised as follows: Following the introduction, section 2 provides a brief overview of the current status of energy use in buildings. Section 3 gives a brief overview of the current policies in place and identifies the gaps. This section also provides insights into the findings from earlier reviews of the shortcomings of Turkey's energy efficiency policies regarding buildings. Section 4 discusses international examples. The paper concludes with section 5, presenting a number of recommendations to enhance Turkey's existing energy efficiency policy framework, in transition to a low-carbon building sector.

2. Current status of energy use in buildings and recent developments

2.1. Energy use and emissions of carbon dioxide

Turkey has a high rate of urbanisation approaching a growth rate of 2% per year. The fast-growth of the building stock is marked by new construction rates often in excess of 4%. The construction sector is one of the most important drivers of Turkish economy, contributing 6.6% of the real gross domestic product (GDP) growth. There are about 9.1 million buildings and 23 million dwellings in Turkey.

On an average year, 100,000 new buildings are added to the building stock in Turkey. Their combined energy use, including those of residential, commercial and public buildings, was responsible for around one-third of the country's total final energy consumption in 2015. In this context, given the rapid increase in the sector's energy demand averaging 4.4% per year in recent years (Ecofys et al., 2018) effectively rendered the building sector the largest energy user in Turkey.

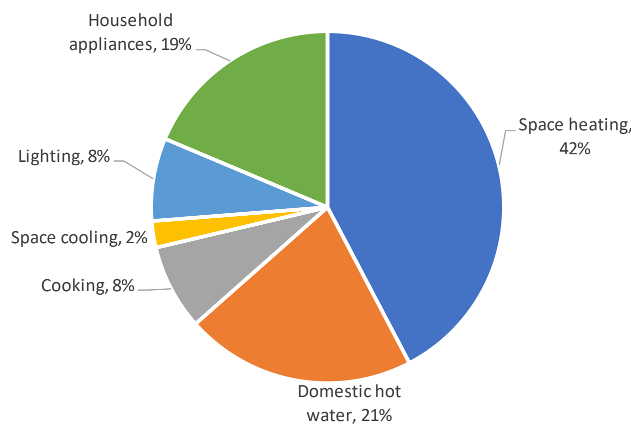
The residential sector's energy demand represents just over half of the entire building sector's total final energy consumption. Public and commercial buildings account for the rest. However, available statistics do not provide sufficient data to allow a further breakdown of this total. Turkey's building stock is characterised by the prominence of rather new dwellings, often built after 1980 (Aydın, 2018). Around three-quarters of buildings were built between 1980 and 2016; and of that volume, around 40% were built after 2000.

Since 2010, around 80% of all new constructions are multi-family residential buildings. The bulk of the remaining 20% is non-residential buildings. The share of single-family houses in new constructions is around 1%. By January 2016, 22 million residential dwellings existed in Turkey. The Urban

Transformation Plan intends to renew about 7.5 million dwellings by year 2030. This implies the renewal of around 500,000 dwellings per year (Ecofys et al., 2018). Renewal is defined as demolishing and reconstruction in line with the standards that comply with earthquake regulations.

Space and water heating leads to more than half of all buildings' energy demand in Turkey (Figure 1). This is also the area where one of the highest energy efficiency improvement potentials exits. Household appliances account for the largest share of electricity demand. Cooling's (air conditioning) share remains low compared to developed countries with similar climate, such as the United States, with the main reason being relatively lower per capita income levels bringing about a currently lower penetration rate of air-conditioning units. But it is one of the fastest growing energy consuming segments with the increasing purchasing power of the population.

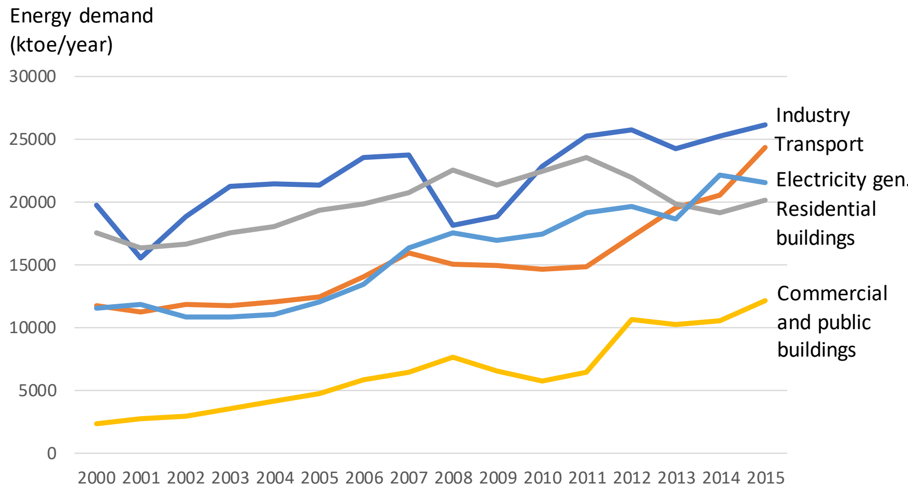
Figure 1: Breakdown of residential buildings energy use in Turkey, 2015



Source: Authors estimate based on (Ecofys et al., 2018), (IRENA, 2014) and (Aydın, 2018)

Figure 2 plots the change in the total energy demand of various energy consuming sectors of Turkey. The residential building sector remains one of the largest energy consuming sectors in Turkey. Yet, in recent years, it has lost its top spot to the rapidly growing transport and the electricity generation sectors. The growth associated with commercial and public buildings is also substantial and continuous. Their energy demand, combined with residential buildings, make the building sector the single largest consumer of energy among all sectors.

Figure 2: Change in total energy demand in Turkey's energy sectors, 2000-2016



Source: (IEA, 2017)

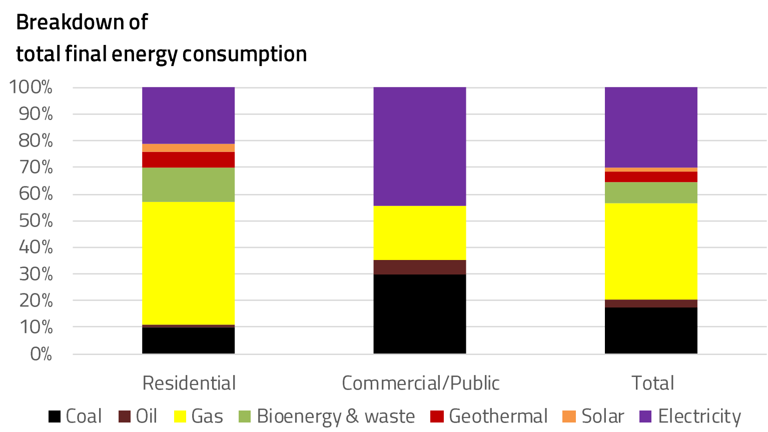
A detailed breakdown of Turkey's building sector energy demand is provided by the national statistics collected from the General Directorate of Energy Affairs (EİGM, 2017) and the international statistics prepared by the OECD/IEA (IEA, 2017). With the exception of solar thermal energy covered by the OECD/IEA (in 2016, consumption of 0.539 Mtoe/year representing 1.6% of buildings' total final energy consumption), the national and international energy statistics differ less than 1% in terms of reported energy use.

Figure 3 provides the breakdown of the total final energy consumption of buildings in Turkey by type of energy carrier, separately for residential and commercial/public buildings. Fossil fuels covered just less than 60% buildings' total final energy consumption in 2016. The share of direct use of renewables was around 12% of the total.[1] Nearly all renewable energy is consumed in residential buildings. Biomass is used for space and water heating and partly for cooking and it accounted for 60% of total direct use of renewable energy. The remaining 40% stemmed from geothermal and solar thermal. Turkey is among the world leaders in solar water heaters with a total installed capacity of 14.9 gigawatts (GW) as of the end of 2016. Much of this capacity is installed in the western and southern parts of Turkey, characterised by high levels of solar irradiation. A new segment of solar thermal applications is emerging for cooling. There is a large-scale solar cooling system installed in Istanbul to cool a wholesale supermarket building, with a total capacity 840 kilowatt (kW) (Weiss et al., 2017).

Electricity's share in overall final energy consumption of buildings' is around 30%. This share is higher for commercial and public buildings (44%) compared to residential buildings (21%). High demand for electricity in commercial and public buildings creates opportunities to supply power from building integrated distributed generation systems such as solar photovoltaic (PV). However, the share of such systems remains negligible in Turkey. Currently, around one-third of all electricity comes from renewables (mainly hydropower). When the share of electricity consumption sourced from renewables is also accounted for, renewable energy's share in Turkey's building sector increases from 12% (only direct use of renewables) to around 20%.

[1] This figure excludes the amount of electricity consumption that is sourced from renewables.

Figure 3: Breakdown of total final energy consumption of buildings in Turkey, 2016



Source: (IEA, 2017)

Natural gas is the most commonly used fuel for Turkey's buildings. On average, annually 1,000 cubic meters (m^3) of gas is consumed per household in Turkey. Virtually the whole gas supply in Turkey is imported, with domestic production representing less than 1% of the total supply.

Gas demand in buildings is largely correlated with temperature levels. For instance, in the first four months of 2017, temperature levels were below the expected average (around 5 degrees Celsius (^oC) lower). This resulted in an increase of around 14.5% in total gas demand compared to the same period of 2016. Given Turkey's exceptionally diverse weather characteristics, with hot summers and cold winters that result in a wide range of climate zones, consumption in the eastern parts of Turkey is around 50% higher than the national average. These weather differences highlight the need to consider various climate zones and adjust to seasonal extremes in terms of temperatures all the while benchmarking annual building energy consumption rates.

Electricity generation accounts for the highest portion of gas consumption in Turkey, burning 38% of all gas supply. The buildings' demand for gas ranks a close second, with a 32% share (see Figure 4) (GAZBİR, 2018). This share is likely to increase as access to natural gas supply is on the rise throughout Turkey. At the same time, the share of gas in electricity generation declines since the general trend is one replacing gas with local energy resources like renewables and lignite.

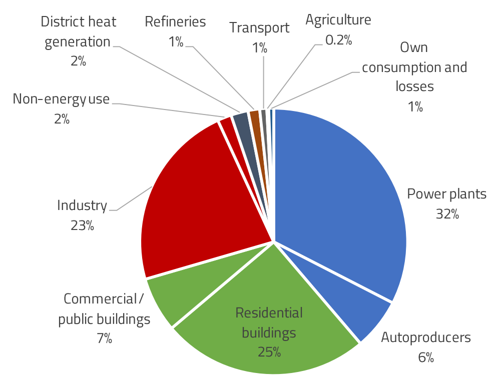
As of the end of 2017, in Turkey, 49.6 million people were actively using natural gas, up from 45.2 million at the end of the previous year. This amounts to a 10% increase in a single year and represents a continuation of the past five years' trend (an increase of 42% with 14.6 million more people having access to gas supply). While these figures represent the population that actively consumes gas, one should note that 62 million people have access to the gas network. 12 million people with access choose not to use gas due to preference for other fuels like coal and oil products, for heating / cooking, or other technologies like heat pumps, over gas. The government aims to increase access to the network by another 2.5 million people by the end of 2018.

Coal is also widely used in Turkey. As of the end of 2015, 8.2 million tonnes of coal equivalent (Mtce) were consumed for heating. Two-thirds of this figure was used for meeting the heating demand of commercial and public service buildings, and it was predominantly sourced from hard coal, more than

95% of which is imported (TTK, 2018). The remaining one-third was used in the residential sector, in the form of either hard coal or lignite. Of the total 70 million tonnes (Mt) of lignite supplied in Turkey in 2015, 5% was used to meet the demand for heating in buildings. The rest was used by power plants and for industrial heating (TKK, 2016). Lignite has a much lower calorific value than hard coal, by a factor of two to three times, and produces significantly higher emissions of carbon dioxide (CO_2) and air pollutants per kilowatt-hour (kWh) of energy generated. However, lignite is cheaper since it is typically locally mined and is available across Turkey's entire geography (MTA, 2018). Hard coal has a higher calorific value than lignite and its combustion is more energy efficient.

Oil's share in Turkish buildings' total energy supply is much lower in comparison, accounting for merely 3% of the overall figure. Nowadays it is only rarely used as a heating and cooking fuel where there are no other alternatives, such as connection to the gas networks.

Figure 4: Breakdown of natural gas use in Turkey by sector, 2016

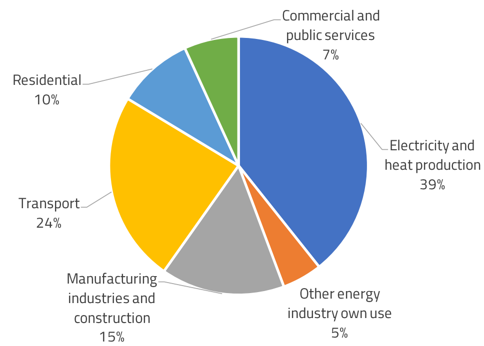


Source: (IEA, 2017)

Combustion of fossil fuels leads to CO_2 emissions, which is regarded as the main driver of climate change. In 2016, combustion of fossil fuels in Turkey resulted in a total of 339 Mt of CO_2 emissions. This represented around two-thirds of all greenhouse gases that were released in Turkey in that year. The CO_2 emissions can be broken down as follows: 130 Mt from electricity and heat generation, 51.1 Mt from manufacturing industry, construction and other uses in industry such as on-site electricity generation, 79 Mt from transport, and 54 Mt from other sectors, in which buildings were among the prominent consumers (see Figure 5).

In this picture, one would not be off-the-mark to observe that the buildings account for the smallest portion of Turkey's CO_2 emissions despite being the largest consumers of energy. Two reasons help explain this result: much of building sector emissions occur indirectly in the electricity generation sector (buildings consume half of all electricity generated in Turkey and electricity generation is accounted for separately in the emission statistics), and around 20% of sector's energy demand is supplied by renewables (taking into account both the direct use of renewables and the consumption of electricity from renewable energy sources). The widespread use of gas, which generate comparably lower CO_2 emission than coal, further reinforces this trend.

Figure 5: Breakdown of energy-related CO_2 emissions in Turkey, 2016



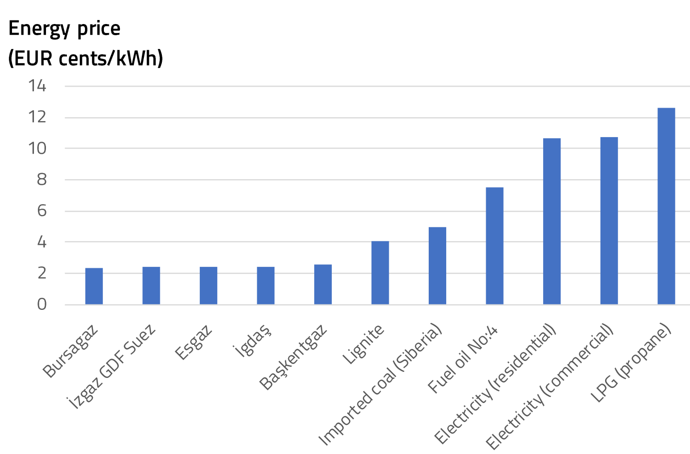
Source: (IEA, 2018)

2.2. Energy prices

In Turkey, the cheapest form of energy supplied to buildings is gas (specifically gas with lower heating value (LHV), of 8,250 kilocalories (kcal) per m^3), the price of which can range between 2.3 Euro (EUR) cents and EUR 2.6 cents per kWh. Coal follows gas as the second cheapest energy source. Domestically produced lignite is priced just above EUR 4 cents per kWh (4,800 kcal/kg). Imported coal (from Russia) comes with a price tag of EUR 5 cents per kWh (7,000 kcal/kg). The electricity price is around EUR 10.6 cents per kWh. Oil products (11,000 kcal/kg) that can be used for cooking and heating are three to five times more expensive than gas (see Figure 6) (DOSİDER, 2018).

As of the end of July 2018, the Turkish gas market took an important step towards switching to cost-based pricing. Boru Hatları İle Petrol Taşıma A.Ş. (BOTAŞ) –the state-owned enterprise that effectively regulates the Turkish gas market– increased the price of gas for electricity generators and for industrial and residential uses. Gas price for residential users remained lower than the prices industry and electricity generators are charged, by 20% and 45%, respectively. The increase in gas prices was also reflected in electricity prices. For residential users, compared to the last quarter of 2017, the increase reached to 33% (in TRY) (Enerji IQ, 2018).

Figure 6: Energy prices paid by buildings in Turkey, 9 January 2018



Source: (DOSİDER, 2018)
Note: On the date these prices refer to (9 January, 2018), the currency exchange rate was TRY 4.48 per EUR.

3. Gap analysis of Turkey’s building energy efficiency policy framework

3.1. Existing policy framework

Turkey is ranked among the fastest growing economies of the Group of Twenty (G20) and the Organisation for Economic Co-operation and Development (OECD). The total demand for energy in Turkey is growing by an average of 5% per year, even during times of economic slowdown. More than 85% of this demand is supplied by fossil fuels three-quarters of which are imported. Virtually all gas and crude oil and a significant portion of coal used are imported.

Energy security is particularly important since energy imports account for a considerable part of Turkey’s trade accounts deficit, and by 2017 the country’s dependency to imported sources of energy reached to the alarming level of 75%. Improving the local air quality and contributing to the global challenge of mitigating climate change are other motives that shape Turkey’s energy and climate policies (Saygin et al., 2018).

Given the rapidly growing demand for energy in Turkey and the central role buildings play, the sector is at the forefront of the country’s energy and climate strategies, policies and regulations.[2] Energy efficiency improvements will be largely driven by the recently released NEEAP that defines 12 specific actions for buildings.

3.2. Identifying gaps in Turkey’s current energy efficiency policies regarding buildings

Methodology

The current versions of Turkey’s energy efficiency policies and regulations were reviewed with the aim of identifying their shortcomings by focusing specifically on the issues listed in Table 1. These issues have been identified with reference to various technology applications, sector characteristics, policy scope and stakeholder requirements.

Table 1: Scope of the policy assessment in this study

Technical coverage	Sectoral coverage	Public engagement approach	System approach	Other overarching issues
• Efficient heating • Efficient appliances • Efficient lighting • Efficient cooling • Building envelope • Use of renewable energy	• Green buildings • New buildings • Existing buildings	• Incentives • Penalties	• Reporting of results • Measurement of overall results • Periodic/regular revision	• Holistic approach • Mention of climate change

Note: The term “Green Buildings” refers to the Sustainable Green Buildings as described in the Green Buildings Certification Regulation dated 8.12.2014, as “buildings that are sustainable, energy efficient, in harmony with nature, and with minimum impact on the environment throughout their lifecycle in terms of location selection, design, construction, operation, maintenance, retrofitting, demolition and disposal of wastes”.

[2] A comprehensive explanation of all high-level strategy documents, policies and regulations that are related to energy efficiency and buildings in Turkey is provided by Ecofys et al., 2018

In the gap analysis (Table 2), colour coding is applied for clarity and simplicity. Green is used to describe issues that are considered to be sufficiently addressed in the existing regulations. Yellow represents issues that are covered to some extent, but not fully and thus have some room for improvement. Red refers to issues where clear gaps exist. The specific documents covering a given issue are mentioned briefly in the relevant cell. Doing so led to a general overview with a qualitative evaluation of coverage. The study entails the assessment of the following policies and regulations:

- Energy Efficiency Law (2007)
- Energy Efficiency Regulation (2011)
- Energy Efficiency Strategy (2012)
- TS 825 (2008, and the draft version of the revision of the same document dated 2013).
- National Energy Efficiency Action Plan (2017)
- Buildings' Energy Performance Regulation (2017)
- Green Buildings Regulation (2017)

It should be noted that due to the legal status of the individual documents (strategy, law, regulation or standard), some documents are more specific in their technical aspects (e.g. TS 825 and BEP-TR) while others are more specific in terms of organizational and administrative issues (e.g. Energy Efficiency Action Plan). Moreover, the dates of the documents have an effect on the inclusion or omission of some specific issues. For instance, documents that were published earlier are of a more technical nature and focus less on relatively newer concepts such as green buildings, climate change mitigation etc.

Results

The summary showing the scope of existing regulations and the gaps identified is provided in Table 2. The technical coverage of the existing regulations is relatively well-established. The following observations stand out regarding the gaps:

- **Heating systems**: All regulations consistently refer to efficient heating systems, indicating that efficient heating is a major issue in energy efficiency in buildings. The only piece of regulation where efficient heating is not explicitly mentioned is the Green Buildings Regulation.
- **Lighting**: Efficient lighting is not mentioned in the Green Buildings Regulation and TS 825. This is not necessarily a shortcoming or omission per se, since TS 825 is only about thermal loss calculation of buildings and the Green Buildings Regulation specifies a committee that will describe the standards and performance criteria applicable to green buildings. Energy Efficiency Strategy and NEEAP mention that efficient lighting is to be used, yet without further clarification or reference to any standards. BEP TR also requires the use of efficient lighting in buildings. This is to be achieved through recommended efficient technologies and applications (e.g. LED and compact fluorescent lamps, automation systems). However, as efficient lighting is not defined clearly, and as no specific limit values etc. are provided, in practice this requirement is not enforced effectively. The Lighting Efficiency class of the building is covered by BEP-TR, yet without any required minimum standard. In this context, minimum acceptable standards of efficient lighting can be considered a universal shortcoming across relevant regulations.
- **Cooling**: Even though the need for energy for cooling purposes become ever more critical as the demand for cooling increases, efficient cooling seems to be overlooked in the existing regulations, compared to the focus on heating. Although mentioned to some extent in all regulations except the Green Building Regulation, it is nonetheless covered only superficially in

the Energy Efficiency Strategy and TS 825. BEP TR requires the cooling load of buildings to be taken into consideration for the energy performance contract (EPC) of the building, and the cooling class of the building is to be reported in the context of EPC. However, as was the case with lighting, no concrete minimum standards are applied for the cooling category.

- **Building envelope**: Building envelope is mentioned in all regulations except the Green Buildings Regulation. Building envelope is often explicitly mentioned and discussed in some depth and technical detail in all regulations, while the Energy Efficiency Regulation just mentions the improvement requirements regarding efficient windows but not building thermal insulation.
- **Renewable energy**: The use of renewable energy is briefly mentioned in each regulatory document but is not addressed in detail in most of them. None of the regulations elaborate the individual role various renewable energy technologies can play in buildings. The NEEAP requires an increase in the use of renewable energy in buildings, but falls short in terms of providing further details. The Energy Efficiency Law considers industrial renewable energy applications aiming to reduce the energy demand of a given facility as energy efficiency, and makes such applications eligible for grants, but does not stipulate any grants for buildings, and does not mention renewable energy in buildings in any further detail. BEP TR requires that the use of renewable energy in building design should be given priority, with an impact on the renewable energy class of the building as reported in EPC. In new buildings with a total usable area larger than 20,000 m^2, investments into renewable energy, cogeneration, or heat pumps, up to 10% of the total building cost are required. However, as in the case with lighting and cooling, no minimum renewable energy class is specified. Given the fact that the subclasses of EPC (renewable energy, lighting, cooling) often are not subject to any further verification process, errors in this document often remain uncorrected. The Energy Efficiency Regulation also requires that renewable energy is used in buildings, but without providing any further details. The Green Buildings Regulation does not mention renewable energy apart from its use in the context of the generic term of sustainable buildings. The effective implementation of renewable energy in the regulatory framework can be considered as an omission, due to the weakness in clear definitions, standards and alignment with international practices.
- **Sectors**: In terms of sectoral coverage of buildings in the regulations in Turkey, green buildings seem to be the one issue are that is neglected the most. The Green Buildings Certification Regulation describes green buildings as “Buildings that are sustainable, energy efficient, in harmony with the nature, and causing the smallest possible impact on the environment throughout their lifecycle in terms of location selection, design, construction, operation, maintenance, retrofitting, demolition and disposal of wastes”. The Energy Efficiency Strategy mentions green buildings as sustainable buildings but does not go further into details. On the other hand, the Energy Efficiency Law, BEP TR and Energy Efficiency Regulation do not mention green buildings at all. TS 825 briefly mentions green buildings without any description or clarification. The omission of green buildings and climate change can be observed across the whole range of regulations. This is probably due to the fact that standard, well-formulated descriptions of these concepts were unavailable until recently, and that the policy makers felt the need for such clear definitions before the introduction of these concepts into regulations, as vague descriptions often make the regulations difficult to understand and implement. These issues can be easily added to existing regulations or introduced in subsequent regulatory

elements. This may also provide an opportunity to introduce passive and (nearly) zero-energy building (nZEB) concepts.

- **Existing and new buildings** are well covered in all regulations. The only regulation that excludes the former is the TS 825, which is only applicable to new buildings. NEEAP focuses on both in the context of different activities, to increase specific impact.
- **Public sector as the front-runner in energy efficiency**: Although the Energy Efficiency Regulation sets targets for government buildings to achieve at least 20% reduction in energy consumption in comparison to 2010 levels, by year 2023, the implementation of this requirement is lagging mostly due to financing issues. Although the public sector is required to be a frontrunner similar to the arrangements in Europe in the context of nZEBs, there is yet room for improvement in implementation.
- **A dedicated national energy efficiency agency** is also missing from the regulations. During the development of most of the current regulations, certain directorates reporting to the Ministry of Energy and Natural Resources (MENR), namely the Electrical Power Resources Survey and Development Administration (Elektrik İşleri Etüt İdaresi - EİE), and thereafter the General Directorate of Renewable Energy (Yenilenebilir Enerji Genel Müdürlüğü - YEGM) which replaced it following the abolishment of the EİE, operated as the centres of energy efficiency, and acted as a dedicated energy efficiency agency for all practical purposes. However, the splitting of responsibilities of YEGM between the Ministry of Environment and Urbanization, the Ministry of Industry, and the MNRE effectively took this focused institution out of the picture. Since 2018, YEGM's work was assigned to the General Directorate of Energy Affairs (Enerji İşleri Genel Müdürlüğü - EİGM) and by early 2019, the Department of Energy Efficiency and Environment (Enerji Verimliliği ve Çevre Dairesi Başkanlığı) were founded. So far, the lack of an agency that predominantly focuses on energy efficiency is considered to be a shortcoming whilst the newly founded Department will play a crucial role in closing this institutional gap.
- **Public engagement**: A glance at the public engagement approach of the existing regulations reveals that very few apply incentives and enforcement together, which, in theory, can prove more effective if applied in balance in the relevant regulations. The NEEAP has detailed incentivising activities but entails no enforcement elements with reference to the minimum performance levels required. The Energy Efficiency Regulation requires public awareness activities regarding energy efficiency in general but does not explicitly mention any activity for energy efficiency in buildings. BEP TR only uses enforcement in terms of not providing building use certificates for non-compliant buildings (with plans in place for enforcement from 2020 onwards), but has no mechanism for encouraging change beyond the minimum requirements. The enforcement of building use certificates is expected to come into force in 2020, but as this deadline has been postponed in the past, doubts about its implementation in 2020 remain. The Energy Efficiency Regulation stipulates grants for encouraging change in industry, but these grants do not apply for buildings. The Green Buildings Regulation stipulates voluntary certification, but no enforcement. TS 825 entails no encouragement for above a standard level of performance, but it sets the minimum standards to be met.
- **Target setting, reporting and revision**: The softer issues of individual results reporting, setting targets, measuring target achievement and reporting of the overall results as well as regular revision are either lacking, or needs improvement in most documents.

- Energy Efficiency Strategy and NEEAP both mention reporting of results but offer no clear mechanism for achieving this.
- The Energy Efficiency Law foresees regular annual revisions regarding implementation. However, these do not lead to meaningful results in terms of reports of progress available to public.
- BEP TR stipulates calculation of the energy demand of each building it is applicable to. However, there is no method put forward for overall performance evaluation, i.e. a comparison of estimated values with actual consumption figures (e.g. through a consumption-based EPC). Nor there is a mechanism to bring about better performance in energy savings in time through iterative improvements.

Also, in most cases there is no clearly defined way for regular revisions of the regulations.

- The Energy Efficiency Regulation requires annual reporting in the case of larger consumers. However, there is no database of baseline efficiency / consumption values available to public, to serve as benchmarks. The Regulation also provides no quantitative targets or timescale for improvements, as well as no responsible institution for follow up. This Regulation also omits the possibility of regular revisions.
- The Green Buildings Regulation mentions annual reporting of results, but this mechanism is not defined clearly. Again, this Regulation omits any quantitative targets as well.
- Although TS 825 essentially stipulates reports of heating energy consumption for each new building, these reports are not compiled for meaningful reporting. TS 825 also does not foresee any regular revision.

Thus target setting, reporting and revision are considered to constitute a shortcoming of the overall policy framework. Efforts to improve the state of affairs on this front can lead to a more realistic assessment of overall progress**.**

- **Overarching and cross-cutting issues** covered by the different regulations or authorities seem to be the area where most attention would be needed. Although any overlap of responsibilities and authority among government entities are addressed and regularly resolved within the relevant authorities' internal procedures, this often is a time-consuming procedure, and may also require repeated or continuous communication processes. A specific method for simplifying these processes and speeding up the resolution mechanism seems to be lacking in much of the regulations. The Energy Efficiency Strategy mentions that cross-cutting issues will be handled by the MENR without further elaboration. NEEAP notes that all cross-cutting issues will be resolved between the relevant authorities. The Energy Efficiency Law does not mention cross-cutting issues at all, but given the comprehensive and general nature of the contents of the document, this issue is not considered a shortcoming per se. BEP TR and TS 825 do not mention cross-cutting issues. The Energy Efficiency Regulation mentions cooperation with non-governmental organisations and other stakeholders in the implementation of the awareness raising programme. The Green Building Regulation requires the revision committee to refer to all other existing national regulations. This shows that cross-cutting issues and coordination are only partly addressed throughout the documents analyzed.

- **Climate change**: Among all the regulations analyzed, only the Energy Efficiency Strategy mentions climate change as one of the reasons for seeking energy efficiency. While NEEAP mentions carbon and greenhouse gas emission reduction sporadically, no other regulation mentions climate change in any significant sense. This makes measuring CO_2 emissions and using them as an indicator for improvements and further requirements implausible, for such references are effectively lacking in the regulatory spectrum.

The issues that would hinder effective implementation of the regulations beyond what is obvious in the review of the existing policy framework are not limited to those noted above. Below is a list of issues observers of the implementation of the regulations noted in various discussions with experts, professionals, potential investors and other stakeholders involved in energy efficiency in buildings:

- **Lack of public awareness**: Public awareness regarding energy efficiency in buildings is mostly limited to bigger cities and can be considered only rudimentary. A public consensus exists on the importance of energy efficiency, but non-technical individuals are often unaware of several cost-effective ways of improving their buildings. Activities to increase public awareness activities seem to have slowed down in time and should be emphasised once again, following a study of training needs.
- **Lack of access to finance**: Access to finance for energy efficiency investments is still an issue, despite the availability of funds from various financial institutions (e.g. TUREEFF by the European Bank for Reconstruction and Development, Ekokredi by Şekerbank). One underlying reason is the lack of creditworthiness of some investors, in the eyes of local financial institutions. Another is the comparatively high costs of and documentation required for energy efficiency finance tools, compared to ordinary consumer loans.
- The **knowledge infrastructure**, although available, is scattered, making it hard for non-experts to make accurate comparisons of the quality/performance/cost of equipment/systems. In Turkey, there are many local producers of energy efficient products, who are able to innovate, produce highly efficient equipment, and deliver such services. However, the demand for services is not necessarily correlated with available technologies, thereby discouraging manufacturers from investing into higher efficiency product development.
- The **urban transformation plan** could potentially limit improvements in existing buildings since the primary objective is to demolish existing building stock and rebuild with a focus on resilience to natural disasters. As many buildings are already on waiting lists in the context of this plan, which, at times, can take years, the existing buildings which may benefit significantly from measures like thermal insulation, or improvement of heating systems –measures which can be implemented quickly without a complete rebuild– may refrain from implement energy efficiency measures as the expected lifetime of the existing buildings may be too short for the costs to be recouped through higher energy efficiency. Even though new buildings are required to have a minimum efficiency class of C, which is estimated to be better than average of the existing building stock, the prospects of a rebuild within the framework of the urban transformation plan could potentially discourage the adoption of costly efficiency measures in existing buildings. Thus, it remains a crucial task to reap the benefits from the Urban Transformation Plan as quickly as possible.
- **The users' weak direct control** over construction companies and suppliers of energy efficient technologies, in practice, encourages the market to seek the minimum acceptable standards

(class C buildings) and not better, for any new buildings. Higher efficiency would not necessarily demand substantial increases in building costs, and might be desirable to some buyers. Yet it is often unavailable in the market. The suppliers of energy efficient technologies are often the only ones making the decisions regarding the efficiency and installed capacity of the equipment; and their decisions may be more aligned for low initial costs versus (lifecycle) operation costs, and higher capacity (with higher safety margins) versus correct sizing for high efficiency. Although this is not really a shortcoming of the regulations, and is rather a result of the conditions prevailing in the market, enhanced regulations may help alleviate this problem.

- **Limited control and auditing by the authorities** reduces the chances of taking snapshots of the building stock with a view to observing developments and assessing the impact of policies. Although BEP-TR stipulates ad-hoc audits for the verification of EPC certificates, the actual implementation is by no means widespread, and the issuers of the certificates and implementers are often not concerned about audits which would potentially expose errors or divergence from the plans. A well-announced and widespread programme of audits would enable the authorities to better observe the development of the building stock, and encourage both designers and implementers to adhering better with the recommended or required designs. Thus, such an improvement would also improve the basis for enforcement of existing regulations.
- The **low energy prices** is considered to be one of the main barriers in terms of encouraging energy efficiency initiatives, though the latest developments in the gas market have raised the prices of both gas and electricity. Given the fact that the country is not rich by any means in terms of local conventional energy sources, the government of Turkey has traditionally subsidised energy prices to end users to varying degrees, to support economic growth and public welfare (Taranto et al., 2019). However, the relatively low cost of energy that is offered to commercial, public and private consumers make the time frames required for the return on energy efficiency investments in buildings longer, to an extent that they are no longer financially viable. There are also several cost items which are not directly related with the price of energy, making it difficult to directly calculate the economic savings achieved through energy efficiency investments, rendering such investments financially uninteresting proposals. Although not directly a shortcoming in the existing energy efficiency policy framework, strategies that address energy pricing could indirectly facilitate better energy efficiency policy impact.

Table 2: Overview of the gap assessment in Turkey's building sector energy efficiency policy framework: technical and sectoral coverage

			TECHNICAL COVERAGE					SECTORAL COVERAGE		
			Technical measures					Building subsectors		
Level of Legislation	**Name**	**Date of Issue**	**Efficient heating**	**Efficient lighting**	**Efficient cooling**	**Building envelope (windows, doors, insulation)**	**Renewables**	**Green buildings**	**New buildings**	**Existing buildings**
Strategy	Energy Efficiency Strategy	2012	Explicitly mentioned	Mentioned in Efficient appliances	Mentioned in Efficient appliances	Explicitly mentioned	Explicitly mentioned	Sustainable buildings are mentioned	Explicitly mentioned	Explicitly mentioned
Action Plan	NEEAP	2017	Requires efficient regional heating	Improvement of efficiency in general lighting required	Requires efficient regional cooling	No mention	Requires the extension of RE use in buildings	Encouraging green buildings through competitions	Explicitly mentioned	Explicitly mentioned
	NREAP	2014								
Law	Energy Efficiency Law	2007	Requires efficient heating in buildings	Requires efficient lighting	Requires efficient cooling in buildings	Requires efficient windows and insulation	Considers RE use in industrial establishments as EE, and subject to grants, but no grants for buildings	No mention	Requires Efficiency certifications for old and new buildings	Requires Efficiency certifications for old and new buildings
Regulations	BEP TR	2008	Explicitly mentioned	Influences the certificate very little, class of lighting reported	Not evaluated, energy consumption of the equipment is added to consumption but reducion from potential requirement not taken into account	Explicitly mentioned	Mentioned, affects the RE class of thebuilding but nothing else.	No mention	Explicitly mentioned	Explicitly mentioned
	Enerrgy Efficiency Regulation	2011	Explicitly mentioned	Explicitly mentioned	Explicitly mentioned	Windows improvements mentioned, building envelope not mentioned	Requires the use of RE in buildings where possible	No mention	Explicitly mentioned	Explicitly mentioned
	Green Buildings Regulation	2014	No mention	No mention	No mention	No mention	No mention	Explicitly mentioned	Explicitly mentioned	Explicitly mentioned
Standards	TS 825	2013	Requires efficient heating in buildings	Not relevant	Mentioned	Explicitly mentioned	Mentioned	Mentioned	Explicitly mentioned	Describes the design method for new buildings

Table 3: Overview of the gap assessment in Turkey's building sector energy efficiency policy framework: public engagement, system approaches and others

PUBLIC ENGAGEMENT APPROACH		SYSTEM APPROACH			OTHER OVERARCHING	
Approach		Measurable Results/Reporting		Evaluation		
Encouraging change	**Enforcing change**	**Reporting of results**	**Measurement of results**	**Regular Revision**	**Holistic approach (coordination with other legislation, standards and implementation)/ Handling of cross-cutting isues with other Authorities**	**Mention of climate change**
Requiring encouragement activities	Requiring institutions to establish rules	Mentioned but no direct source of information to see results	Numerical targets on efficiency improvement, timescales and responsibe institutions mentioned, requires YEGM capacity to be improved for measuring results	First revision in 3 years, following revisions every 2 years	EE described as a cross-cutting issue in introduction. Organic connections with other legislation will be coordinated by the Ministry of Energy	Mentioned in introduction as one of the reasons for need of energy efficiency
Foresees widespread training and public awareness activities, sharing best bractice case studies. Encouranging green buildings through competitions	No mention	Mentioned	Numerical targets on efficiency improvement, timescales and responsibe institutions mentioned, requires databases to be developed	The outcomes of the Plan to be revised every year in April	Mentioned	Sporadic mention of low carbon measures and reduction of GHG emissions
Training and public awareness activities, tv programmes, annual EE Forum, describes grants for EE investments for industrial establishments	Fiscal enforcement	Annual reporting of energy consumption by major consumers required	Monitoring, analysis and projection activities	Annual revisions of implementation on November through EE Coordination Commitee, no regular revisions at higher level	No mention (rather integral document, the lack is not very disturbing)	No mention
No clear method for encouragement	All buildings required to obtain an EPC	Each building's class is reported separately, some statistics regarding overall (countrywide) results, but database open to public	Although results are measured by each building's class, no method for annual ovearll performance evalutation	No mention	No mention	No mention
Describing Grants, not available for buildings	Defines fines	Annual reporting of energy consumption by major consumers required	No numerical targets on efficiency improvement, timescales and responsibe institutions mentioned	No regular revision envisaged	References to public and NGO stakeholders, public awareness activities	No mention
Voluntary certification	No enforcement	A national database of greenbuildings mentioned, but not the level of reporting not clear	No numerical targets	A commitee for revision is described with regular revision	Revision commitee to refer to other national strategies and plans	No mention
No encouragement	All new buildings are required to be designed in accordance	No method described for reporting results obtained	Provides the basis for calculating future heating energy consumption	No mention	No mention	No mention

Comparison of findings with former gap analyses

Several studies conducted by various institutions, on Turkey's policies regarding energy efficiency in buildings include gap analyses. Some of these documents are dedicated to gap analysis only, while others are parts of other larger-scale reports on energy efficiency.

The most comprehensive documents found to be available on the internet, on gap analyses of Turkish regulations with regard to the EU legislation are:

- "Binalarda Enerji Verimliliği: AB ve Türk Mevzuatı" (Energy Efficiency of Buildings: EU and Turkish Regulations) (NIRAS, 2015)
- "Politika Boşluk Analizi ve Enerji Verimlilik Programı Değerlendirmesine İlişkin Danışmanlık Hizmetleri" (Consulting Services for Policy Gap Analysis and Energy Efficiency Program Evaluation) (MWH, 2015)

Both reports include a detailed evaluation of Turkey's energy efficiency regulations, and provide comparisons with EU regulations. The first report is a detailed study of EU and Turkish Energy Efficiency regulations regarding buildings, and their comparison to come up with an identification of their shortcomings. The most important gaps found by this report can be summarised as follows:

- Insufficient capacity of the administrative structures of the relevant ministries and municipalities responsible for implementing BEP-TR
- Inadequate description of roles, responsibilities and authorities of various administrative bodies related to BEP-TR
- The Commission of Energy Efficiency (which is responsible for reviewing relevant regulations) not being very active
- The inadequacy of proportional and applicable enforcement
- The lack of adequate awareness about the impact/benefits of EPC certificates, among stakeholders
- A shortage of activities to serve as models regarding energy efficiency of public buildings
- Lack of awareness regarding building energy performance and low-cost opportunities
- Turkey's slowness in keeping up with developments in the EU, and inadequate compatibility
- The unmet need for regular updates of the software used for BEP-TR
- Inadequacy of independent control and audit mechanisms
- Delays in regular updates of standards regarding technological developments

The second report is a high-level gap analysis of Turkish energy efficiency regulations, and is not focused only on buildings but on industrial energy efficiency as well. This report's findings which are relevant to energy efficiency in buildings are as follows:

- Despite the reasonably robust legal framework, Turkey's long-term energy intensity targets cannot be met with the existing portfolio of policies and programmes. This points to a major internal gap in energy efficiency policies in Turkey.

- Improvement of adaptation to EU regulations and standards will improve energy efficiency in Turkey, but a major gap will remain in place nonetheless, until complete adaptation of such regulations and standards.[3]
- The main barriers to full adaptation of EU regulations are the lack of diversity in existing programmes, the need to change the approach to policy development and implementation, and the need to set higher long-term targets.
- The regulatory, educative, informative and financial tools are established yet inadequate.
- The reliance on international programmes is too strong in energy efficiency investments. Improvements in public sector support are clearly needed.

This working paper, as well as the other two reports mentioned above, have identified gaps in Turkey's energy efficiency policy framework regarding buildings. The gaps and shortcomings identified are mainly related to administrative capacity, implementation issues, and the lack of complete harmonisation with EU regulations. Table 4 below provides a summary to enable the comparison of the findings of the three reports. It can be seen that every study identified similar gaps, despite differences in focus.

Table 4: Comparison of policy gaps identified in various reports

	This working paper	**NIRAS (2015)**	**MWH (2015)**
Gap	Identified as a Gap?		
Lack of enforcement in some regulations	Yes	Yes	No
Lack of mention of passive buildings and near-zero-emission buildings	Yes	No	Yes
Lack of quantitative targets particularly for existing buildings	Yes	No	No
Lack of ambitious targets for public buildings, and mechanisms for financing the transformation	Yes	Yes	Yes
Weakness of financial support mechanisms	Yes	No	Yes
Weakness of evaluation and revision mechanisms for the regulations	Yes	Yes	Yes

Summary of key gaps

Turkey's policies on energy efficiency in buildings are well developed and comprehensive, despite the existence of some gaps. The most critical gaps identified are as follows.

- Across sectoral coverage, the largest gap seems to be the ones regarding green buildings, sustainable buildings and nZEB. This is not surprising since there is only one regulation dedicated to green buildings, whereas other aspects of energy efficiency are covered by a law, plans, strategies and regulations.

[3] Although this statement could be interpreted to take all EU regulations as good and useful, while deviations should be avoided, considering Turkey's long-term strategy to join the EU, and harmonise its regulations and technical standards with those the EU justifies the statement that Turkish regulations and standards need to meet EU standards as a minimum.

- In terms of the technical measures, the most prominent gaps stem from the relative indifference regarding cooling and the use of renewable energy technologies. Although both issues are mentioned, with requirements for efficiency and recommendations to comply with best available practices in most regulations, there is an observed lack of detail and concrete guidance.
- This is followed by the administrative gap in public sector's involvement in terms of a fully dedicated agency for energy efficiency, that could help harmonise the efforts of all stakeholders, support different relevant departments within the government agencies with specialist know-how, and contribute to the wide-spread dissemination of information. Such an agency would also be able to support the buildings of the public sector as front runners in energy efficiency. The newly established Department of Energy Efficiency and Environment will play a crucial role in closing this institutional gap.
- Quantitative targets and progress indicators for improvements in energy efficiency across sectors and technologies, with clear methodologies for assessment, enforcement and reporting of progress indicators, as well as mechanisms for their revision are also considered major gaps existing in Turkey's policy framework.
- Provisions for regular evaluation and revision of policies are also far from satisfactory. A lack of clear description of methodologies and practices to be implemented for regular evaluation of the implementation and the success of each element of the regulations, and for the revision of these documents, leads to regulations becoming outdated quickly, and thus unable to achieve the intended results.
- The lack of any reference to climate change and the relevant requirements and definitions of decarbonisation and greenhouse gas emission reduction is also seen as a gap which needs to be remedied in order to achieve harmonisation with Turkey's climate change targets.

4. International examples of closing the gap in the policy framework

Examples from other countries and regions may provide inspiration for policies that could be implemented to close these policy gaps. A high-level overview is provided below. The selected case studies reflect solutions addressing finance, standards, innovative business models and the role of energy performance certificates, across a range of building types and jurisdictions.

Example	**Related gap covered by the example**
Revolving loan fund - Estonia	Finance mechanism Multi-family buildings
Energy Performance Contracting - Croatia	Finance mechanism Public buildings Existing buildings
Enforcement and strengthening building standards over time – Flanders, Belgium	Building standards Building standards enforcement and compliance Nearly zero energy buildings
Nearly Zero Energy Building standards – European Union	Building standards Nearly zero energy buildings
Green building standards - International	Building standards Green buildings
Energy Performance Certificates – Portugal	Awareness raising Standards Compliance
Energiesprong - Netherlands	Nearly zero energy/passive buildings Business model Industrialisation (off-site construction)

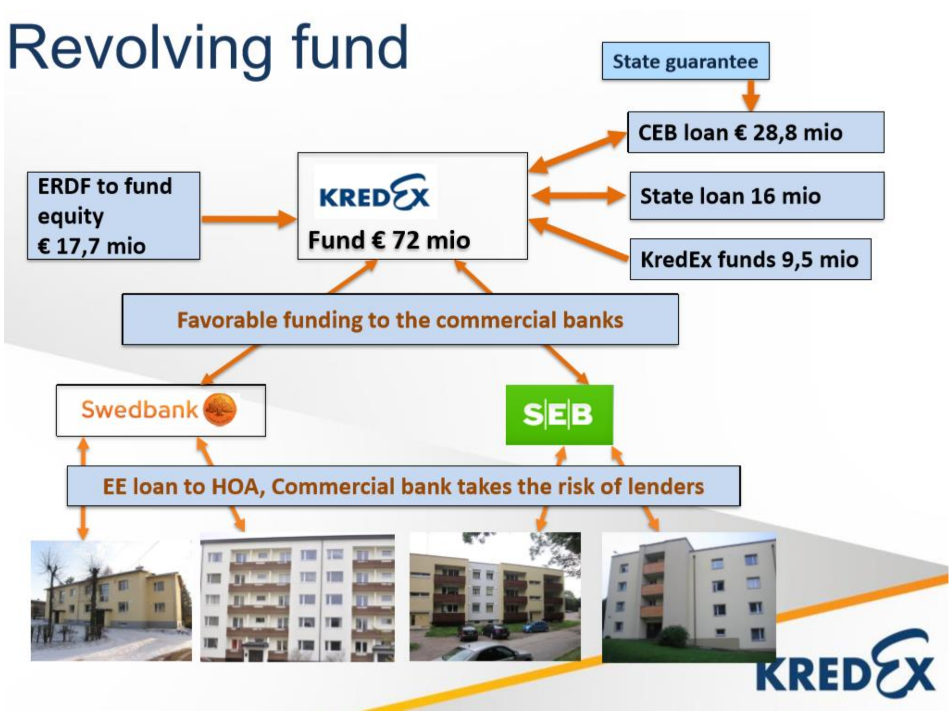
Revolving loan fund - KredEx, Estonia

Prior to 2008, Estonia had not imposed any legal obligations to insulate buildings or to provide efficient technical systems such as heating in buildings despite the cold climate in this Northern European country. As a result, Estonian buildings were wasteful in terms of energy use, having an average heating energy demand of around 200-400 kWh per square meter (m^2) per annum. Two-thirds of Estonia's population of 1.3 million live in Soviet-era apartment blocks, the vast majority of which are in private ownership. Apart from having poor thermal performance, these buildings suffer from structural defects as well. This situation led to the Estonian Government establishing the KredEx Foundation. The foundation manages a revolving fund, the first of its kind to use EU Structural Funds (EU funds) to enable low-interest loans to housing associations and municipalities.

In order for an apartment block to be renovated under the loan scheme, a mandatory five-step process must be followed in line with the strategic renovation scheme. An additional grant is provided to support the efforts. The grant rate depends on the expected energy savings and ranges from a 15% grant for savings between 20% and 30%, to a 40% grant if 50% savings are achieved. The average renovation cost is EUR 250/m^2.

This revolving fund mechanism provides the housing sector with an opportunity to reuse loan repayments in the scheme to further renovate the building stock. The fund has been successful in increasing the rate of deep renovations. In the period 2010-2014, 661 buildings comprising 24,000 apartments were renovated. The average saving rate is around 40% (around 75 gigawatt-hours (GWh) per year), bringing about 15,000 tonnes CO_2 emission reduction per year.

Figure 7: Overview of the Kredex fund



Source: http://www.kredex.ee/et/

Energy Performance Contracts - Croatia

Croatia is the newest member of the EU, having joined in 2013. There are 80,000 public buildings in Croatia, most of which were constructed before 1980 and hence ripe for renovation (Ministry of Construction and Physical Planning, 2014). Action to improve energy performance in the public sector can be an important trigger for wider stimulation of the market for energy performance improvements. Croatia has effectively used Energy Performance Contracting to finance the renovation of public buildings. The country's National Energy Efficiency Action Plan from 2017 (Ministry for Protection of the Environment and Energy, 2017) refers to the "Energy Efficiency Act (OG 127/14) [that] states that all counties and cities with a population of over 35,000 shall adopt three-year Energy Efficiency Action Plans, in accordance with the National Energy Efficiency Action Plans. In addition to the Action Plan, cities and counties also prepare Annual Energy Efficiency Plans, which define the measures in detail, with clearly indicated amounts and sources of financing and calculated savings".

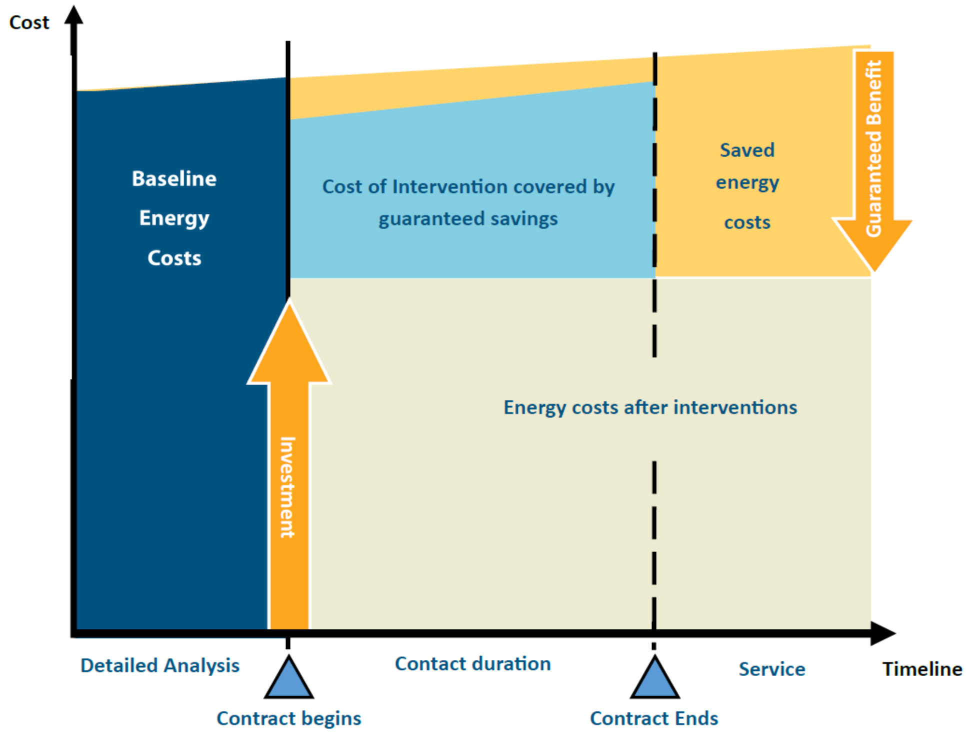
The adoption of the Energy Efficiency Act, and accompanying Regulation on contracting and the implementation of energy services in the public sector (OG 11/2015), is one of three main elements that triggered the beginning of the growth for the market of Energy Service Companies (ESCOs). Rising energy prices encourage consumers to seeking savings, while the Croatian Environmental Protection and Energy Efficiency Fund provides grants for projects to improve energy efficiency in public buildings under the ESCO model. The Fund is financed through environmental charges imposed on polluters, for waste and vehicles.

The EPC market in Croatia is still in the early stages of its development, but the number of market participants in this field is increasing rapidly. Aside from HEP ESCO (the ESCO owned by national utility company HEP), companies present in the market are small start-ups which are preparing for the market to take off. EPC companies usually have 5 to 20 employees, supported by additional external experts as needed.

Under the Croatian Environmental Protection and Energy Efficiency Fund, The Ministry of Construction and Physical Planning launches calls for "Energy renovation of public buildings" (allocation of grants from the European Regional Development Fund). Project proposals that promote energy efficiency and the use of renewables can then be submitted by ministries, central state departments, state and county administrations, local and regional self-governments, public institutions or social institutions, religious communities and associations of public authorities defined by law.

EPC and the use of ESCOs are measures that support the Croatian government in deeply renovating public buildings without additional expenditure from national budgets. In general, private capital (e.g. the ESCO) provides 60% of the financing for the joint investment while the Croatian government provides the remaining 40%.

Figure 8: Business model of an energy service company



Source: www.bpie.eu

Enforcement and strengthening of building standards– Flanders (Belgium)

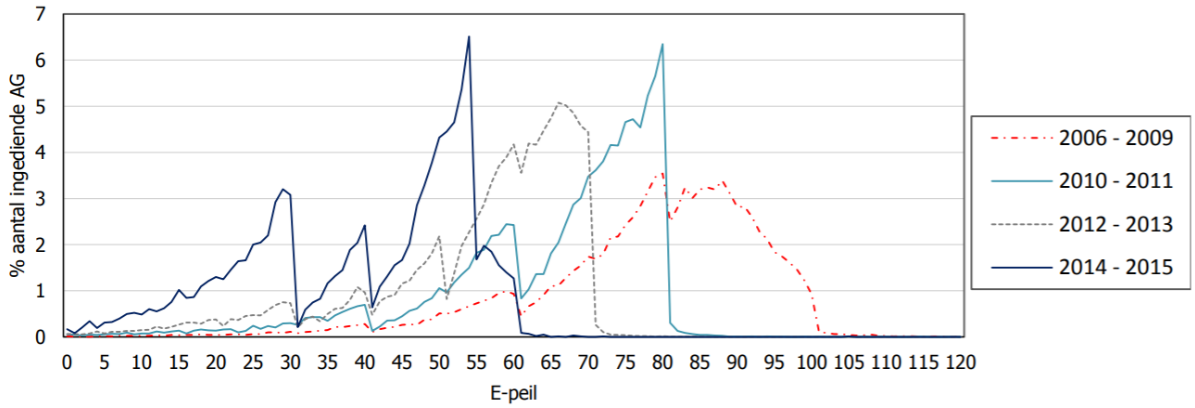
Building codes specify the minimum standards for new and existing buildings. They can be an effective tool to foster improved energy efficiency of buildings. By enforcing minimum standards in terms of energy performance, it is possible to phase out inefficient and inadequate buildings from the market.

Belgium is divided into three regions – Flanders, Wallonia and Brussels Capital Region – each of which is responsible for developing its own energy policies and implementing the requirements of the EU Energy Performance of Buildings Directive. Among these is the requirement to produce a long-term roadmap setting out minimum standards for new residential buildings, to guide the market towards the Nearly Zero Energy Building-requirements (whereby all new buildings must be nZEB from 2021). The minimum standards are strengthened regularly and progressively, allowing and encouraging building owners and investors to plan ahead.

The analysis of the energy performance of single-family houses in Flanders over time (Figure 9) shows clearly that these requirements steer the level of energy performance. As the construction standards are progressively tightened, so the curve of building performance shifts to the left, i.e. to lower E values which means more energy efficient buildings. For example, the spike on the 2010-2011 curve at E80 reflects the fact that E80 became the minimum requirement in that year. Interestingly, while buildings that just meet the standard have the highest share of the total, most new buildings achieve a better than minimum performance (i.e. all buildings to the left of the peak).

One can also witness the impact of support measures on the graph. For example, in 2014 there were subsidies for E50 and E30 (=nZEB level), which resulted in spikes at these performance bands.

Figure 9: Energy performance of single-family houses in Flanders



Source: (ZEBRA2020, 2016)

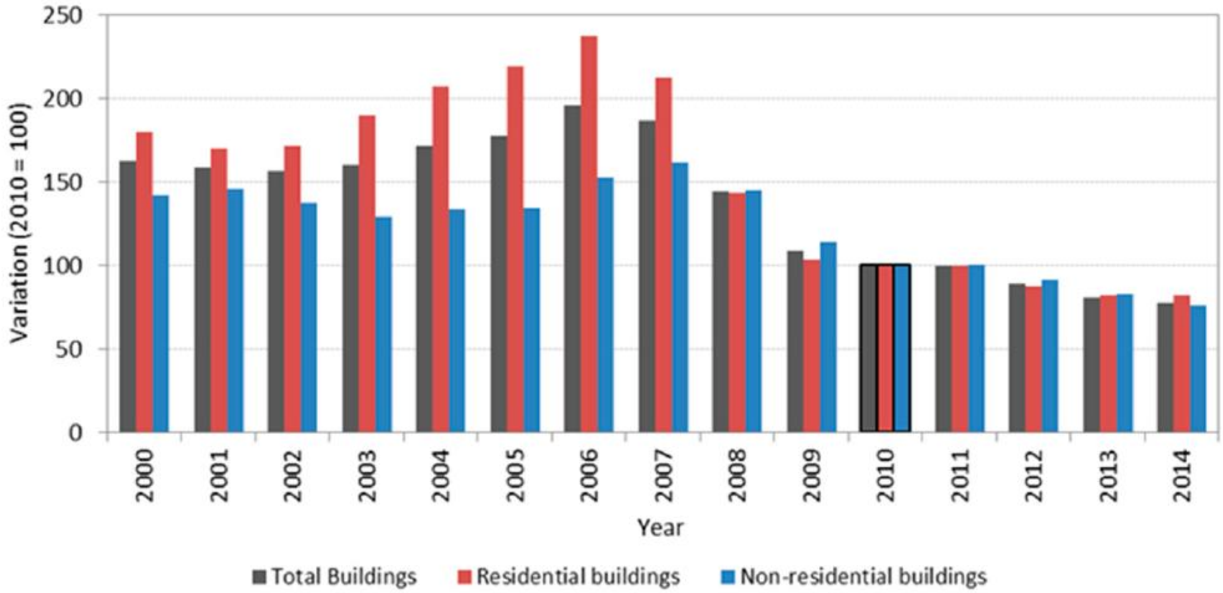
Notes: Vertical axis = % of new build permits, Horizontal axis = energy performance (nZEB=E30, E50=requirements 2016, E60=requirements 2014, E70=requirements 2012).

Nearly Zero Energy Building standards – European Union

The EU Energy Performance of Buildings Directive requires all new public buildings built from 2019 on and all other new buildings built from 2021 on, to be nZEB. The Energy Performance of Buildings directive (EPBD) defines a nZEB as a “building that has a very high energy performance […]. The nearly zero or very low amount of energy required should, to a very significant extent, be covered by energy from renewable sources, including renewable energy produced on-site or nearby”. Member States have flexibility in how they define nZEB in their countries, so the requirements vary across the EU.

Figure 10 compares the relative energy performance of new buildings annually from 2000 to 2014, with 2010 as the base year (=100). Prior to this date, there was a large variation in energy performance, and even a rising trend until 2006. Since 2011 the variation has reduced considerably, and there is a clear improvement year-on-year.

Figure 10: Towards nZEB – trend of building permits in EU-28



Source: (D'Agostino et al., 2017)

The European Commission issued recommendations for benchmarks for the energy performance of nZEBs, which are to be in the following ranges for various climate zones in the EU (see Figure 11).[4] These may provide a useful model on similar standards for Turkey (European Commission, 2016). For each climate zone, there is a range for the building's target energy use, and also a target for the amount of on-site renewable energy generation. The difference between the two (last column in Table 5 and

Table 6) represents the net fossil energy used by the building (all figures are in primary energy terms):

Table 5: Benchmarks for nZEB across different Climate zones in the EU – office buildings

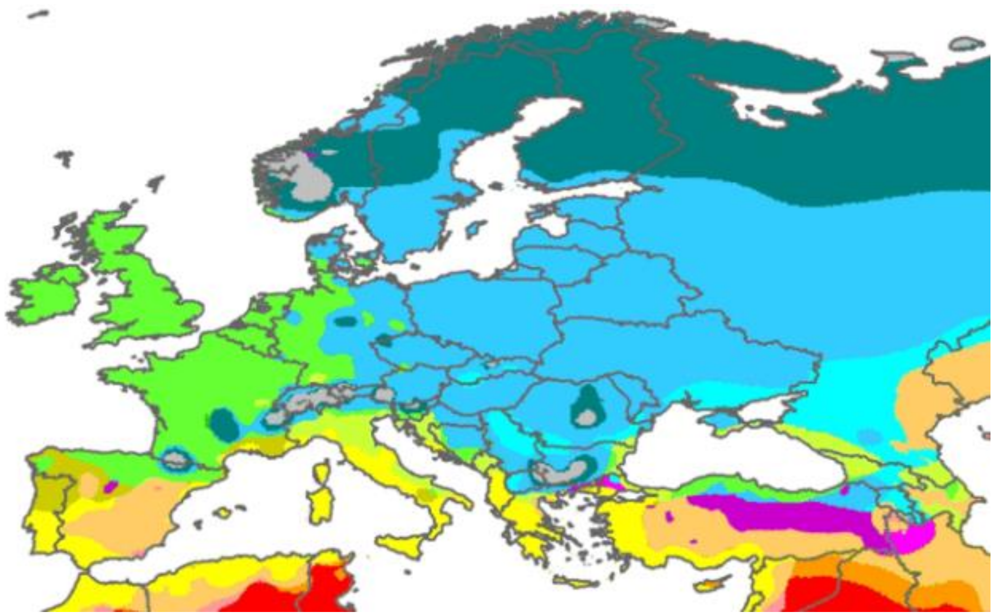
(kWh/m^2/year)	Primary energy	On-site renewable energy generation	Net primary energy
Mediterranean	80-90	60	20-30
Oceanic	85-100	45	40-55
Continental	85-100	45	40-55
Nordic	85-100	30	55-70

Table 6: Benchmarks for nZEB across different Climate Zones in the EU – single-family houses

(kWh/m^2/year)	Primary energy	On-site renewable energy generation	Net primary energy
Mediterranean	50-65	50	0-15
Oceanic	50-65	35	15-30
Continental	50-70	30	20-40
Nordic	65-90	25	40-65

[4] Mediterranean is considered to cover Catania, Athens, Larnaca, Luga, Seville, Palermo; Oceanic - Paris, Amsterdam, Brussels, Copenhagen, Dublin, London, Macon, Nancy, ; Continental - Budapest, Bratislava, Ljubljana, Milan, Vienna; Nordic - Stockholm, Helsinki, Riga, Stockholm, Gdansk, Tovarene.

Figure 11: Main Climate Zones in Europe



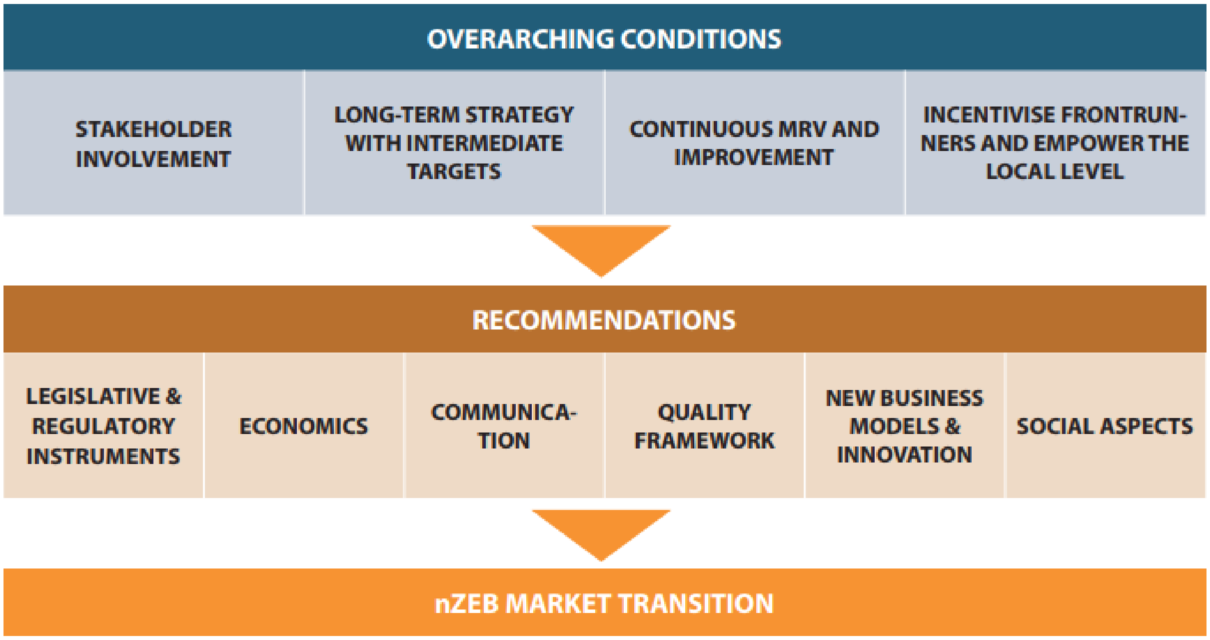
Note: Mediterranean = yellow and light brown; Oceanic = green; Continental = light blue; Nordic = dark blue
Source: (Peel et al. 2007)

The EU project ZEBRA2020 also set out several overall conditions that should be in place in order to make nZEB a reality:

- Guarantee involvement from a broad set of stakeholders. It is essential that governments and authorities involve stakeholders early in the process.
- Member States should adopt long-term strategies to upgrade the building stock.
- Assessment and review should be an on-going exercise that includes data collection and quality assurance to ensure compliance and monitor progress.
- Local level or private initiatives should be empowered (e.g. through dedicated national programmes supporting local demonstration cases) to go beyond the set goals and lead by example to help accelerate the rate and depth of nZEBs.

More details on each of these recommendations is provided by the ZEBRA project (ZEBRA2020, 2018).

Figure 12: Making nZEB a reality



Source: (ZEBRA2020, 2016)

International green building standards

Green building standards were first introduced in the UK in the 1990s by the Building Research Establishment (BRE), under the name BRE's Environmental Assessment Method, or BREEAM. This was followed in 2000 by the U.S. Green Building Council (USGBC, 2018a) launching its Leadership in Energy and Environmental Design (LEED) scheme (USGBC, 2018b). Besides dominating their respective home markets, these two schemes were also adopted in many other territories. Several other rating systems have since been adopted, including Green Star in Australia/New Zealand, and CASBEE in Japan (Say and Wood, 2008). In total, there are now over 40 rating systems in operation in 160 countries around the world (Cedeno-Laurent et al., 2018), covering new as well as existing (renovated) buildings. The exact contents vary from scheme to scheme, but most focus on the following environmental parameters: energy, water, waste, land use, emissions, sustainable sourcing and indoor environmental quality.

To date BREEAM and LEED remain the largest and best-known schemes. As of the end of 2017, there were 6,657 LEED-certified projects covering more than 158 million m^2 of space. BREEAM can lay claim to over 15,000 certified buildings, most of which are in the UK and the rest of Europe (GreenBook, 2018).

For the commercial real estate industry, building certificates for energy or environmental performance were introduced to reduce information asymmetry, providing prospective buyers and tenants with a credible signal regarding the quantitative sustainability performance of a building. Such buildings are also valued by the market. In a study (Chegut et al., 2014) on the impact of green building rating on property values and rental rates in London UK, BREEAM-certified buildings commanded a 19.7% premium in terms of rent, and 14.7% premium in terms of sales, both relative to non-certified buildings in the same neighbourhood.

In addition to their premium value benefits, green buildings also perform better in environmental terms. The World Green Building Council (WGBC, 2018), the umbrella organisation for nationally-based Green Building Councils which are behind many of the rating systems, notes the following benefits:

- In Australia, Green Star certified buildings produce 62% less greenhouse gas emissions than average Australian buildings, and use 51% less potable water than the case that would happen if they had been built to meet minimum industry requirements only. The comparable figures for Green Star in South Africa are 30-40% energy savings and carbon emission reductions and 20-30% savings in potable water.
- Indian buildings certified by the Indian Green Building Council (IGBC) results in energy savings in the 40-50% range, and water savings between 20% and 30% compared to conventional buildings.
- LEED-certified green buildings consume 25% less energy and 11% less water compared to non-green buildings.

The EU nZEB regulations do not refer to existing (commercial) building labels or standards such as BREEAM, LEED or Passive House Standard. Member states are free to develop their own nZEB definition according the general framework provided in the EPBD and can apply existing green or sustainable building standards. In several countries, national implementation of nZEB regulation is often embedded in a larger building regulation framework. This framework often includes green or sustainable aspects such as water efficiency and the use of rainwater, accessibility of the building and indoor air quality.

In the USA, the LEED standard requires an improved energy performance level (reductions in the 3% to 5% range, depending on the situation) compared to the baseline case building performance as specified by the ASHRAE Standard 90.1 (American National Energy Standard for Buildings Except Low-Rise Residential Buildings).

Energy Performance Certificates – Portugal

The energy performance rating given in EPCs should be used as an indicator for the energy efficiency of a property, therefore they can, if well and properly developed, be a useful tool to raise the awareness of occupants/tenants/owners of the energy performance of their building (and potential measures that could be taken to improve it) and encourage efficient new building constructions. They can also be useful to gather data on the building stock.

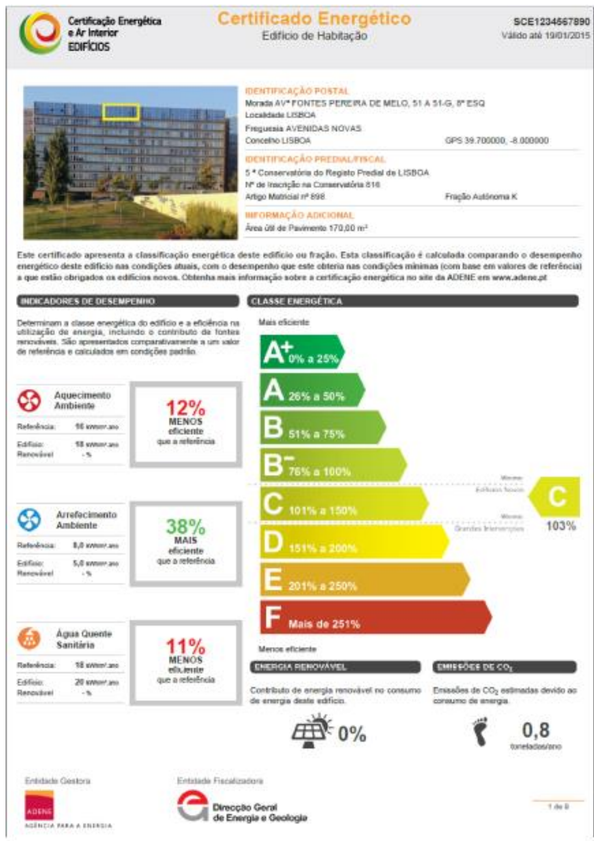
Portugal began implementing EPCs in 2007. Since then, over 1.3 million EPCs were issued and recorded in a publicly available registry, representing over 15% of the residential building stock. This registry contains information on energy class, year, district and building type.

The energy performance assessment is described in Portuguese Buildings Codes and is based on EU standards. The methodologies take asset ratings, data derived from building inspections or drawings, and building specifications regarding the primary energy needs, into account. The calculation methodology for residential buildings includes three energy efficiency indicators: heating, cooling and domestic hot water, expressed in terms of primary energy required. In multi-family buildings, each dwelling is certified individually (iBroad, 2018).

EPCs for residential buildings comprise the following elements:

- The overall energy performance score and other general information, such as the address, photo and size of the building.
- The quality of the envelope components based on a simple grading system, showing the score of thermal insulation for walls, roofs, floors and windows.
- An illustration of the buildings' heat losses.
- A list of recommendations of potential measures selected by the energy expert[5] from a predefined list and accompanied with clarifying descriptions. The EPC can display up to 10 potential measures with detailed information on the technical description, the investment required, and the benefits expected from the implementation of each measure.
- Comparison of the building's performance with the market average[6]

Figure 13: Example Portuguese EPC



Compliance checks are important. In Portugal they consist of two approaches: basic and more detailed. The basic approach includes an automatic check of the data inserted in the EPC registry, followed by a simple verification of the basic methodologies. The more detailed check on a random sample of EPCs entails a full-data review of calculations and an on-site visit to test compliance with requirements and methodologies.

[5] Qualified energy experts must be architects or engineers with at least five years of experience in the energy efficiency of buildings. To obtain the accreditation, the expert must take an exam offered by ADENE, the national energy efficiency agency which is also the EPC scheme administrator.

[6] There is no requirement to check the actual performance of the building.

Energiesprong, Netherlands

Deep renovation of existing buildings can be a lengthy, complicated and expensive process. As a result, few buildings in Europe currently undergo deep renovation. In an effort to deliver affordable, net zero energy renovations on a mass-market basis and with minimal disruption to building occupants, the *Energiesprong* initiative was developed in the Netherlands. At its heart is the shift away from individual renovations to renovation at scale, i.e. industrialisation, by aggregating and streamlining replicable processes, instruments (e.g. financial models) and products (e.g. pre-fabricated materials or modular buildings). The main benefit is a lower per unit price due to economies of scale since processes are standardised and marginal costs decrease with increasing production levels.

The Dutch *Energiesprong* project has demonstrated that the costs for a holistic net zero renovation of a terraced house can fall from EUR 130,000 for the first pilot-project in 2010 to EUR 70,000 in 2018, while realising a 70 to 80% energy demand reduction. This is based on a combination of economies of scale and 3D designed pre-fabricated materials. To boot, the on-site execution takes as little as one week, limiting the burden for the inhabitants, while at the same time increasing comfort and improving the look of the house. This state-of-the-art renovation programme is embedded in a holistic approach (aiming to meet the requirements of regulations, sales channels, net-zero retrofit, marketing, value uplift and finance), involving all relevant actors and achieving upscaling through an industrialised production process.

The project has benefitted from the lessons learned in previous Dutch initiatives to implement holistic renovations, accumulating experience through each iteration. In 2010, 134 houses in Roosendaal were targeted at a cost of EUR 130,000 each. In 2011, 150 houses in Kerkrade were retrofitted to passive house levels at a cost of EUR 100,000 each. Finally, in 2012, 188 zero energy dwellings were renovated in Apeldoorn at a cost of EUR 80,000 per dwelling. The latest projects had an average cost of EUR 70,000 per dwelling. These projects show how quickly the price/performance ratio is improving for achieving the same ambitious energy performance, i.e. net-zero energy level bringing about 70 to 80% energy demand reduction. The model is currently being replicated in the UK, France, Italy, Germany, the United States and Canada.

Figure 14: Installation of premanufactured facade in an Energiesprong project in the United Kingdom

Source: Energiesprong International

Another innovative competitor in the premanufactured newly-built market is IKEA's BoKlok concept in partnership with Skanska. The BoKlok concept is described as 'building affordable homes for ordinary people', which has resulted in the construction of apartment blocks and two-storey houses in a number of European countries. In a process that claims to offer high levels of environmental sustainability, modular housing is located in pleasant surroundings and is designed to meet the needs of residents who want to live in homes of their own, but have only limited income (EU Innovate, 2017).

5. Recommendations for enhancing Turkey's building energy efficiency policy framework

Based on the gap assessment of Turkey's existing policy framework, and in the light of a number of models implemented in other countries, this section presents a number of realistic and practical recommendations by category to improve Turkey's building energy efficiency policy framework.

Administrative and institutional

- Establishing an independent energy efficiency agency will be crucial to combine policy efforts and energy efficiency measures, minimise overlaps, coordinate and harmonise the efforts of all stakeholders, support various relevant government departments with specialist know how, and contribute to the wide-spread dissemination of information. The newly established Department of Energy Efficiency and Environment will play a crucial role in this regard.
- The energy efficiency targets presented in the Energy Efficiency Strategy are only generic goals and refer to the whole building stock, or large sectors like buildings larger than 10,000 m^2. Furthermore, the overall targets for 2023 are set without any breakdown for specific regions, building groups and the time frame till 2023. Rather more specific targets, with a clear time plan, reflecting sector- and region-specific circumstances could be more effective. The following can serve as examples to simple and clear targets: all new commercial buildings in climate zone 1 built after a certain date should meet class A or B cooling standard; at least 20% of all residential buildings in climate zone 2 should have appropriate thermal insulation by 2019, while this figure is to raise by 20% every year, resulting in net savings of a certain level in GWh. A number of EU countries as well as others have already set such concrete targets, which can provide a basis for this purpose. Such a specific approach will help to address sector- and region-specific circumstances, and facilitate realising the overall national targets. Progress towards the targets set should be monitored and audited by independent bodies, to provide input for a realistic evaluation of policy effectiveness.

Existing buildings

- A national building renovation strategy should be developed, prioritising energy efficiency in line with the Urban Transformation Plan, and including annual targets for broad renovation, clear policies, measures, and financing mechanisms to enable such renovation in the existing building stock. The strategy should build on the bottom-up assessment of technology, sector- and region-specific potential, cost and benefits of energy efficiency technologies, and measures in retrofitting the existing building stock.

Heating and cooling technologies

- A plan for the phase-out of inefficient heating and cooling equipment and lighting should be developed. Policies should address the potential costs and benefits (including savings in energy demand) associated with the introduction of efficient lighting technologies, such as those in the BEP-TR. Similar phase-out policies have already been introduced in various EU countries, for instance for non-condensing gas boilers, achieved by setting an efficiency limit and facilitating the phase-out process through the Ecodesign regulation. Similarly, the phase-out can be triggered by a clear timeline supported by incentives for producers and distributors of efficient equipment, followed by incentives where relevant, for more energy efficient equipment as well as by disincentives for inefficient equipment (such as higher taxes). The phase out should be encouraged by government-supported guidelines and by raising awareness about passive cooling and lighting, as well as the introduction of exemptions from building permits for existing buildings implementing these passive measures, such as light wells and shading.
- Setting minimum standards for energy efficiency of cooling devices indicated by seasonal energy efficiency ratios at levels, for instance, twice as high as the average efficiency of technologies currently available in the market, or above average EU best practices, anticipating the expected increase in demand for cooling in the future, will be important. Such standards can be supported with regulations on the production and efficiency of equipment, and requirements applicable to the operation and maintenance of equipment.

Green buildings/New buildings

- While adapting an overall building policy framework, both green building and energy efficiency policies should be emphasised and aligned with each other, targeting different building types and climate zones. Such a framework should include measures regarding performance standards, accessibility of the building, water usage, indoor air quality standards and renewable energy consumption. Existing international green building standards will be a key starting point.
- A master plan for green buildings should be developed, including clear definitions of applicable performance requirements, annual deployment rates, required investment in terms of technology and finance, not to mention the models applicable. These energy performance requirements should be highly ambitious. For instance targets set to match the level of nZEBs would not be off-the-mark.

Renewable energy

- Potential synergies between renewable energy and energy efficiency technologies should be assessed. Based on this assessment, promising technologies and region-specific targets should be deployed, for instance to enable the introduction of more efficient air-to-air and geothermal heat pumps while the required electricity is supplied from renewable sources (including buildings integrated PV systems). Incentives should be offered and awareness should be raised to facilitate the achievement of these targets. Also the role of renewable energy in district heating and cooling should be assessed, and for regions with such potential, a roadmap should be developed ahead of policy design. More renewable energy uptake can be initiated by the development of a master plan for renewable energy for buildings, based on regional potentials, requirements of the building stock, cost and availability and suitability of technologies, as well as the social and economic benefits of local renewable energy resources.

Financing

- New and innovative models of financing energy efficiency should be developed by accounting for Turkey's national circumstances. These models can take the form of revolving funds, property assessed clean energy (PACE), ESCOs, energy efficiency obligations, or on-bill financing. The models should address specific requirements applicable to various building types, consumers and regions and aim for the deployment of both existing and new energy efficiency and renewable energy technologies. When applying different financing models to different policy items, it is important to choose the most promising and applicable ones. For example ESCOs should be supported where they are the most suitable solution, i.e. for public or large commercial buildings, while advantageous loans and revolving funds, or tax reductions are more relevant for residential buildings. The right combination depends not just on available funding but also on policy priorities as per the other measures discussed.
- A scheme for implementing energy efficiency measures directly subsidised for a limited number of buildings (privately- or publicly-owned), well distributed across the geography to create more Turkish best practice case models to help with raising public interest in smaller towns can be recommended. The models thus built up should be informative, easily and widely accessible, as well as replicable by less experienced contractors or home owners. Funding models should also be developed for this effort. The generated information should also be useful for building owners in choosing energy efficiency measures and discussing the implementation with potential contractors.

Consumers

- Efforts to improve the pricing strategy for electricity and gas should be sustained, prioritising the social and economic welfare of consumers. One way of doing this could be increasing the number of pricing tiers (lower unit prices for smaller-scale consumers), to make energy efficiency investments economically attractive for higher consumption end-users, and designing a balanced pricing strategy for low-income and low-consumption end users.
- The public engagement should be maintained to raise awareness about energy efficiency, and to encourage more informed choices about energy efficiency investments. In-class and on-the-job training programmes for engineers, technicians and contractors, as well as municipality officers can be organised throughout the country. These programmes should aim to disseminate up-to date know-how on theoretical calculations, case studies covering both good and bad examples typical to the specific context (climate zone, building types) and practical tips for the implementation of energy efficiency measures in buildings. The trainings for engineers and contractors would benefit from economic analyses of energy efficiency applications, as many low-efficiency decisions are made based on the misguided assumption that high-efficiency buildings are significantly more expensive than low-efficiency ones. A lifecycle-cost perspective should see increased popularity to avoid short-term thinking on investments. Passive heating, cooling, lighting and ventilation techniques need to be either integrated into these trainings or covered in dedicated training programmes about passive / green buildings, to raise interest among the lower socio-economic groups of developers, and to disseminate the relevant know-how which would lead to commitment to energy efficiency among all stakeholders.
- A user-friendly online database (which could be developed by the proposed agency to cover energy efficiency issues) of recommendable energy efficiency products available on the market

(like ETL in UK, TUREEFF LEME-LESI Lists in Turkey) should be prepared to support the wider public in identifying the level of energy efficiency of equipments involved in a project. The existing databases described above are designed to support the particular programmes through which they are developed and maintained, and as such, may exclude some perfectly good products or include products that only satisfy high efficiency requirements under given conditions (provided by the programme) due to particular limitations of the programme. The proposed database, instead, should be listing equipment based on energy efficiency performance and be kept up-to-date and at equidistance from all producers / vendors and sectors to guarantee impartiality.

- Online energy efficiency calculators enabling the users to compare their consumption and saving potential with best case and average benchmarks in their own context can also be expected to encourage end users in terms of considering energy efficiency investments.
- Development of user friendly and high quality energy efficiency games for mobile devices, backed up by more formal education on climate change and clean energy topics in schools, can help raise awareness about and establish the understanding of energy management among younger generations.
- Following the development of these (and other) tools, a widespread campaign can be launched to raise awareness about energy efficiency (and perhaps climate change) among the wider public. Newspapers and TV channels can be involved as well as internet-based social media, as different media channels usually reach different social groups. Such campaigns should be conducted in close coordination with the proposed energy efficiency agency.

References

Aydın, E., 2018. An Assessment of Residential Energy Efficiency in Turkey.

Cedeno-Laurent, J.G., Williams, A., MacNaughton, P., Cao, X., Eitland, E., Spengler, J., Allen, J., 2018. Building Evidence for Health: Green Buildings, Current Science, and Future Challenges. Public Health 39–291.

Chegut, A.M., Eichholtz, P.M.A., Kok, N., 2014. Supply, demand and the value of green buildings. URBAN STUD 51, 22–43. https://doi.org/10.1177/0042098013484526

D'Agostino, D., Zangheri, P., Castellazzi, L., 2017. Towards Nearly Zero Energy Buildings in Europe: A Focus on Retrofit in Non-Residential Buildings. Energies 10, 117. https://doi.org/10.3390/en10010117

DOSİDER, 2018. Yakıt Fiyatları [WWW Document]. URL http://www.dosider.org/?p=5 (accessed 10.31.18).

Ecofys, 2013. Towards nearly zeroenergy buildings: Definition of common principles under the EPBD. European Commission, Milano.

Ecofys, İstanbul Aydin University, İzoder, 2018. Türkiye Bina Sektörü Enerji Verimliliği Teknoloji Atlası. GIZ - Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, Ankara.

EİGM, 2017. Enerji İşleri Genel Müdürlüğü - 2016 Yılı Ulusal Enerji Denge Tablosu [WWW Document]. eigm.gov.tr. URL http://www.eigm.gov.tr/tr-TR/Sayfalar/2016-Yili-Ulusal-Enerji-Denge-Tablosu (accessed 10.31.18).

Enerji IQ, 2018. Enerji IQ.

EU Innovate, 2017. SUSTAINABLE INNOVATION IN ACTION: THE CASE STUDY “SNAPSHOT” SERIES. EU Innovate, Brussels.

European Commission, 2016. Commission Recommendation (EU) 2016/1318 of 29 July 2016 on guidelines for the promotion of nearly zero-energy buildings and best practices to ensure that, by 2020, all new buildings are nearly zero-energy buildings, C/2016/4392 [WWW Document]. URL https://publications.europa.eu/en/publication-detail/-/publication/f2a71495-5876-11e6-89bd-01aa75ed71a1/language-en (accessed 10.31.18).

GAZBİR, 2018. 2017 Yılı Doğal Gaz Dağıtım Sektörü Raporu. Türkiye Doğal Gaz Dağıtıcıları Birliği, Ankara.

Google, 2018. Enerji Verimliliği [WWW Document]. Google Trends. URL /trends/explore (accessed 10.31.18).

GreenBook, 2018. GreenBook Live: Certified BREEAM Assessments [WWW Document]. URL http://www.greenbooklive.com/search/scheme.jsp?id=202 (accessed 10.31.18).

iBroad, 2018. Current use of Energy Performance Certificates Factsheet - Portugal. Buildings Performance Institute Europe, Brussels.

IEA, 2018. CO2 emissions from fuel combustion. Highlights. OECD/IEA, Paris.

IEA, 2017. World Energy Balances. OECD/IEA, Paris.

IRENA, 2014. Remap 2030 A Renewable Energy Roadmap. International Renewable Energy Agency, Abu Dhabi.

Ministry for Protection of the Environment and Energy, 2017. FOURTH NATIONAL ENERGY EFFICIENCY ACTION PLAN FOR THE PERIOD FROM 2017 TO 2019. MINISTRY FOR PROTECTION OF THE ENVIRONMENT AND ENERGY, Zagreb.

Ministry of Construction and Physical Planning, 2014. Proposal of the Long-Term Strategy for Mobilising Investment in the Renovation of the National Building Stock of the Republic of Croatia. Ministry of Construction and Physical Planning, Zagreb.

MTA, 2018. Kömür Arama Araştırmaları [WWW Document]. URL http://www.mta.gov.tr/v3.0/arastirmalar/komur-arama-arastirmalari (accessed 10.31.18).

MWH, 2015. Politika Boşluk Analizi ve Enerji Verimlilik Programı Değerlendirmesine İlişkin Danışmanlık Hizmetleri. MWH Mühendislik ve Müşavirlik Ltd., Istanbul.

NIRAS, 2015. Binalarda Enerji Verimliliği AB ve Türk Mevzuatı. Türkiye Cumhuriyeti Çevre ve Şehircilik Bakanlığı, Ankara.

Say, C., Wood, A., 2008. Sustainable Rating Systems Around the World. CTBUH.

Saygin, D., Hoffman, M., Godron, P., 2018. How Turkey Can Ensure a Successful Energy Transition. SHURA Energy Transition Centre, Centre for American Progress, Agora Energiewende, Istanbul, Washington, D.C., Berlin.

Taranto, Y., Saygin, D., Kosar, M., 2019. Energy pricing strategies and non-market flow mechanisms in Turkey's energy sector. SHURA Energy Transition Centre, Istanbul.

TKK, 2016. 2015 Kömür (Linyit) Sektör Raporu. Türkiye Kömür İşletmeleri Kurumu, Ankara.

TTK, 2018. 2017 YILI TAŞKÖMÜRÜ SEKTÖR RAPORU. Türkiye Taşkömürü Kurumu, Ankara.

USGBC, 2018a. USGBC homepage | USGBC [WWW Document]. URL https://new.usgbc.org/ (accessed 10.31.18).

USGBC, 2018b. LEED | USGBC [WWW Document]. URL https://new.usgbc.org/leed#rating (accessed 10.31.18).

Weiss, W., Spörk-Dur, M., Mauthner, F., 2017. Solar Heat Worldwide. AEE Institution for Sustainable Technologies, Gleisdorf.

WGBC, 2018. The benefits of green buildings | World Green Building Council [WWW Document]. URL https://www.worldgbc.org/benefits-green-buildings (accessed 10.31.18).

ZEBRA2020, 2018. Zebra2020 - Nearly Zero-Energy Building Strategy 2020 [WWW Document]. URL https://zebra2020.eu/ (accessed 10.31.18).

ZEBRA2020, 2016. BOOSTING THE NZEB MARKET TRANSITION. Buildings Performance Institute Europe, Brussels.