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TURKISH BUILDING SECTOR
ENERGY EFFICIENCY TECHNOLOGY ATLAS
EXECUTIVE SUMMARY AND ROADMAP

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List of Abbreviations

BAT	best available technology
BAU	business as usual
BEP TR	Building energy performance Turkey (certification)
CAGR	Compound Annual Growth Rate
CO_2	carbon dioxide
CTF	Clean Technology Fund
EBRD	European Bank for Reconstruction and Development
EEL	Energy Efficiency Law
EET	energy efficiency technology
EPBD	Energy Performance of Buildings Directive
ESCO	energy service companies
EU	European Union
EUR	Euro
GDP	gross domestic product
GDRE	General Directorate of Renewable Energy
HP	heat pumps
HVAC	Heating, ventilation and air conditioning
IFC	International Finance Corporation
INDC	Intended Nationally Determined Contribution
İZODER	association of thermal insulation, waterproofing, sound insulation and fireproofing material producers, suppliers and applicators
kWh	kilowatt-hour
MENR	Ministry of Energy and Natural Resources
MEPS	minimum energy performance standards
MFH	multi-family housing
MoEU	Ministry of Environment and Urbanisation of Turkey
nZEB	Nearly Zero Energy Building
R&D	research and development
SDG	Sustainable Development Goals
SFH	single-family housing
TS	Turkish Standards
UNFCCC	United Nations Framework Convention on Climate Change
USD	US dollar

Summary for the Ministry, Investors and the Industry

Turkey has a high rate of urbanization that has reached 2% per year. This leads to a fast-growing building stock with new construction rates of more than 4%. The construction sector is one of the most important drivers of the Turkish economy, contributing 6.6% of real gross domestic product (GDP) growth. The building sector in Turkey that includes residential, commercial and public buildings is responsible for more than 35% of the country's total final energy consumption. Due to the significant new construction activities, this share is expected to increase further in the future where it is estimated the residential building stock will reach almost 4.0 billion m^2 by 2050 compared to the approximately 2.4 billion m^2 in 2015. It will be paramount to ensure these new buildings are equipped with the best energy efficiency technologies and renovation rates of the existing building stock are accelerated. Realising this would create big opportunities for Turkey's energy efficiency technology manufacture sector.

This study explores the market potential of technologies in accelerating the energy efficiency of buildings and it informs the relevant decision makers and private sector actors on the products, services, actors and driving forces behind the energy efficiency market in Turkey. The study therefore serves as a key source to identify where more effort is required to accelerate the availability and cost-effective deployment of these technologies and strengthen the construction markets.

The study estimates an additional investment potential of EUR 3.2 billion over the estimated current levels of EUR 6.2 billion for energy efficiency technologies in Turkey. Three-quarters of this investment gap exists in the residential sector and around 60% would be invested in renovating the existing building stock. Around half of the gap is located in the second climate zone of Turkey where half of Turkey's population live. Heating and cooling equipment and windows (including frames) represent one-third of the investment gap each. The other third is split between insulation, ventilation and lighting.

Closing this investment gap will require the continued uptake of existing energy efficiency technologies such as condensing gas boilers, but also opening markets and the deployment of newer technologies such as heat pumps, automation and control systems. The technology efforts will need to be complemented with the development and implementation of new policies and financing models that can create incentives to reduce technology costs, increase awareness about energy efficiency and its benefits, strengthen the technology and human resource capacity and create an enabling investment market environment. These efforts will need to be complemented with international cooperation efforts that can strengthen the Turkish construction sector and its innovation, research and development capacity, especially looking at new developments technically and legislatively.

Based on the analysis, results and the consultation with the stakeholders that represent various branches of Turkey's building and construction sectors, the study ends with the following recommendations:

• Implement a targeted financial scheme which incorporates different stakeholders, components and systems, full supply chain and life cycle and supporting instruments like training and awareness.

• Develop a holistic approach for a more effective policy framework and, promote and communicate the available vision and strategies broadly. Regulations should be updated on a regular basis, using the cost optimality approach. Special emphasis should be given to the enforcement and monitoring.

• To raise the awareness, streamline campaigns, while focusing on the right messaging for the relevant target groups.

• Focus on the quality of craftsmen's work and learn from international best practices.

Introduction and approach

Importance of buildings for the Turkish economy and the energy sector

With 2%, Turkey has a high annual rate of urbanization, which leads to a fast-growing building stock with new construction rates of more than 4% annually. For comparison, Germany's new construction rates are around 1% per year. The construction sector is one of the most important drivers of the Turkish economy, contributing 6.6% of its real gross domestic product (GDP) growth (Kaymaz, 2015). The building sector in Turkey—residential and non-residential sectors—is responsible for more than one-third of the country's total final energy consumption (see Figure 1).

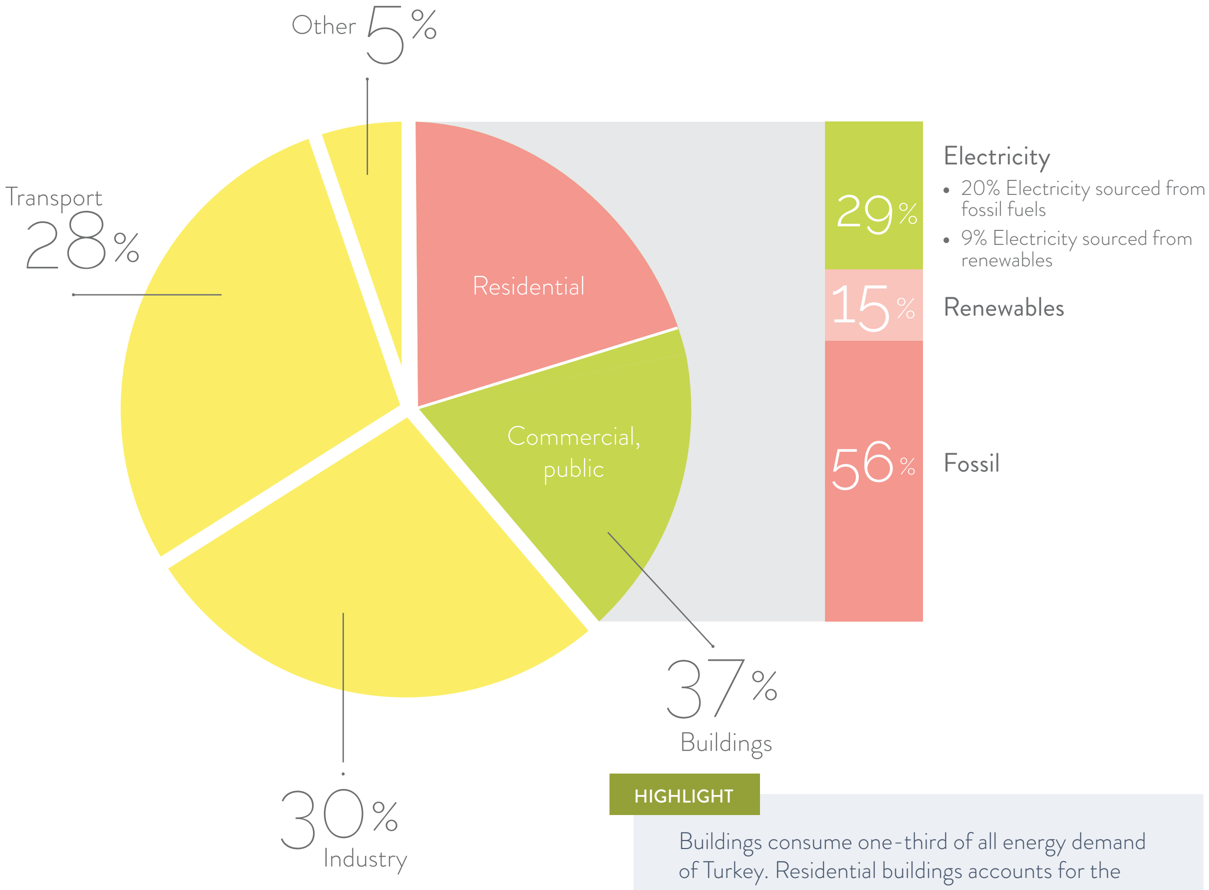


Figure 1: Breakdown of Turkey's total final energy consumption, 2015
Source: OECD/IEA (2017)

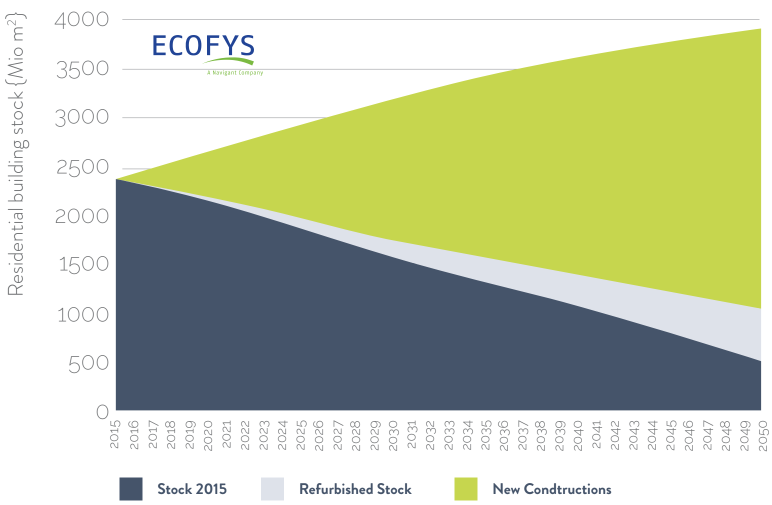
HIGHLIGHT

Buildings consume one-third of all energy demand of Turkey. Residential buildings accounts for the main share of this demand with nearly 76% of the energy sourced from fossil fuels and 24% sourced from renewables.

Driven by the Urban Transformation Plan, the significant new construction activities are opening opportunities for implementing energy efficiency measures in new buildings. The residential building stock is expected to grow from approximately 2.4 billion m² today to almost 4.0 billion m² in 2050. This is a total increase of approximately 68%, which corresponds to an annual average increase of about 1.5%. By 2030, nearly half of all buildings in the stock would be new and by 2050 around 80% (see figure 2) will have been replaced compared to today's baseline. Because of that expected growth, the Turkish building sector is one of the most important pillars for achieving Turkey's climate protection targets as defined in Turkey's Intended Nationally Determined Contribution (INDC) (Republic of Turkey, 2015), which was submitted to the United Nations Framework Convention on Climate Change (UNFCCC) in 2015.

New buildings in Turkey are required to perform the thermal standards similar to EU countries since 2000. TS 825 (Turkish Standards Institution, 2008), which defined the calculation procedures for heating energy demand in buildings and provides accompanying reference and permeable values, was revised in 2008 to improve the standard and is now a standard under the BEP. The TS 825 and other building-related legislation represent the country's efforts to reduce energy consumption in the building sector. The building sector in Turkey presents significant opportunities for cost-effective energy- and CO_2-savings which can account for up to half of current demand [4].

Figure 2: Estimated developments of Turkey's residential building stock, 2015-2050



HIGHLIGHT

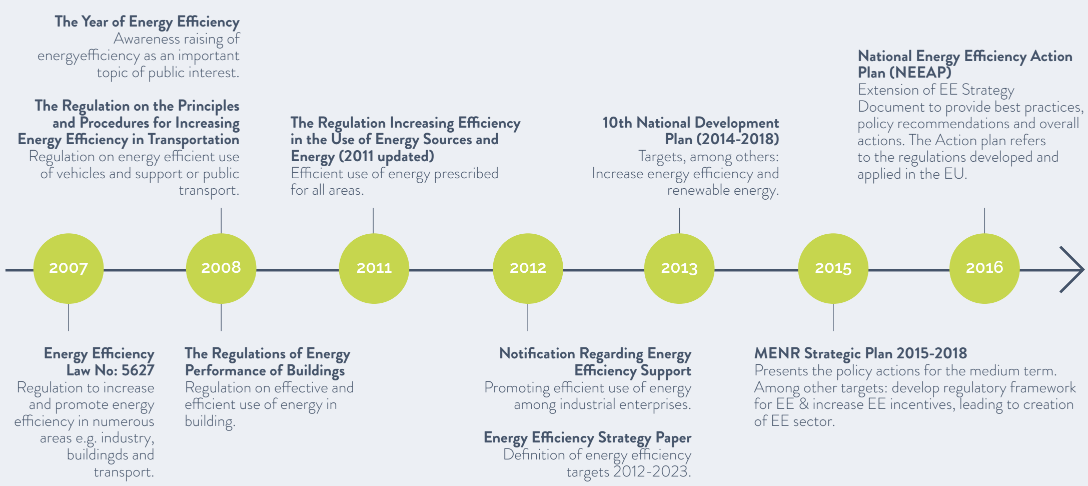
The residential building stock is expected to grow by more than 50% from approximately 2.4 billion m^2 today to almost 4.0 billion m^2 in 2050.

BOX 1 The long history of energy efficiency policies of Turkey

Energy efficiency has become one of the cornerstones to reduce oil and natural gas dependency and a means to achieve the targets set across the different overall energy and climate goals of Turkey, all of which emphasise the urgency to implement energy efficiency measures in all sectors.

In the buildings sector, Turkey has harmonised its energy efficiency regulations, standards and labels with those of the EU framework; however, it has not implemented the full EU Energy Efficiency Directive. The harmonisation that did take place, concerns transposing the EU eco-design and labelling directives (which have already been imposed partially / on some items, generally to avoid low quality imports), which require certain equipment to provide information on energy consumption through labels and minimum energy performance standards (MEPSs). Turkey published these regulations in 2010 and 2011 under the codes EU/2009/125 and EU/2010/30, respectively.

Figure 3: Historic development of energy efficiency policies in Turkey



HIGHLIGHT

A long history of policy efforts address improving energy efficiency in Turkey's energy system.

SCOPE OF THE STUDY

In this context, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), German International Cooperation, commissioned a study prepared by a consortium of Ecofys, Association of Thermal Insulation, Waterproofing, Sound Insulation and Fireproofing Material Producers, Suppliers and Applicators (İZODER) and Istanbul Aydın University titled the *Energy Efficiency Technology Atlas for Turkey's building sector*, prepared for the Ministry of Environment and Urbanisation of Turkey (MoEU) under the Energy Efficiency in Public Buildings in Turkey Project. It explores the market potential of technologies in accelerating the energy efficiency of buildings and informs the relevant decision makers and private sector actors on the products, services, actors and driving forces behind the energy efficiency market in Turkey. The study therefore serves as a key source to identify where more efforts are required to accelerate the availability and cost-effective deployment of these technologies and strengthen the construction markets and where specific (technical as well as market) potentials lie. The detailed findings can be found at the full version of the *Energy Efficiency Technology Atlas*.

METHODOLOGY

The study explores the energy efficiency technology (EET) market situation for a total of six technology groups, namely thermal insulation, windows, space and water heating, air conditioning, ventilation and lighting. For each EET, the respective energy efficient technologies have been included, such as heat pumps and condensing gas boilers for heating etc., and form the basis for the study of future market development of building energy technologies.

The results build on a dual methodology that compromises desk research by international experts and qualitative and quantitative assessments among 90 local and national experts and stakeholders of the Turkish building sector (Figure 4). The results of this interaction provide a sound understanding of the current processes, sensitivities and efforts to reach low carbon construction. Through interviews with these stakeholders, the market situation of each EET was assessed from the aspects of policy, economics, technology availability, know-how and professional expertise, and information and social acceptance.

Figure 4: Sector breakdown of the experts that have contributed to this study

49	26	15
Manufacturing	Services	Research

HIGHLIGHT

The study uses both desk research and expert inputs. 90 experts provided their inputs to this study out of which more than half were from the manufacturing (private) sector.

For each EET, the study estimates the current potential and the technical potential, and –as the difference the estimates of these two potentials– the investment gap is calculated as described in Figure 5. To capture the differences across all contexts in Turkey, the analysis distinguishes between four climate regions[1] and three building types.[2]

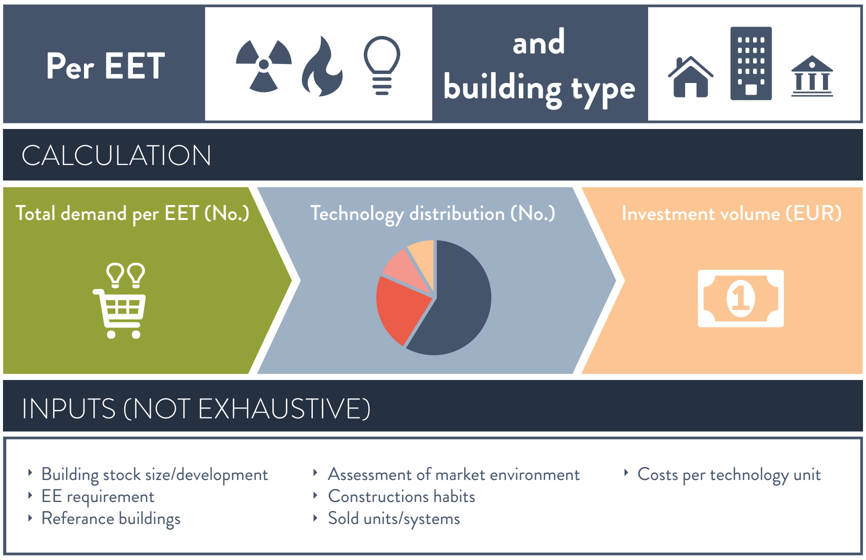
The scope of each market indicator is discussed below:

Current potential: Investment volume in EUR, which is required to cover the demand for new construction (for the year 2015) and renovation activities under current circumstances and regulations (i.e. TS 825 construction requirements added to by the business as usual (BAU) building technologies)

Technical potential: Investment volume in EUR required to cover current demand for new construction and renovation activities *using energy efficient solutions* considering the implementation of all best available technologies (BAT) that are considered cost-effective.[3] In reality, however, not all (energy efficient) technology options that are deemed cost-effective are likely to be implemented and other options that are not cost-effective but that offer other benefits could be implemented instead. The technical potential is therefore an idealised scenario which takes into account economically viable EETs. Regarding the penetration rates of the BAT´s, lifetime has been taken into account to determine the replacement rate for the renovation case. Furthermore, only BATs which already have a significant share (higher than 3%) in the Turkish market were considered, so no demonstration or niche products were included in the calculation.

Investment gap (in EUR): Difference between the current and technical potential.[4]

[1] The standard TS 825 and its definition of four climate zones are considered as the basis for the four climate regions.
[2] New and existing residential and non-residential buildings were considered. To illustrate residential buildings, reference buildings for single-family and multi-family buildings were taken into consideration. The non-residential building sector had to be simplified by choosing one commercial building as the reference building, representing all commercial and public buildings.
[3] For new buildings, a 100% theoretical penetration rate with cost-effective EETs (based on the given new construction rate) was assumed, while for existing buildings slightly higher-than-current (still realistic but more ambitious) renovation rates have been assumed, also using cost effective EETs (100%).
[4] The currency exchange rate assumed in this study is 1 EUR / 1.15 USD = 4 Turkish Liras



HIGHLIGHT

The market assessment methodology allows the calculation of the investment gap in Turkey's building sector if all buildings were to implement cost-effective BATs.

Figure 5: Overview of the methodology to assess the market potential

PRIORITY AREAS FOR THE TURKISH BUILDING SECTOR

The study provides a comprehensive overview of key technologies and innovations and their potential to reduce the energy demand of buildings of Turkey. Subsequently it assesses the investment gap if all buildings were to implement cost-effective BATs. This market assessment was complemented with a qualitative assessment of the local market situation based on the position and perspective of local stakeholders. The study ends with recommendations that contain advice on key priority areas and address identified stakeholders and drivers, pointing out specific fields where knowledge transfer and capacity building are most needed. Based on the findings of this market analysis and the feedback from stakeholders, the study identified six priority areas that warrant immediate action from both policy makers and industrial stakeholders. For each priority area, the respective sections provide the key findings, action areas and action needs by stakeholder.

- **Energy efficiency technologies have a huge market potential in Turkey:** Implementing the cost-effective potential of energy efficient BATs would create an additional investment potential of EUR 3.2 billion in Turkey. This is over 50% higher than the current investments of EUR 6.2 billion, raising the EET market to EUR 9.4 billion. This gap is constituted to one-third space by heating & cooling, 30% by windows and a quarter by insulation. The remainder is split across ventilation and lighting systems.

- **Renovation needs to continue to complement the opportunities derived from new energy efficient buildings:** The Urban Transformation Plan offers a significant potential for new investments in EETs. The investment gap for energy efficiency BATs related to new buildings is around EUR 1.3 billion. The investment gap for renovation is much higher – estimated at EUR 1.9 billion, highlighting the importance of improving energy efficiency in existing buildings.

- **Opportunities exist across all regions and building types:** In terms of absolute energy demand, the difference between residential and commercial/public building is not significant. But in terms of the investment gap, the residential sector is nearly three times higher, indicating the large potential for energy efficiency improvements. Regionally, the second climate zone that includes more than half of Turkey's population represents around half of the investment gap, but even in the least prominent climate zones, there is significant proportional potential.

- **Energy efficiency improvements will need to be enabled by new and innovative technologies and models for finance and business:** Space heating and cooling is by far the largest area in terms of the current EET investments with a total of EUR 2.7 billion. While many technologies offer potential to close this gap, new solutions will need to address the changing energy demand profiles – such as growing demand for cooling whilst also supplying heating. Enabling the development of financing, business and service models will be key to accelerate the implementation of new and existing EETs.

- **Filling in the energy efficiency investment gap and the growing export opportunities will make Turkey's construction sector even stronger:** Turkey is a key player for the production and trade of all types of EETs and it is also a logistics hub for international manufacturers, for production plants and trade activities, as the country offers a connection between African and Asian countries. While the production and export capacities for all EETs are promising, with the growing domestic and international markets, more attention may be needed for some technologies of heating, cooling, ventilation and lighting markets. What is also relevant in this context is to ensure as far as possible that the technologies produced in Turkey follow the highest standards for energy efficiency.

• **Utilising these potentials requires creating an enabling investment environment with new policies as well as private sector buy-in:** Realising the potential of this investment gap will only be possible by creating an enabling investment environment in the energy efficiency sector. The priority areas of **ensuring technology availability, allowing cost-competitiveness** and **creating the know-how** all need to be supported with the development of new regulations, targets and incentives and by increasing awareness and social acceptance of EETs.

BOX 2 **Characteristics of the reference buildings and applicability of the energy efficiency technologies**

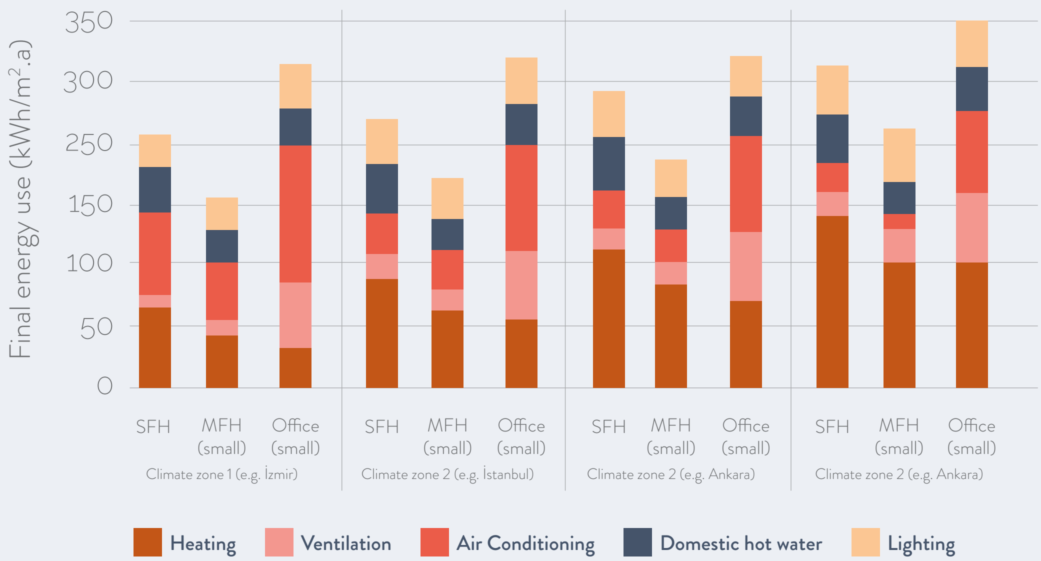
This study used three types of reference buildings to estimate the EET market potential (see Table 1). The single-family reference building chosen is a detached single-family building with two floors. The multi-family building has a ground floor and four storeys, 10 dwellings, and is detached. The medium-size office building has a net useful floor are of 2,749 m^2 over 5 storeys. One third of the vertical shell consists of transparent window surface.

Table 1: Characteristics of the reference buildings used in this study

		Residential		Non-residential
		SFH	MFH	
Net floor area	m²	158	1440	2749
Roof	m²	90	288	550
Façade	m²	173	918	1375
Window	m²	20	62	687
North	m²	4	27	172
East	m²	4	54	172
South	m²	8	27	172
West	m²	4	54	172
Ground	m²	90	288	550
Number of storeys	m²	2	5	5
Number of dwellings	m²	1	10	-
Room height	m²	2,5	2,7	2,95
Building volume	m³	402		

In Turkey, single family houses consume around 220 kilowatt-hours (kWh) energy per square meter (m^2) each year. Multi-family houses consume around 20% less, at approximately 175 kWh/m^2.a The consumption in non-residential buildings is the highest, typically exceeding 270 kWh/m^2.a The least energy consuming buildings are multi-family houses in the first climate zone of Turkey where much of the energy demand goes to cooling. Most energy is consumed in office buildings of the fourth climate zone where one-third of the energy demand is for heating. Heating is equally important in single family houses in the third and fourth climate zones (see Figure 6).

Figure 6: Estimated annual energy demand of different building types in Turkey by climate zone, 2015



HIGHLIGHT

The least energy consuming buildings are multi-family houses in the first climate zone of Turkey where much of the demand goes for cooling. Most energy is consumed in office buildings of the fourth climate zone where one-third of the energy demand is for heating.

To focus on the most relevant technologies and their allocated energy consumption the EETs were mapped according to climate zone, building type and age (i.e. new or renovated). Figure 7 presents the technologies with the buildings (stock and new buildings) per building type and gives an overview of an EET's relevance. This was completed based on an assessment by international and national experts. The mapping provides a gradual estimation of relevance, from very relevant to not relevant, in four grades.

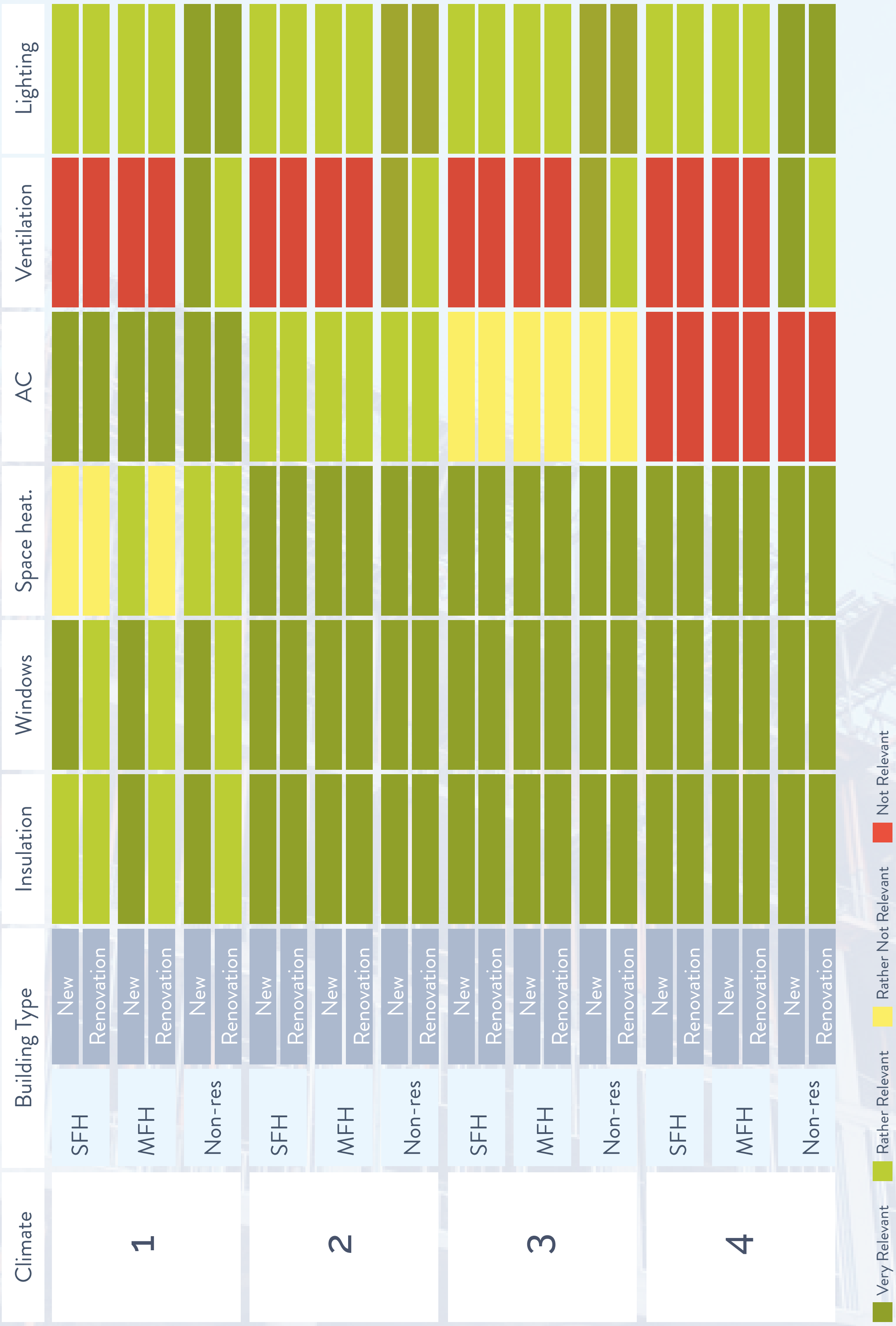


Figure 7: Relevance of technologies by climate zone and building type

Energy efficiency technologies have a huge market potential in Turkey

Implementing the cost-effective potential of energy efficient BATs would create an additional investment potential of EUR 3.2 billion in Turkey. This is 50% higher than the current investments of EUR 6.2 billion, raising the EET market to EUR 9.4 billion. This gap is characterised by one-third space heating & cooling, 30% windows and to one quarter by insulation. The remainder is split across ventilation and lighting systems.

KEY FINDINGS

The total current investments of EETs reaches EUR 6.2 billion as displayed in Figure 8. With over EUR 1.8 billion per year, investments in AC systems have the highest share (29%), followed by windows (EUR 1.34 billion), and insulation (EUR 1.24 billion). In comparison, investments in space heating systems, ventilation and lighting technologies together total EUR 1.77 billion—i.e. 29% of the total investment in 2015. Residential buildings generate about 80% higher investment in EETs than non-residential buildings. Excluding investments in mechanical ventilation systems, which are uncommon in the Turkish residential sector, residential buildings spend more than twice as much for the remaining EETs than non-residential buildings.

The overall technical potential estimated at EUR 9.4 billion is 50% higher than current investments. Thus, there is a huge potential for increased investments in EETs. The gap between current and potential investments is EUR`3.2`billion, which could be invested in EETs. This investment gap is distributed as follows: 0.93 billion for windows (0.29%), 0.86 billion for air conditioning (0.26%), 0.77 billion for insulation (0.24%), 0.40 billion for ventilation (0.12%), 0.21 billion for space heating systems (0.06%) and 0.06 billion for lighting (0.02%). Specifically windows, insulation and ventilation technologies have technical potentials that are far higher than the current annual investment, bridging the gap from current investments towards reaching the technical potential.

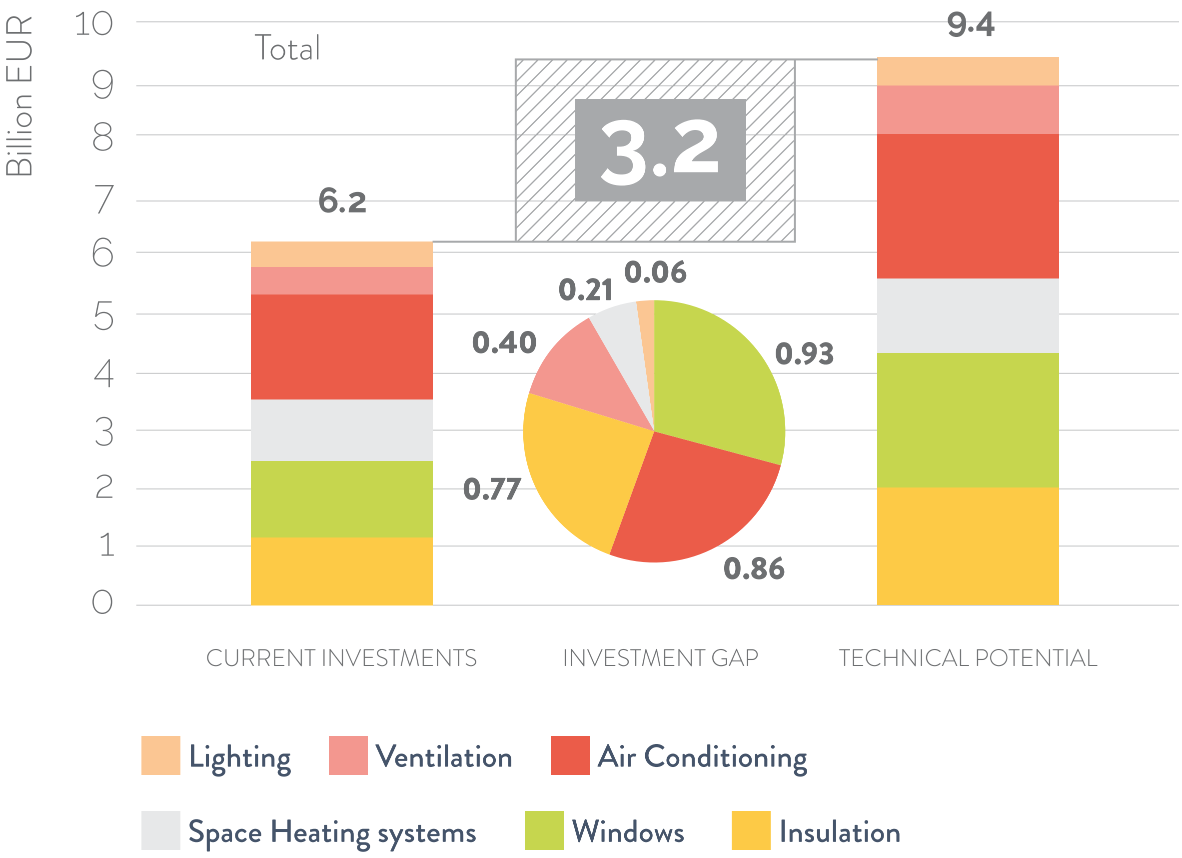


Figure 8: The investment gap to implement energy efficiency BATs in Turkey's building sector

HIGHLIGHT

Implementing the cost-effective potential of energy efficient BATs would create an additional investment potential of EUR 3.2 billion in Turkey.

The technical investment increase potential by EET is distributed as follows: for ventilation, the original investment of 0.55 billion has an increase potential of 73%. For windows, an extra 69% investment potential exists beyond the current market of 1.34 billion, while for insulation, the current investment of 1.24 billion can be increased by up to 62%. An additional 48% could be invested in air conditioning (1.81 billion current investment), and an additional 23% for space heating systems (currently on 0.9 billion). Lighting is the closest to having exhausted its technical potential with the original investment of 0.33 billion only promising an increase potential of 18%.

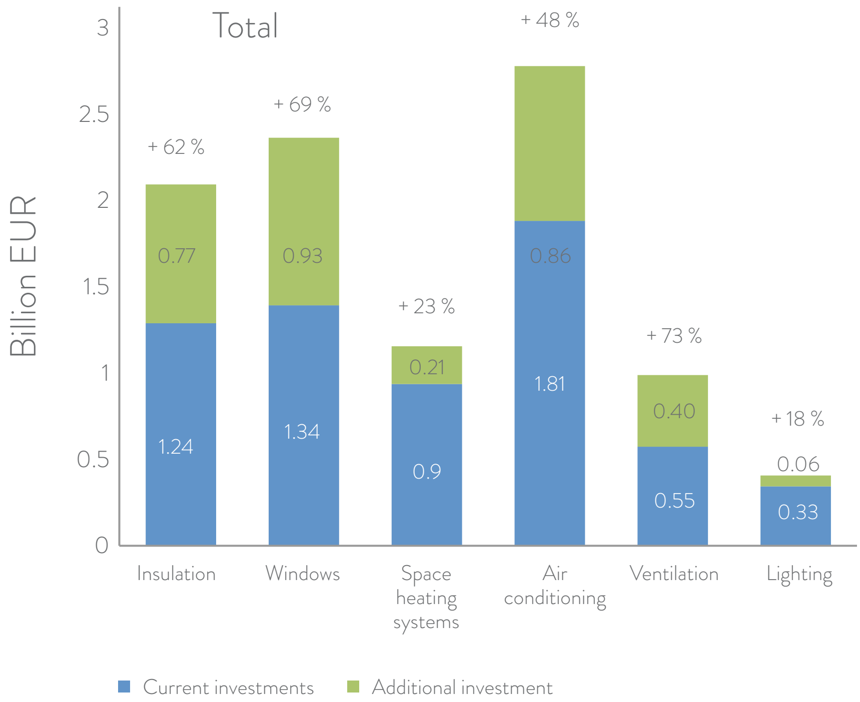


Figure 9: The investment gap for each EET by increase

HIGHLIGHT

The added technical investment potential by EET range between 73% for ventilation and 18% for lighting.

ACTION AREAS

Insulation: There is a gap of EUR 0.8 billion between current investments and the cost-optimal building insulation from BATs. Even when considering a doubling of the current renovation rate in existing buildings towards 1%, 85% of the additional investments can be achieved in new construction. The Turkish market is composed of a variety of national and international suppliers offering a wide range of thermal insulation products (EPS, XPS; stone and glass wool, etc.). Companies active in the Turkish market can easily supply for an increased demand of thermal insulation due to already oversized production facilities and quick response in newly-built facilities. One main policy challenge to overcome in order to ensure the implementation of the EETs is **updating the U-values in the TS 825 and ensuring cooling is also accounted for.**

Windows: On top of the EUR 1.3 billion in current investments for windows, there is a potential investment gap of EUR 0.9 billion. **Of this, more than half (53%) comes from replacing windows in existing buildings.** The non-residential sector only contributes 25% to the total investment gap. To produce energy efficient windows, two components of the window need to be improved: glass and frames. The sector will need to grow with the demand for new housing arising. Under the NEEAP, the sector will receive incentives, support and taxation advantages for renovation activities using thermal insulation and high efficiency windows. This is especially important because policy instruments for renovation to install more efficient windows would lead to a surge in the existing building market. For instance, if the appropriate instruments were in place focusing on retrofit activities, the rate of windows renovation could be doubled from 1% to 2%.[5]

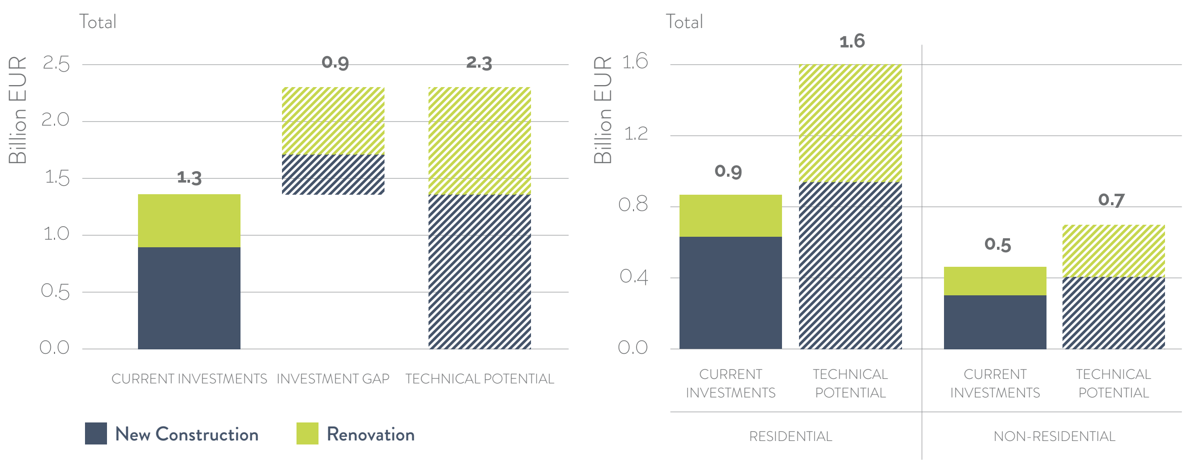


Figure 10: Current investments versus technical investment potential for windows

HIGHLIGHT

The technical potential for windows is nearly equally split between new constructions and renovation, however, much of the potential exists in residential buildings.

Heating and cooling: The calculated investment gap for energy efficient space heating systems is EUR 0.2 billion compared to current investments of EUR 0.9 billion. Encouraging investments in existing residential buildings alone may yield two-third of these additional investments. New construction accounts for 20% of the investment gap. More than 80% of the additional investment potential (EUR`0.9`billion) for energy efficient cooling systems may be gained from existing buildings due to the lifetime of air-conditioning units (15 years in theory) combined with the large building stock affected (7.5% annual replacement rate for building stock to 4% for new buildings' construction rate), most of it in the residential sector, indicating the share of older and highly energy consuming

[5] A maximum of 3.5% is possible (according to experts' estimates) based on the theoretical lifetime of windows.

buildings in the stock. No additional cooling investments are expected for the coldest climate zone. In recent years Turkey has become Europe's and Africa's production base in the field of HVAC. Gas is the predominant source for heating purpose and the market offers boilers in different sizes and efficiencies. As Turkey's gas infrastructure expands, the gas boiler market will gain a bigger market share, but it is **crucial to ensure the production of the most efficient gas boilers and eliminate poor quality products from the market.** As for heat pumps, the market share is currently small and without financial support it is not expected that it will grow because of the high costs involved. Ensuring deployment of efficient cooling technologies will require better integration of cooling in building energy policy and regulations.

Ventilation: Investments in ventilation may grow by 74% towards EUR 0.9 billion from EUR 0.5 billion. Two-thirds of this additional investment can be spent on existing buildings. As integrated ventilation systems are uncommon in residential buildings, the whole budget is considered to apply to the non-residential sector. However, currently there are no mandatory regulations available to use ventilation and there is no control of that system. Increasing awareness about benefits of ventilation, such as contributing to improving human health and indoor air quality, guaranteeing specific air exchange rates (i.e. mandatory ventilation concepts) and minimum heat recovery rates of 80% are possible ways to close the investment gap related to ventilation.

Lighting: For lighting, an investment gap of EUR 0.1 billion is estimated. All additional investments are in LEDs. Most of the additional investments exist in existing buildings due to the large floor area to be equipped and due to the short lifetimes of currently installed lighting equipment, which result in high replacement rates. The lighting industry has shown substantial growth in the past 15 years in terms of production capacity, product quality, product diversity and research and innovation activities, which has also contributed to increasing the production capacities for energy efficiency lighting systems with a clear focus on the LED technologies with a CAGR of 15.6%[6] (in the years 2016 – 2022) in Turkey. Production technologies have been improved continuously as well. The sales of energy efficient lighting need to be further promoted (user behaviour), along with the use of sensors (automation) for efficient lighting usage.

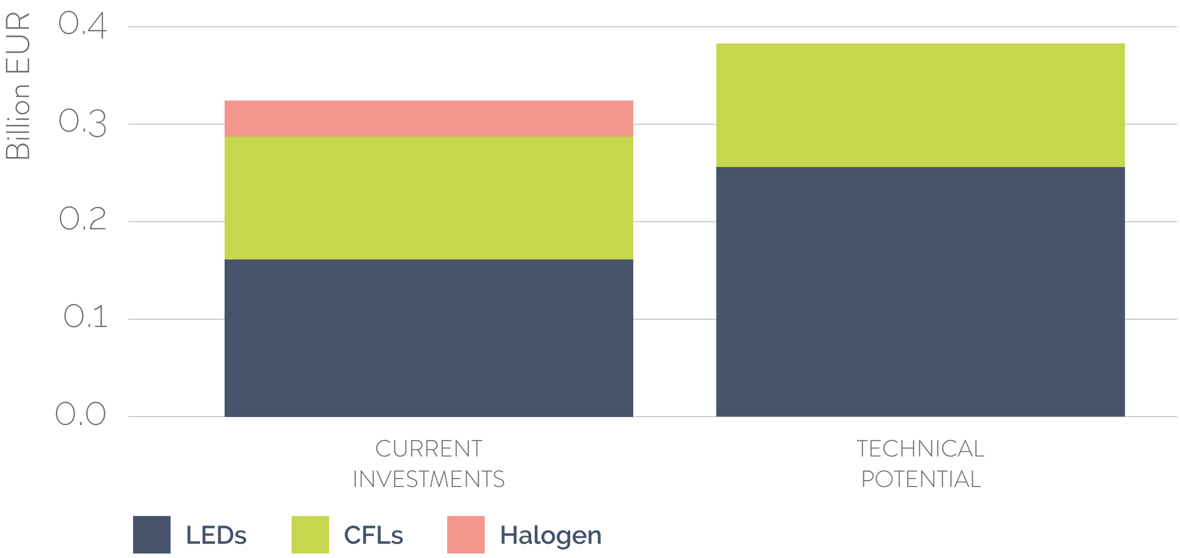


Figure 11: Current and technical investments in lighting by technology type

HIGHLIGHT

Implementing the cost-effective potential of energy efficient BATs in lighting will predominantly exist for LEDs.

[6] Research and Markets, Turkey LED Market

Renovation needs to continue to complement the opportunities from new energy efficient buildings

The Urban Transformation Plan offers a significant potential for new investments in EETs. The investment gap for energy efficiency BATs related to new buildings is around EUR 1.3 billion. The investment gap for renovation is much higher estimated at EUR 1.9 billion, highlighting the importance of continuing to improve energy efficiency in existing buildings.

KEY FINDINGS

About two-thirds of the building stock of Turkey is younger than 30 years, which is caused by a relatively high new construction rate in the past. On the other hand, about 20% of the building stock was built before 1960 and thus is older than 57 years. About 19% of the building stock has been built since 2012, implying a rate of 4-5% of new buildings coming into the stock. Between 2012 and 2016, on average 170 million m^2 new buildings came into the stock.

By 2023 and by 2030, around 17% and 33% respectively of the total building stock will be demolished, creating significant opportunities for new building investments. The buildings invested in these investments can be equipped with the best available energy efficient and renewable energy technologies, thus contributing to various energy and climate goals of the countries. The remainder of the building stock will need to rapidly be renovated to ensure the sector's energy use as a whole can be reduced. **For new buildings, the key will be to create a market that ensures the implementation of EETs in each investment decision through enabling policy frameworks.** While lighting and heating sectors are on track, showing that energy efficiency investments pay off, there is a large untapped potential to be exploited through these frameworks in ventilation, windows, insulation and AC systems.

Total current investment estimates can be split into EUR 3.7 billion for new buildings and EUR 2.5 billion for renovation in existing buildings. By comparison, the estimates for technical investments are closer to each other, estimated at EUR 5 billion and EUR 4.4 billion for new and existing buildings, respectively. This creates a large investment gap of EUR 1.9 billion for renovation compared with EUR 1.3 billion for new buildings.

Looking at which technologies in which contexts explain this substantial gap, insulation for example has far larger potential in new buildings as opposed to existing buildings. This is expected as it technically easier to implement insulation technologies during new construction, which has to be ensured going forward. For all other EETs, the investment gap is higher for renovation (see Figure 12) due to the large existing building stock.

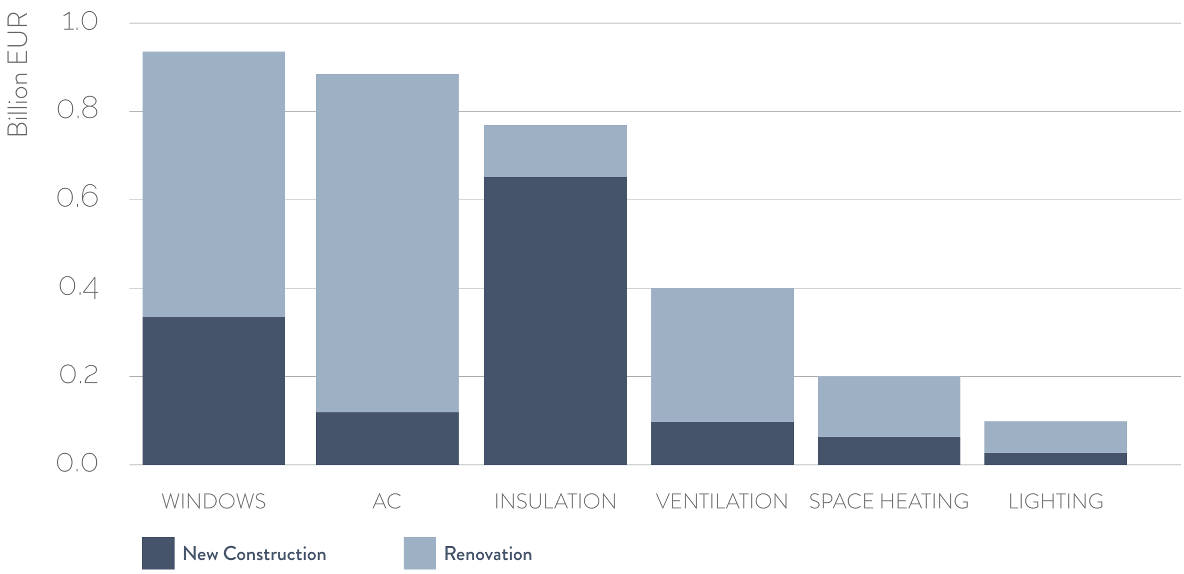


Figure 12: Breakdown of the investment gap by new construction versus renovation

HIGHLIGHT

The investment gap is much larger for renovation as opposed to new constructions except for insulation.

ACTION AREAS

Renovation: The findings of this study show the key role renovation plays if Turkey aims to achieve its energy efficiency goals. To reach these potentials, accelerating renovation rates is of utmost importance. A good practice example in this regard, is the German KfW Energy-Efficient refurbishment programme that offers low-interest loans including redemption grants for existing private and public owned residential buildings. In addition, the **energy savings that can be achieved by retrofits should be maximised by ensuring deep renovation that avoids any carbon lock-in effects.** In any case, many buildings undergo natural maintenance processes. During these processes, energy efficiency improvements should be prioritised through conscious policy decisions to implement suitable and where possible the best available technologies for insulation, lighting, windows and heating/cooling equipment. Enabling this will require renovation schedules and mandatory renovation rates for different types of buildings as well as the implementation of more ambitious energy performance standards and building codes that cover both existing and new buildings. Policy effort should be complemented with financial support mechanisms and awareness programmes to ensure implementation. Acceleration of renovation and meeting targeted retrofitting rates is a challenge for most countries, not only in Turkey. For instance, in the EU and the US, renovation rates of up to 3% annually are targeted, whereas they struggle to push for enough activities to reach in exceess of 1% renovations per year. In order to close the gap towards reaching these targets, countries are preparing long-term strategies about which technologies they can implement in renovations and how. **The latest amendment of the EPBD in December 2017 therefore obliges all EU member states to present long term strategies for their retrofit activities.** This step should be emulated in Turkey by coming up with a **strategy to incentivise renovation where appropriate.** Countries are also introducing new incentives such as specific renovation grants.

Three policy steps to accelerate renovation:

1. Regulate (e.g. demanding minimum requisites): As a starting point for Turkey a list of the top performers might be created and followed up on

2. Inform: Landlords and building owners have to be made aware of the benefits of timely renovation as well as the importance of the right retrofitting measures – for the building owner as well as the tenants

3. Incentivise: To move renovations even further ahead, policy measures can extend to incentives for renovations like credit lines for building owners (like KfW's in Germany) or tax exemptions for selected technologies

New construction: Deep decarbonisation of the building sector will not be possible without a major effort to harness the opportunities created when investing in new buildings. The savings that can be achieved in new buildings when they employ EETs are much higher than for renovation and they can come with lower costs to achieve the same level of energy efficiency. Achieving this requires the design and implementation of a holistic energy strategy for buildings that prioritises the use of energy efficiency and renewable energy technologies across different energy use phases of a building, including demand side (building envelope and ventilation), supply side of heating, cooling, cooking and appliances and control of these energy flows in an efficient way. In addition, the opportunity offered by the Urban Transformation Plan can be utilised more effectively where investments to very energy efficient buildings are encouraged.

BOX 3 **(Nearly) Zero energy buildings (nZEBs): What do they mean in the context of green buildings and contribution to climate change mitigation**

Green buildings can be defined as those that are resource efficient, prioritise the use of renewable energy and energy efficiency technology and compromise materials that have low environmental impacts over their life cycle. The global green building market size is doubling every three years for over a decade (IFC, 2016). Given this broad definition, increasing the green build share in the stock has cross-cutting effects that can contribute to various Sustainable Development Goals (SDGs): good health and well-being, affordable and clean energy, economic growth, industry, innovation and infra-structure, sustainable cities and communities, responsible consumption and production, climate action and life on earth (CEDBIK, 2017 [6]).

2017 has marked a new record year for Turkey where more than 245 projects that cover more than 6 million m^2 of green building area were developed. This has put Turkey eighth in the world ranking of the US Green Building Council that operates the most widely known green building certification system (CEDBIK, 2018 [7]). Due to this and the high levels of building activity, there is a large market poten-tial of green buildings according to the IFC (2016) which represents around a total of EUR 17 billion by 2020 in Turkey.

(Nearly) Zero Energy Buildings are a different case, on the other hand. While there are different approaches across the world to define these buildings, they predominantly fulfil the "energy" goal of green buildings, thereby resulting in no or very limited emissions of greenhouse gases which are regard-ed as the main driver of climate change. These building types achieve this by paying particular attention to the implementation of measures to reduce energy demand and subsequently meet the remaining energy demand from renewable energy sources.

In a world that aims to meet the goals of the Paris Agreement, decarbonisation of all sectors that consume energy will be key, including building. Near or net zero energy buildings is one of the key approaches in achieving this, however, two main barriers remain: costs and design. Research shows that initial costs of nearly Zero Energy Buildings are slightly higher than conventional buildings (according to Ecofys)[7]; however, when the economics are considered for the whole lifetime of the building, the advantages of the NZEB concept materialize through a general payback period of around 15 years for all relevant measures. When compared with renovation, an NZEB solution can thus be cheaper if the expected lifetime exceeds 15 years, though such a calculation depends on various factors. Hence, the key is to prioritise their implementation for all new buildings as early as 2020 (Kuramochi et al., 2018 [9]). To facilitate their implementation, previously isolated design processes need to be integrated with architecture, energy engineering and mechanics approaches that favour energy efficiency and renewa-ble energy (IEA, 2015 [10]).

Experiences from the EU

According to Article 2 of the directive 2010/31/EU of the European Parliament and of the council of 19 May 2010 on the energy performance of buildings (recast), a Nearly Zero-Energy Building (nZEB): "means a building that has a very high energy performance [...]. The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby". Furthermore, Member States shall ensure that by 31 December 2020, all new buildings are nearly zero-energy buildings (public buildings already by 31 December 2018). Therefore, they are required to draw up national plans for increasing the number of nearly zero-energy buildings.

[7] Experiences of Ecofys show that the incremental costs of NZEBs range up to 10%. It starts with an optimized design (at almost no costs), improved demand side (low cost), integrate renewables (additional cost, but with good pay-back periods depending on the conditions) and is rounded off by closing the gaps to zero consumption with mechanical systems (with highly efficient HVAC as available).

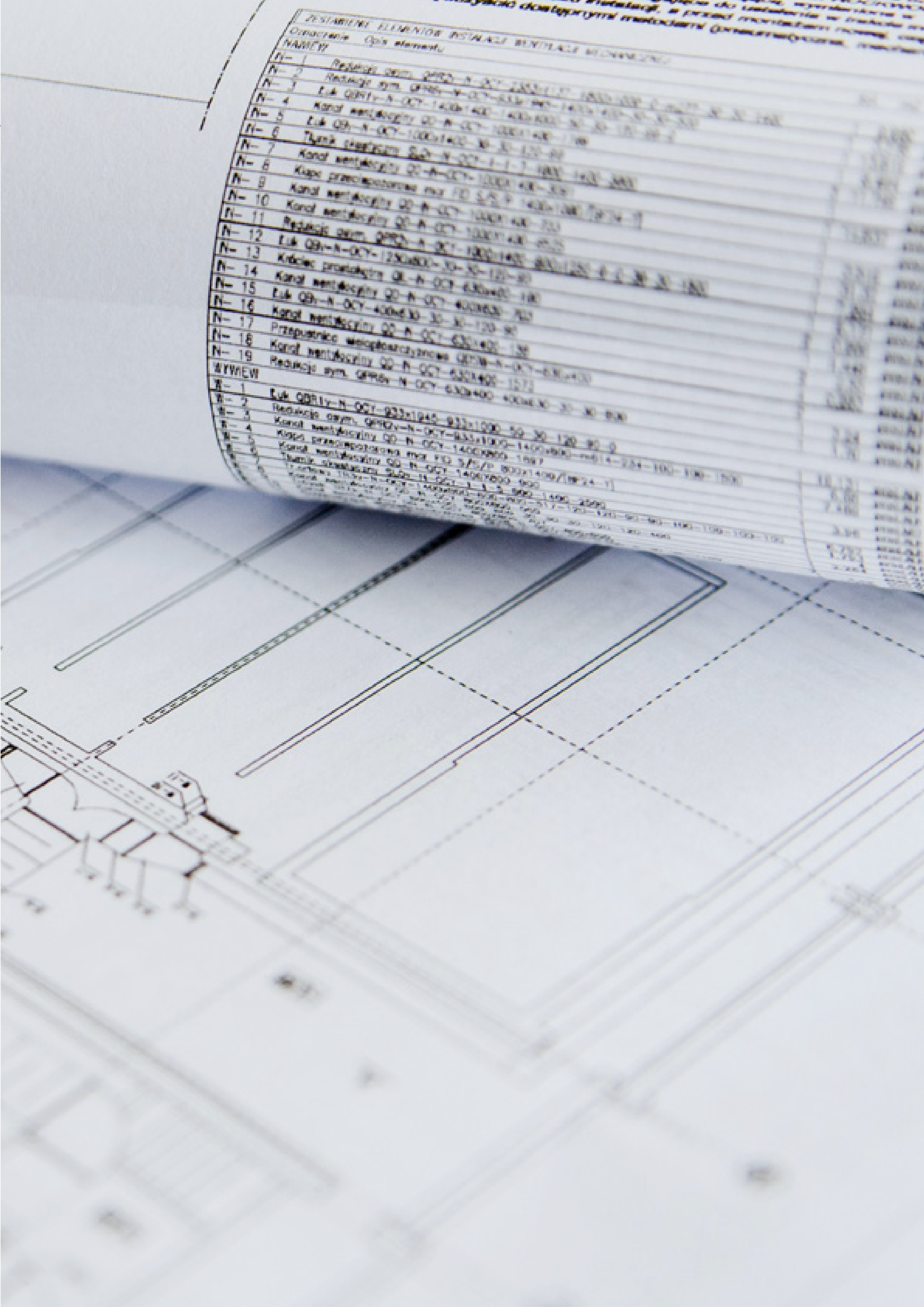
The transposition of the nearly zero-energy building definition into national law and the setting of the ambition levels however are under the authority of each of the Member States. Currently, most Member States have a formal nZEB definition in an official document, or at least one under development. Ambition levels differ between countries. They can be identified by looking at primary energy requirements (in total or in comparison to a reference building), but also in terms of renewables quantitative requirements for the energy still consumed. In Germany, a first nZEB definition for public buildings is provided in the “GebäudeEnergieGesetz” line with the “KfW-Effizienzhäuser 55”, it means that an nZEB can only have up to 55% of the primary energy consumption of the reference building, in Flanders in Belgium nZEBs even have to stay below 40% (non-residential) or 30% (residential) since 2015 already. Austria on the other hand may not seem as ambitious, but is one of few countries to set very concrete intermediate targets from as early as 2014 to have a smooth process with some early results (and hence CO2-savings from the outset). Austria also set differentiated requirements between new and existing buildings; this adds an incentive for comparatively high levels of ambition for building stock.

In an effort to increase the number of nZEB buildings, Member States have also adopted financial and fiscal support policies and programmes, as well as information and capacity building measures. The policies and measures focus on incentive schemes and taxation mechanisms, utility-funded energy efficiency programmes, the use of market instruments for energy efficiency renovations and the promotion of training and education campaigns [].
Germany for instance implemented KfW’s Energy Efficient Construction and Rehabilitation (EECR) programme for residential properties that provides subsidised lending for the renovation of existing building stock. The funding is set according to the level of energy efficiency achieved and up to 100% of the loan can be financed by KfW. When more than one element is improved, or a combination of measures are undertaken it is possible to receive a bonus. Likewise, the KfW Energy-Efficient Refurbishment programme, improved in 2013 by adding budget funds annually through 2020, offers low-interest loans including redemption grants for existing private and public owned residential buildings. In terms of taxation mechanisms, the ‘Haushaltsnahen Dienstleistungen’ tax incentive allows for 20% of the labour costs (up to EUR 6.000, i.e. tax relief on up to EUR 1.200) of certain home renovations associated with reducing the energy demand of the building. Finally, the German energy agency (DENA) organises training and education campaigns, distributes information to the public and supports the building sector (architects or craftsmen) to work in line with current standards and regulations and develops standards and labels for efficiency.

Poland has implemented the Operational Programme Infrastructure and Environment (POIE). Since 2014 and up to 2023, with a budget of EUR 165.9 Mio. for public buildings and EUR 225.6 Mio. for residential buildings, the programme intends to support the complex energy modernization of existing private and public-owned buildings, including the replacement of technical equipment for energy efficient technology solutions.

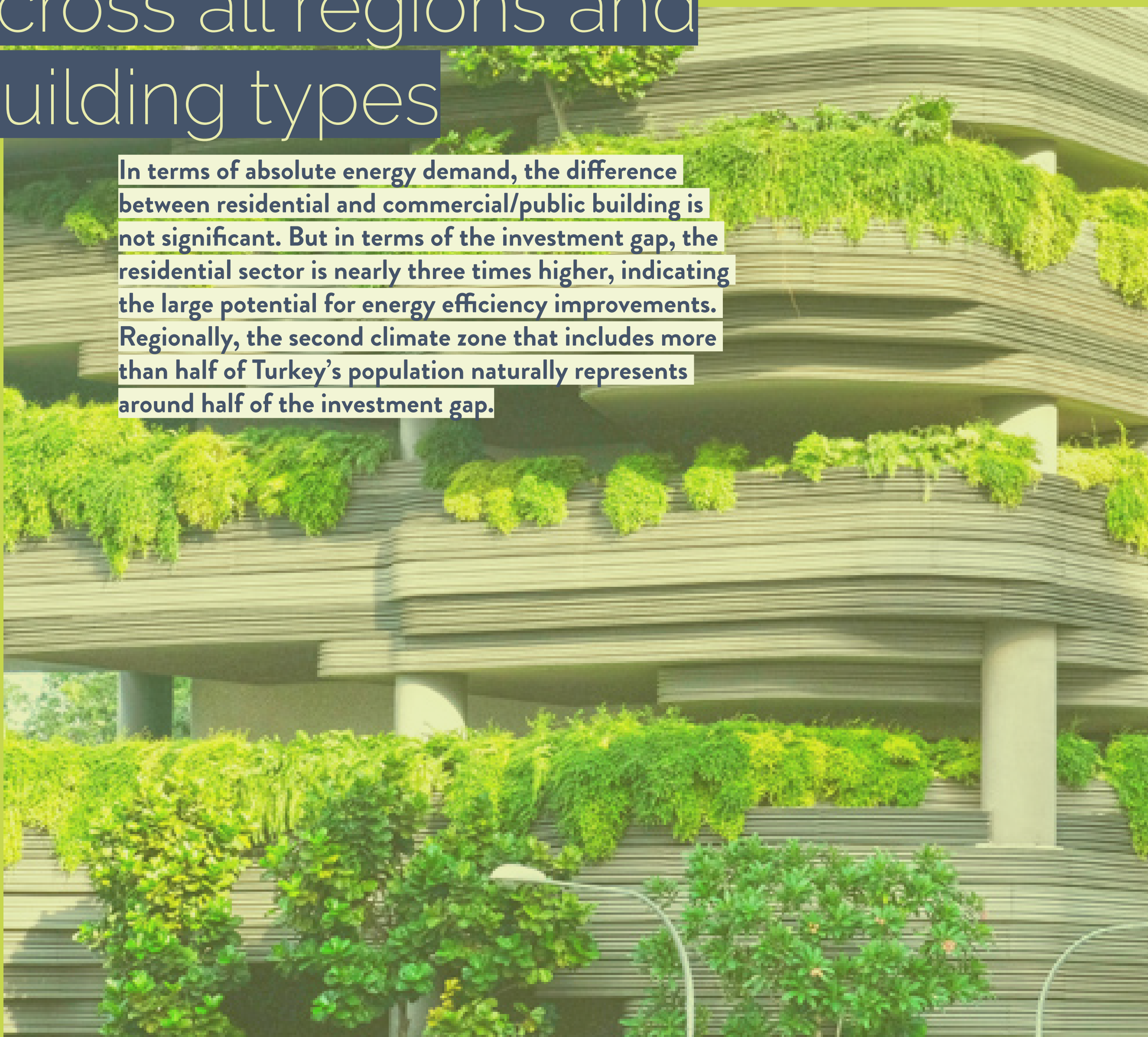
HIGHLIGHT

Another good practice example is the Klimaaktiv grant programme in Austria, The programme (with a budget of 7 Mio. EUR/year) is intended for new and existing privately-owned residential and non-residential buildings.



Opportunities exist across all regions and building types

In terms of absolute energy demand, the difference between residential and commercial/public building is not significant. But in terms of the investment gap, the residential sector is nearly three times higher, indicating the large potential for energy efficiency improvements. Regionally, the second climate zone that includes more than half of Turkey's population naturally represents around half of the investment gap.



KEY FINDINGS

Residential buildings represent the lion's share of the total building area in Turkey with an estimated floor area of 2.4 billion m². Non-residential, commercial and public buildings cover a total of 0.5 billion m² area. Their total comprises about 23 million dwellings. Multi-family houses cover the majority of the total residential floor area, equalling around 80%.

Turkey is characterised by four distinct climate zones (according to TS 825). More than half of the population lives in climate zone 2 (e.g. Istanbul), while 17% of the population live in climate zone 1 (e.g. Antalya) and 21% in climate zone 3 (e.g. Ankara). About one-tenth of the population lives in climate zone 4, which is the also coldest climate zone (e.g. Erzurum). TS 825 also determines the maximum U-values per climate zone and part of building envelope.[8] The better-insulated a structure is, the lower the U-value will be. The distribution of the existing building stock (floor area) follows nearly the same distribution as that of the population (see Figure 13).

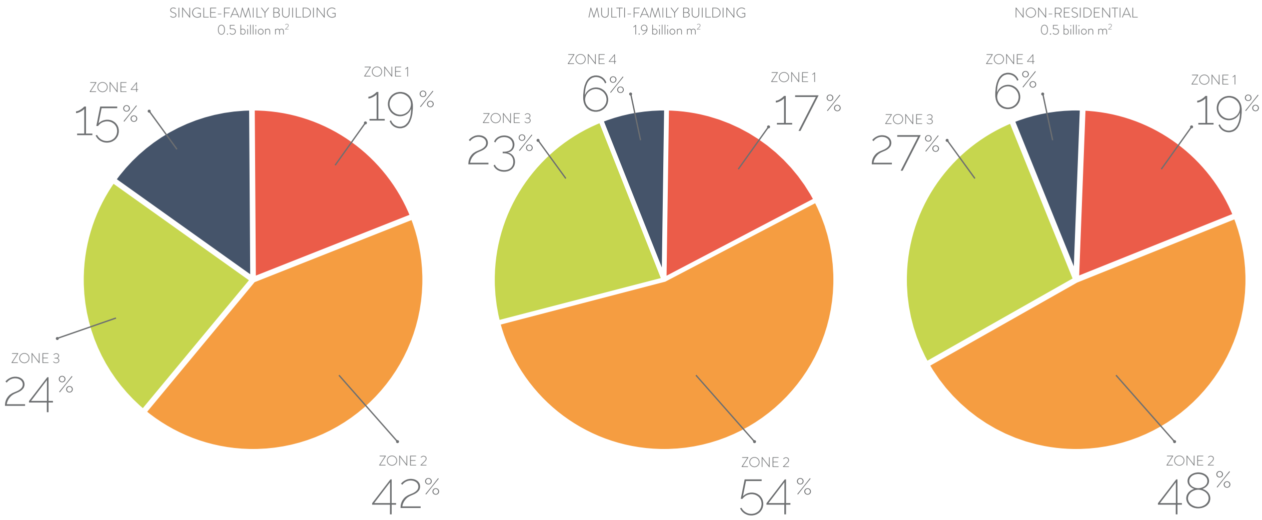


Figure 13: Breakdown of the total building floor area by building type and climate zone, 2015

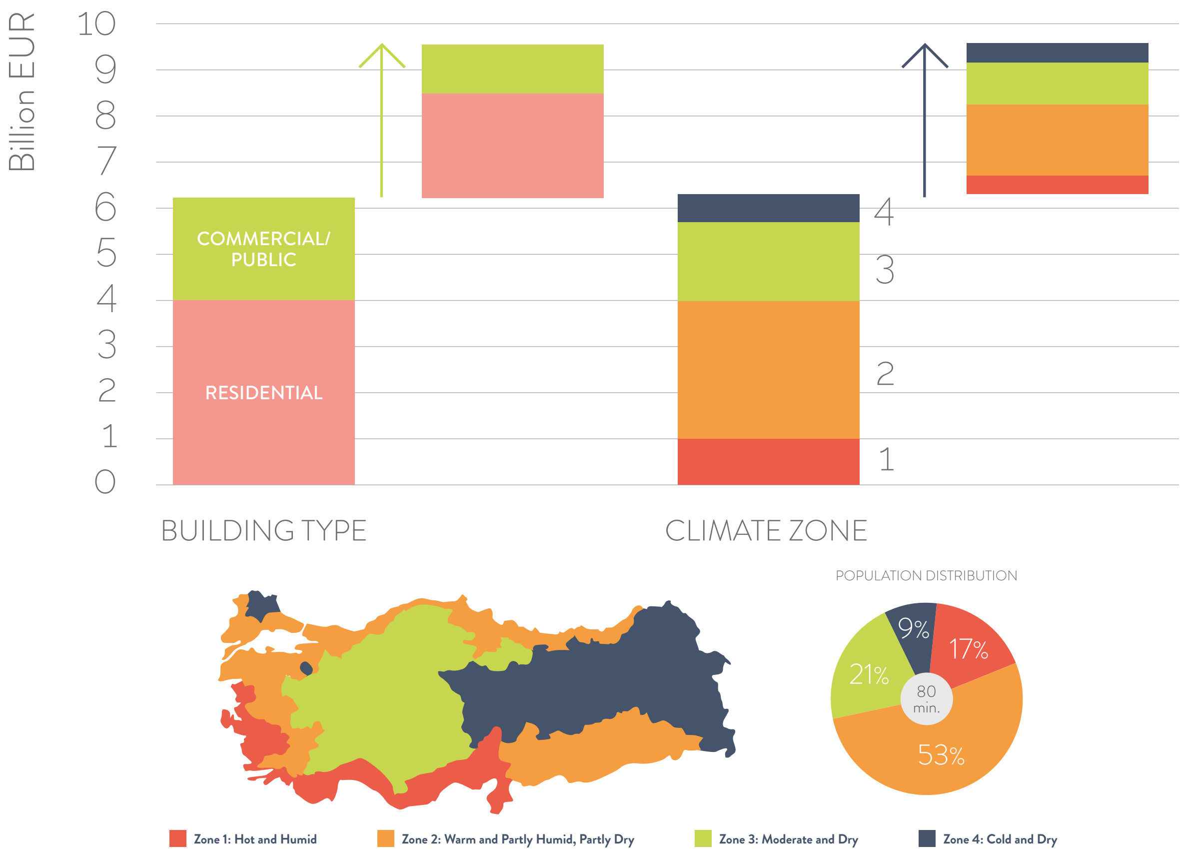
HIGHLIGHT

Multi-family buildings have by far the largest share of Turkey's building floor area. Roughly half of all building area is in the second climate zone.

The performed calculations show that multi-family houses are the most dominant building types for current investments. That also holds true for the technical potential, where the share of MFH increases to 58% compared to 53%. The remaining 47% of the total current investments are split between 12% for single family houses and 35% for non-residential. In terms of climate zones, the breakdown between current and technical investments is nearly the same: Around 50% for climate zone 2, 30% for climate zone 3, 13% for climate zone 1 and 7% for climate zone 4. The breakdown of the investment gap for the climate zones is nearly identical for most individual EETs. For building types, nearly the entire investment gap for ACs refers to residential buildings whereas all investments for ventilation relate to commercial/public buildings. For all other EETs, residential buildings have a share of about three-quarters of the investment gap.

[8] The U-value indicates the thermal transmittance, that is the rate of transfer of heat through a structure (which can be a single material or a composite), divided by the difference in temperature across that structure. The units of measurement are W/m²K.

Figure 14: Breakdown of the total current and additional investment gap by building type and climate zone



HIGHLIGHT

Nearly 60% of the total investment gap exists in the residential buildings that are located in climate zones 2 and 3.

ACTION AREAS

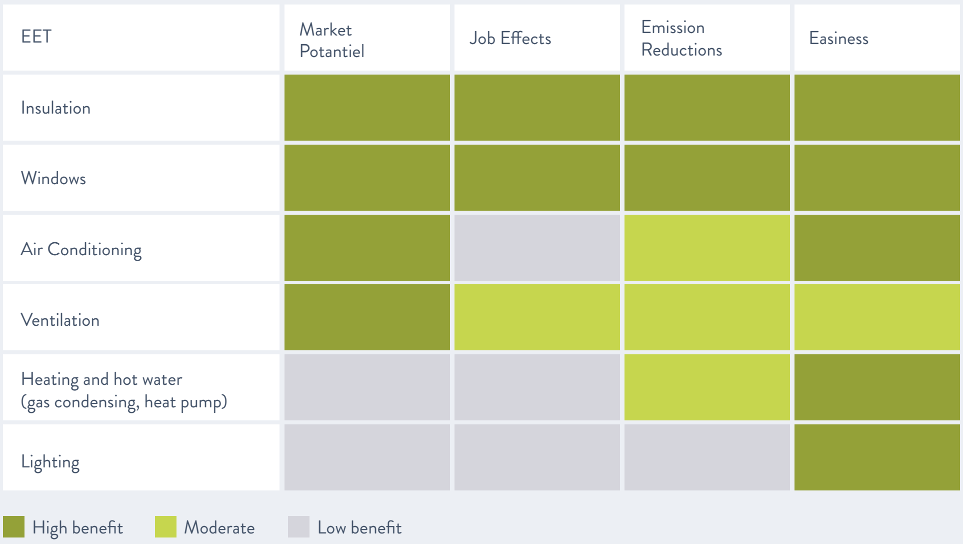
Climate zones: The total energy demand of the different climate zones can differ by up to 30%, mainly related to the need for heating and cooling. While the difference does not seem too high, this has large implications on the choice of materials and technologies and their costs when meeting energy efficiency requirements. Hence technology availability in Turkey needs to be sufficiently diverse to encompass these differences. **In addition, the existing U-values for each climate zone should be updated to reflect the local conditions, in particular for windows where a single value represents the entire country. This requires the estimation of the cost-optimum U-values that will be needed for Turkey to fulfil its energy and climate goals.** Much of the demand for EETs will be in places with a large share of the population, but implementing energy efficiency in these parts of Turkey alone will not be sufficient. Buildings in all climate zones need to be covered. This highlights the need for accessing available technologies in close proximity in all zones.

Building types: The main investment potential lies in the residential buildings. The estimated payback periods for most EETs range between 2 and 6 years. However, the high upfront investment and the lack of awareness of the cost-effectiveness are the core challenges. **Ensuring the supply of financing will therefore particularly important to ensure EETs are affordable to ease the economic burdens on the consumers.** Several international financial institutions are already active in this regard, but loan schemes in Turkey for both commercial and residential buildings are scarce. These instruments will need to be expanded and supplemented with new and innovative forms of finance and incentive models and awareness programmes which also consider the economic, social and well-being (health or comfort) benefits of energy efficient buildings.

BOX 4 **Benefits of improving energy efficiency in buildings**

Improving energy efficiency reduces the energy bill of the consumer. But it has wider benefits for the economy and society than just that. As already mentioned in earlier sections, energy efficiency has a large **market potential** in Turkey that can scale up the current investments in EETs by 50% if the cost-effective BATs are implemented. This will drive creating new economic activity and potential areas of **new employment** in the short to long term. For the private sector, this has benefits beyond job creation such as being up-to-date regarding global energy technology developments and R&D and scaling up the company profiles to sustainable branding through corporate social responsibility. Manufacturers increasingly have to produce top performers in EE to be competitive and not to lose ground in the international (export) market. More efficient buildings mean less demand for energy that is typically generated by fossil fuels, thereby **reducing the release of emissions** of greenhouse gases and air pollutants. Finally, EETs come with different opportunities that enable the **easiness of their implementation** such as cost-effectiveness, social acceptance and support by available financial incentives. Each EET has been assessed considering these benefits in Figure 15.

Figure 15: Comparison of the benefits of the EETs



HIGHLIGHT

In Turkey, all EETs come with favourable ease of implementation and the majority of them have a large market potential in comparison to their current investments. The additional job effects and contribution to emission reductions come at varying levels depending on the technology type, its supply chain and contribution to the total energy savings in buildings.

Energy efficiency improvements will need to be enabled by new and innovative technologies and models for finance and business

Space heating and cooling have a significant share in terms of the current EET investments with a total of EUR 2.7 billion. Both together experience a gap of EUR 1.1 billion, while many technologies offer potential to close this gap, new solutions will need to address the changing energy demand profiles such as growing demand for cooling whilst simultaneously supplying heating. Enabling the development of financing, business and service models will be the key to accelerating the implementation of new and existing EETs.

KEY FINDINGS

For each EET, the analysis shows a detailed breakdown of the individual technologies that would contribute to improving the energy efficiency in buildings (Table 2). While some of the technologies like split AC systems or LEDs are already commonly used in Turkey, some of the technologies such chiller-based cooling systems and heat pumps are just emerging.

An interesting case is heat pumps where currently the market size is typically constrained to single family houses that either have no access to gas infrastructure or no affordable energy sources. Heat pumps are particularly important because they can be operated in a dual mode to provide both heating and cooling. They use electricity, much more efficient than any combustion system (the heat output from the condenser could be up to four times higher than the amount of electricity used in the compressor, thereby indicating a conversion efficiency of around 400%) and they do not release the emissions of any pollutants (other than what results from electricity generation, the source of which is crucial in deciding if the use of electricity is environmentally preferable) which is important in urban environments. **They should therefore be coupled with solar PV where possible to ensure fully renewable and energy efficient electricity, heating and cooling systems.**

Various types of heat pumps exist: ground source heat pumps (GSHPs), which extract heat from the ground (via horizontal or vertical probes); hydrothermal HPs, which draw heat from water (the water table, rivers or lakes; and air source HPs (ASHPs), whose heat source is air (outside, exhaust, or indoor air). Heat pumps can provide heating/cooling to both residential buildings (typically capacities below 35 kW) and the commercial/office building sectors (including technologies like VRF, chillers etc). Globally, the market is moving forward with annual growth rates of about 10.3% per year forecast until 2020. In Turkey, the 2019 forecasts of heating equipment estimate a marginal share despite the availability of favourable large ground sources for example. Against this forecast, only about 30,000 units were sold of which 80% exists in the Aegean region (a moderate climate region where heat pumps can also be used for cooling) and the remaining 10% in Black Sea and Central Anatolian regions TMMOB; TTMD (2016): [11]. High investment and installation costs, price difference between electricity and competing fuels, dependency on equipment imports and the lack of incentives to heat pumps have hindered the creation of a heat pump market. Various best practice examples exist from across the world about how heat pump markets can be created. For instance the case of the Switzerland, to phase out the use of oil, the federal energy office has designed a long-term heat pump promotion programme and partially funded an institution to lead this programme. In the case of Germany, one key to success is that German utilities are offering special heat pump electricity tariffs (18ct/kWh compared to 30 ct/kWh). Another is a private sector initiative in which **manufacturers have become active further down the value chain with German suppliers of heat pumps requiring that installers are accompanied by an in-house engineer on their first 6 installations.** For the supplier, this ensures the quality of the installation and helps their product achieve a reputation as a high performing heat pump. For the installer, the additional cost is balanced by the increased confidence the end-user has in the performance of the heat pump and better prospects for future sales. In the Danish Energy Agency's Long Term Promotional Strategy, a wide range of promotional campaigns are being undertaken.

HIGHLIGHT

As part of a long-term strategy to increase total heat pump installations from 25,000 in 2011 to 200,000 in 2020, the Danish Government through the Danish Energy Agency is undertaking a wide-ranging promotional campaign. The overall programme comprises many elements including:

- Subsidies
- Heat pump trials
- A heat pump promotion and information dissemination campaign focussed on active marketing, awareness raising and an education initiative for installers

Table 2: Market shares of the technical investments by technology type (data provided by IZODER)

EET	Breakdown
Insulation	Façade: EPS (80%), XPS (13%), Mineral wool (7%) Roof: EPS (5%), XPS (20%), Mineral wool (5%), Glass wool (70%) Ground plate/ underground basement wall: EPS (5%), XPS (85%), Mineral wool (10%)
Heating	Gas condensing (97%), Heat pumps (3%)
Air Conditioning	Split (88-99%), VRF (2%), Fancoil with chiller (8%), AHU with chiller (2%)
Ventilation	Central ventilation with HR (2-8%), decentral room ventilation mechanical (2-8%), decentral room ventilation natural (92-96%)
Lighting	LEDs (70%), CFLs (30%)

To support the financing of energy efficiency implementation in Turkey, international financing institutions have been assisting the government through loans and technical assistance. Notably, the Clean Technology Fund (CTF), administered by the World Bank, the EBRD, and the International Finance Corporation (IFC) have been active in the country. The CTF alone has furnished Turkey with loans in the amount of USD 250 million, as well as soft loans and technical assistance. Since 2009, the EBRD has granted loans of USD 285 million and IFC of USD 255 million—all through Turkish financial institutions—which ultimately channelled the funds to finance renewable energy and energy efficiency projects. As an outcome of CTF-financed projects, an estimated 87 Mt CO_2 emissions reduction was achieved.

There are also programmes developed by EBRD, supported by Climate Investment Funds and the EU, called TuREEFF and TuRSEFF. TuRSEFF and TuREEFF are two foundations that support private sector and residential energy efficiency projects, respectively. A credit line was developed by EBRD for SME-sized industrial companies and commercial enterprises that wish to invest in energy efficiency or renewable energy projects since 2010. The loans are distributed through commercial partner banks in Turkey, including AKBANK, Deniz Bank, Garanti, Vakif Bank, and Turkey Is Bankasi. The total amount of the finance is USD 270 million. However, loan schemes in Turkey for both commercial and residential buildings are scarce and the successes of existing financing schemes have not been monitored, which can be improved to show the road to future successes of financial support schemes.

With the implementation of the Energy Efficiency Law (EEL) in 2007, ESCO activity in Turkey restarted. The EEL states that ESCOs need to be authorised by the state and are required to operate under state regulations. In May 2011, the first authorisations (licenses) for ESCOs were officially delivered.

As of September 2017, there are 43 ESCOs operating in Turkey, 37 of which are authorised for the building sector, six for industry, and 9 for both sectors. Around 70% of the ESCOs are in Istanbul, while the others are distributed in eight other cities. ESCOs in Turkey are typically privately-owned enterprises with certified experts mostly with an engineering background. In Turkey, ESCOs are facilitated by the General Directorate for Renewable Energy and the MENR. All ESCOs are obliged to receive and renew their authorisation documents and certificates through GDRE (2017).

Turkish ESCOs mainly provide services such as energy certification of buildings, energy audits, energy management, and monitoring. A few of these ESCOs are also eligible to organise educational workshops regarding energy efficiency. Clients from office buildings, hotels, shopping malls, and factories can get energy consulting services as well as energy performance certificates from ESCOs in Turkey.

Energy performance contracting, which is one of the main activities performed traditionally by ESCOs, is not yet fully adopted in Turkey. ESCO customers are mostly from the commercial sector and industry, as buildings in these sectors usually have higher energy intensities. The reason for these sectors to seek ESCO services differs. Companies can benefit from energy audits to see how much energy they can save by implementing EETs, or they get help from an ESCO for their application for incentives from the government. GDRE provides a contract that is, in principal, similar to energy performance contracting and ESCOs can be supportive when a company applies for this incentive.

BOX 5 **The role of emerging technologies: building automation and control systems**

With the growing use of energy efficiency and renewable energy technologies in the buildings, the way energy is being consumed is changing. House owners are also becoming producers and distributers of energy through solar PV or battery storage technologies (prosumers), taking on new responsibilities. Buildings will no longer remain isolated from the rest of the energy system and will increasingly relate to sectors like transport for providing charging services to electric vehicles and selling electricity to the grid – to neighbouring buildings and other sectors like industry alike. These changes call for the effective management of energy flows inside buildings through various analytic functions for data collection, measurements, forecasting, demand response, providing climate comfort to owners or reporting to provide the basis for robust energy decisions and actions. Emerging automation and control systems provide these services to buildings which include products, software and services for automatic controls, monitoring and optimization.

There are in principle five essential components for building automation systems Control solutions (2015): [12]:

- Sensors: devices to measure temperature, humidity, daylight etc.
- Controllers: that decide how the system will respond based on the data collected.
  Output devices: Based on controller decision these provide a command.
- Communications protocols: This defines the main language used to communicate between the different components of the automation system.
- User interfaces: Communicates and reports the data, information etc. to the building owners.

If one views only from the perspective of energy efficiency, buildings which do not have such system consume up 25% more energy than those which employ control system for heating, cooling and lighting U:S Department of Energy (2013): [13]. Understanding their role and implementing these systems will be key for the Turkish building sector as well with the improving energy efficiency and increasing use of renewables (including rooftop systems) in buildings. In developing a strategy for building automation for Turkey, the following steps can be followed: characterisation of buildings, understanding the architectures needed for communication, identifying the suitable automation systems and their requirements and what this implies in terms of economics. Various success stories exist about how automation and control systems are integrated in buildings. One recent example from Germany shows how a shopping centre optimised its heating and cooling demand across a total area of 34,000 square meters based on automation European Building Automation controls association (2018): [14], European Building Automation controls association (2015): [15]. Market studies predict a compound annual growth rate (CAGR) of 10% till 2022.

HIGHLIGHT

Success factors for ESCo development and performance contracting:

a. Legal framework must be in place
b. Critical mass in terms of demand needs to exist and capacity needs to be available
c. Investment cost to running cost ratio needs to be attractive

Turkey has been transposing and implementing EU legislation related to energy efficiency and environmental protection already. The EEL transposes part of the Energy Service Directive (EN 2006/32) and is the regulation that defines energy services and ESCOs; it sets the requirements for training energy managers and auditors and the procedure for authorising ESCOs. EEL also describes provisions for financing energy services through state incentives.

The General Directorate of Renewable Energy is responsible for the issuance of authorisations for ESCOs. Precondition for an ESCO to receive the authorisation is to have a quality management system in place (according to TS EN ISO 9001) and to have the facilities, devices, and equipment authorised by the Turkish Accreditation Agency. There are six different certificates for the industry (sub-sectors) and two for the building sector (residential and commercial).

In the past seven years, the Turkish ESCO market fell short of its opportunities. 34 actors for the building sector with its 3 billion m^2 stock area appears underrepresented compared to e.g. Germany, where 500 ESCOs provide services for a stock of 5.6 billion m^2. One potential strategy could be to attract internationally active, established ESCos (through incentives and easy registration processes) to boost the market with reliable and proven expertise and possibly foreign up-front investments (if the pay-back period is attractive enough).

ACTION AREAS

New technologies: Closing the investment gap and achieving the energy efficiency potential quantified will require the development and deployment of a mix of technologies. Especially new technologies require several years before they can be commercialised and additional years before a market can be created. The stakeholders of the building sector need to be prepared. Sufficient manufacturing capacity needs to be available to supply and create access to equipment; policies and finance instruments need to be in place to create a market for these new technologies.

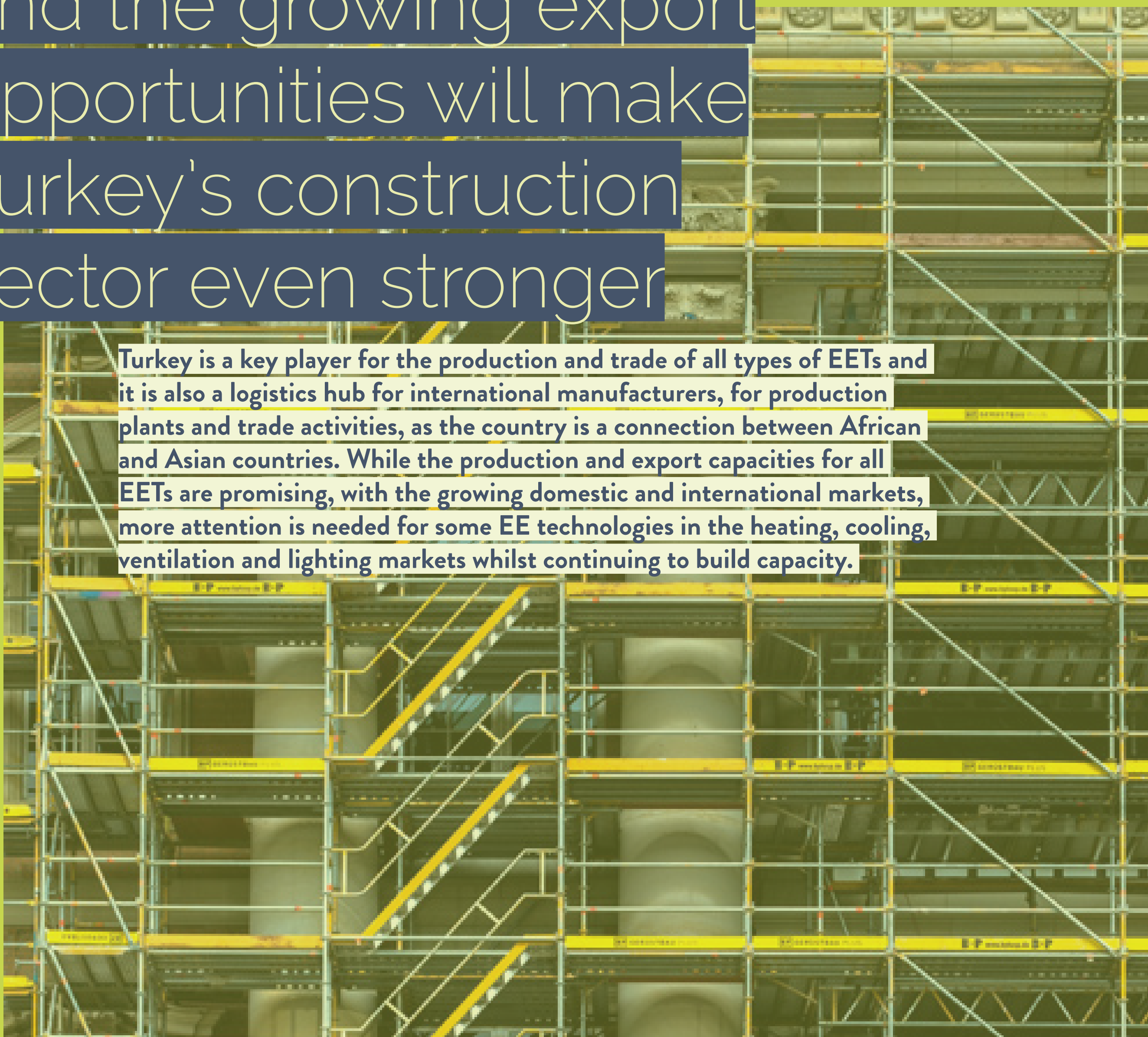
Financing: Financing instruments needs to be rapidly expanded to close the EUR 3.2 billion investment gap. Without support and leaving the responsibility to the market to push sales of energy efficient equipment would only create limited deployment. New models of financing such as tax reduction or green certification schemes as applied in other countries can be introduced [ATEE – Association Technique Energie Environnement (2017): Snapshot of Energy Efficiency Obligations schemes in Europe: 2017 update. Fourth European Workshop of the White Certificates Club. Available online at http://atee.fr/sites/default/files/part_6-_2017_snapshot_of_eeos_in_europe.pdf]. For instance, in the Netherlands, to produce larger volumes of EETs, a critical demand of EETs is being created to approach suppliers (energiesprong). Italy, among several other EU countries, uses tradable white certificates to achieve a certain target of energy savings. The energy efficiency fund in Tunisia is financed by penalties from inefficient EETs imported from other countries. These can be complemented with grants or low-interest loans provided by the Turkish Development Bank in cooperation with other similar actors for renovating the existing building stock. Creating the availability of a portfolio of finance models can address the varying needs of different customers, building types and technologies. In particular for renovation, it will be important to provide incentives that consider component or system approaches which enable technology integrability. In order to better coordinate the financing with technologies, the cost-effectiveness of EETs should be assessed in detail.

Services: In order to strengthen the effectiveness of the ESCO market a number of measures have been suggested to the MENR, including: (i) develop an accepted set of documents: contracts, investment-grade audits, M&V protocols, etc. that can be recognized as legitimate on the market, (ii) the MENR should support the implementation of energy performance contracting-based projects for demonstration and information dissemination purposes, (iii) favour the development of smaller and simpler projects that could use only a single technology to facilitate the adoption of the concept by potential ESCO clients, (iv) support the creation of an independent arbitration mechanism that could be used to facilitate the resolution of disputes in energy performance contracting projects. Through these measures, a strong ESCO market can enable large-scale solutions for non-residential buildings.

Policy and private sector initiative: For the success of innovative solutions and high-end in particular, it is crucial to ensure that "on paper" performance of NZEB and other buildings materializes in reality and also persists to have that high performance. This can most easily be achieved by using proven high-end technologies that do not drop in yield / efficiency or soon do not constitute the state-of-the-art anymore.

Filling in the energy efficiency investment gap and the growing export opportunities will make Turkey's construction sector even stronger

Turkey is a key player for the production and trade of all types of EETs and it is also a logistics hub for international manufacturers, for production plants and trade activities, as the country is a connection between African and Asian countries. While the production and export capacities for all EETs are promising, with the growing domestic and international markets, more attention is needed for some EE technologies in the heating, cooling, ventilation and lighting markets whilst continuing to build capacity.



KEY FINDINGS

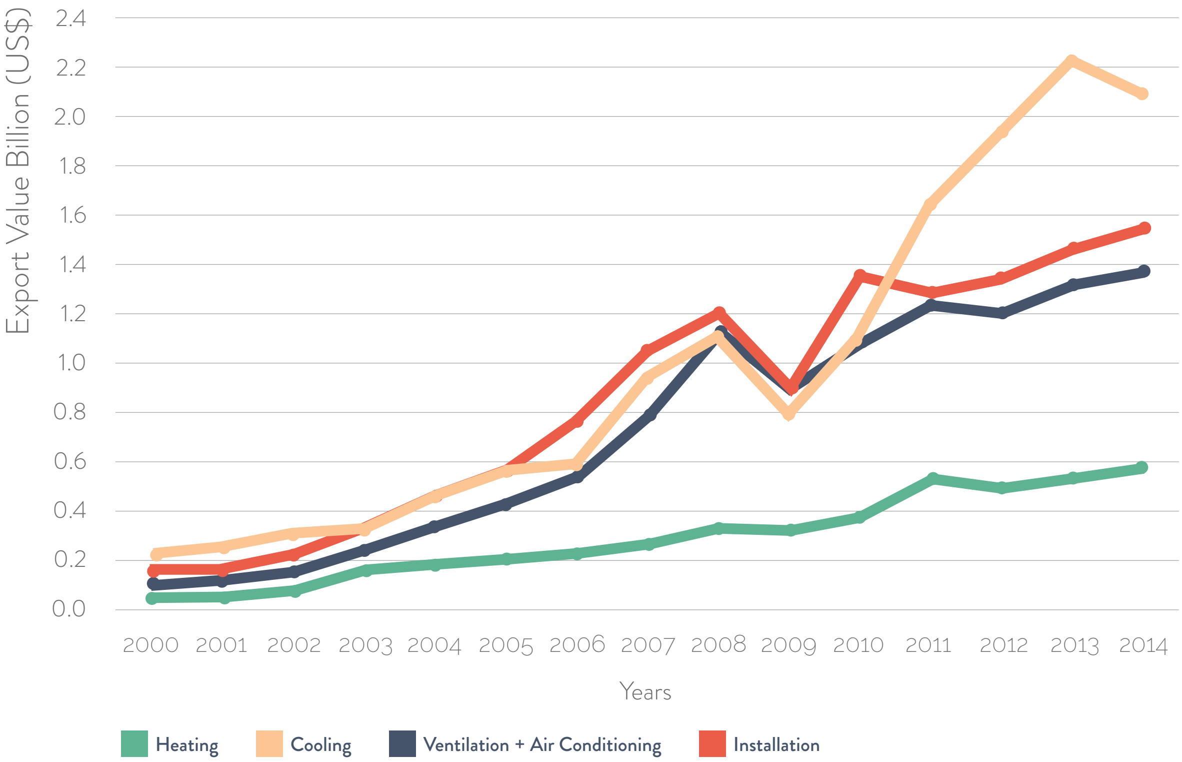
The potential investments can only be realised if the Turkish market can supply the EETs through either local manufacture or imports. **The qualitative market assessment shows that Turkey has a promising production capacity of all types of EETs** and all other types of construction materials. This is a very important outcome for a rapidly growing country where demand for EETs will certainly increase. **The large production capacity also allows for exports. Including the EETs, for all construction materials, Turkey's export volume has been ranging between USD 15 and USD 20 billion since 2011** despite the international and national economic turmoil KPMG (2018): [18]. However, in case of some technologies, **Turkey currently imports technologies which could be produced domestically, such as heat pumps, chillers, ventilation and partly lighting.** On average, the total import volume of construction materials was around half that of the the total exports [20].

Since 2011, the annual growth rate for insulation industry has been around 20% and the whole industry has grown by a factor of ten over the last 10 years (SFE and GIZ, 2014). Turkey is currently one of the biggest markets in Europe, with production capacities of more than 20 million m^3 for several types of insulation materials. The Turkish market is composed of a variety of national and international suppliers offering a wide range of thermal insulation products (EPS, XPS; stone and glass wool, etc.). It is expected that companies active in the Turkish market can easily provide for an increased demand of thermal insulation due to already oversized production facilities and quick response in newly-built facilities.

The glass industry is one of the major industries that contribute to the construction industry in Turkey. Nearly 98% of the raw materials needed to produce glass are available in Turkey; therefore, mostly local raw materials are used. **Considering the urban renewal project in Turkey, approximately 7 million residential buildings are still in need for renovation or reconstruction. Thus, in the upcoming 10 years, nearly 35 million windows are expected to be demanded by building sector.** The double-glazed window penetration rate has reached around 70% in existing buildings. Due to the Regulation on Energy Performance in buildings, all new buildings are using double-glazed windows. It is expected that the sector for both windows and frames will grow with the demand for new housing, especially through the National Energy Efficiency Action Plan that aims to give incentives, support, taxation advantages for the renovation activities using thermal insulation and high efficiency windows.

Turkey has become Europe's and Africa's production base in the field of HVAC, mainly related to boilers (2 million units) and AC split units (around 1 million). Some of the world's leading companies have selected Turkey as their production base. The production of boilers has been following an increasing trend since the 2000s and around 1 million boilers were produced in 2014. The sector is also a large exporter of various product groups and represents about 1% of total global HVAC exports (see Figure 16). From April 2018, the import and production of non-condensing boiler will be prohibited. These measures will strengthen the development of energy efficient heating supply, in particular as the gas infrastructure of Turkey is being extended and solidified.

Figure 16: 2000-2014 HVAC Sector Product Groups Export Values
Source: TOBB, 2015



HIGHLIGHT

In 2010, the HVAC sector constituted 3.4% of Turkey's industrial products exports and the sector's export value has been growing rapidly for more than a decade.

In the last 10 years, the central and individual air conditioning industry has grown by a factor of 6 or 7 in Turkey and has reached 13% of the total European market. Currently Germany, Italy and France are the major manufacturers of central and commercial air conditioning units, while Turkey is the largest producer of individual (split) air conditioning in Europe. The market for chillers in Turkey mainly consists of international companies. Besides being an exporter, Turkey also imports AC systems in large volumes, making it a vibrant sub-market of HVAC systems.

The lighting industry has shown substantial growth in the past 15 years in terms of production capacity, product quality, product diversity and range. To keep up with the increasing demand and changing customer needs and tastes, especially the large-scale companies perform research and innovation activities. Production technologies have been improved continuously as well. Turkey's LED market has seen rapid development after the country implemented intellectual property licensing on LED products, and adopted LED lights as solution to reduce building energy consumption. With government promotion, the adoption of other LED products has grown significantly. The Turkish government has also invested in retrofitting public lighting. **Several market studies estimate that the LED market in Turkey will experience an 15.6% compound annual growth from 2016 to 2022.** Currently, Turkey ranks 22nd in total global lighting product exports.

ACTION AREAS

Potential in the global markets: Global incremental investments in buildings-related EETs have reached EUR 117 billion, representing one-third of the total global spending of EUR 352 billion (IEA, 2017 [IEA-International Energy Agency (2017a)] In the coming years, the market volume for EETs will increase with growing population, prosperity and the urgent need to cut down on energy demand. **Market studies project that the construction sector, which also includes EETs, will gain a large share of the total global economy, particularly in developing countries** KPMG (2018): [18]. **This creates important opportunities for Turkey to grow its export potential and given its geographical position allows to attract foreign investments to foster its production base that already has a strong corporate and finance capacity.**

Innovation: As a large producer of EETs, Turkey holds a big advantage to meet growing demand. This is particularly important since the country prioritises the use of locally produced technologies. While maintaining this capacity, it will also be important to ensure a balanced approach towards developing technologies that comply with global benchmarks and best available practices. **This requires strengthening research and development activities to the level in other developed countries through allocating more public and private sector spending, technology transfer and developing related strategies.**

There could be a focused financing scheme (and other policy efforts) with the aim of incentivising innovation, local production of energy efficient technologies as well as rewarding investors targeting energy efficiency measures (potentially including subsidies for CO_2 saving technologies).

Capacity building and skills: While production facilities and engineers were assessed to be providing high quality, the craftsmen in Turkey have potential for improvement. A huge barrier for higher penetration of EETs is the lack of training. In general, there is a rather low quality of implementation for various reasons including the high competition levels which lead to lower prices. The challenges are similar across the different EETs: training programmes are scarce and craftsmen lack the skills necessary to install adequate technology or implement high quality, innovative solutions. Implementing and improving (incentivised) qualification programmes, implementing (publicly) regulated education for craftsmen to plan and install EETs, improved inspections by independent inspectors and promoting the initiation of pilot projects to prove technical and economic feasibility would help to overcome these challenges.

BOX 6

The role of international cooperation for accelerating energy efficiency improvements in Turkey's building sector

The deployment of EETs at scale in the Turkish building sector can be accelerated through international cooperation as well as learning from such projects implemented internationally. Such cooperation comes in different facets for different stakeholders of the sector. There are various international policy and finance examples that can help the Turkish policy-makers design and ensure new incentives, regulations and targets are in place for Turkey to meet its energy and climate goals. Cooperation can enable to apply such best practice policy and financing examples to the case of Turkey. Some examples are discussed below:

- The Green Funds Scheme, the Dutch Agency Ministry of Housing, Spatial Planning and the Environment: This is a tax incentive scheme that makes investing in green projects easier and more beneficial for the investors. In short, individuals who invest in a green fund or save money with financial institutions practicing green banking receive a lower rate than the market interest rate; investors are then compensated by a tax incentive. In return, the banks charge green projects a lower interest rate. In Turkey, several banks provide credits with the support of international funding schemes through TuREEFF and TuRSEFF, as mentioned previously. However, there is not yet an established tax reduction scheme or green certification scheme as applied in the Netherlands example. However, this example could be applicable in Turkey with cooperation and agreements between the banks and the government.

- KfW Germany: The bank provides loans and financial support for financial support for energy efficient building construction and refurbishment (residential and commercial buildings). Financial support by the KfW can be requested by companies, public institutions, and individuals. KfW incentives for energy efficient building and renovation are strongly embedded in the German real estate market, with more than 3.9 million dwellings being supported since 2006. The applicability in Turkey can be achieved through TKB (Development Bank of Turkey) or their cooperation with similar actors. TuREEFF and TuRSEFF offer similar benefits for new buildings and refurbishment projects with the cooperation of several banks in Turkey and the EBRD.

- Cost optimality approach: This approach for the minimum energy performance of buildings is considered to be a best practice to tighten regulation and pave the way to near-zero energy buildings in the future. Energy Performance of Buildings Directive (EPBD) of the EU states that the Member States (MSs) shall take the necessary measures to ensure that minimum energy performance requirements for buildings or building units are set with a view to achieving cost-optimal levels. The EPBD requires that MSs calculate cost-optimal levels of minimum energy performance requirements for buildings and building elements using a comparative methodology framework to be established by the Commission. Turkey could realise these calculations for different building types and for different climate zones, thus preparing a way to adapt the threshold to cost-optimal values.

In addition to the transfer of best practice policies to Turkey, cooperation can play a key role in strengthening Turkey's energy and climate plans based on country experiences that have achieved streamlined frameworks for planning, target setting and technology deployment. International cooperation will be vital to advance the development and deployment of EETs. Cooperation can create large impact by strengthening the Turkish construction sector's technology, R&D, transfer and innovation base so as to ensure that the country expands its production capacity with the most efficient and cost-effective technologies. In this regard, the **continuation and expansion of cooperation between Turkish research organisations and industry with their foreign peers through European research grants or government and specifically private-public partnerships will also be key.**

Utilising these potentials requires creating an enabling investment environment with new policies as well as private sector buy-in

Realising the potential of the investment gap will only be possible by creating an enabling investment environment in the energy efficiency sector. The priority areas of ensuring technology availability, enabling cost-competitiveness and creating the right know-how all need to be supported with the development of new regulations, targets and incentives and by increasing awareness and social acceptance of EETs.

KEY FINDINGS

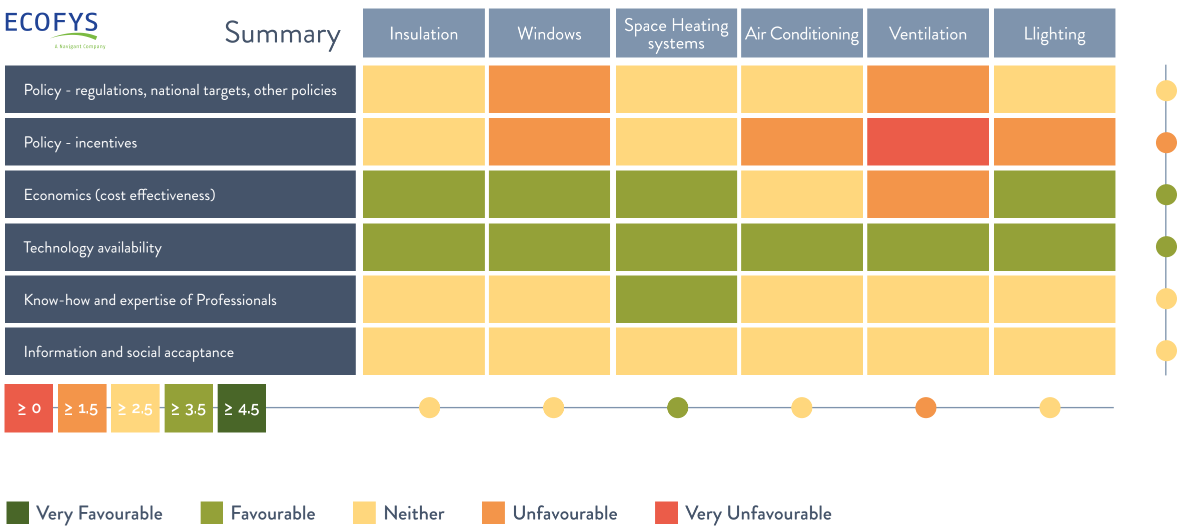
The market assessment investigated the effect of six criteria on the market environment for the EETs as shown in Figure 17. This section focuses on the policy aspects (excluding the financial incentives that have already been discussed in the previous sections) and the social angles of improving energy efficiency in buildings.

The assessment of the different criteria shows that, compared to the other criteria, policy regulation and incentives are rated lowest. It can be concluded that most of the main challenges are found within these two criteria and that experts see room for improvement particularly from the private sector's perspective. The two criteria rated as rather neutral are information and social preference.

An important criterion to assess the market environment is the policy framework, i.e. the relevant national regulations. The *Policy regulation* criterion was assessed ranging from neutral for some EETs to negative for others (windows and ventilation) by the local experts. In comparison with other criteria that affect the market environment, *policy regulation* is seen as the most challenging aspect that presents a barrier to a wider implementation of EETs.

Another main challenge is the lack of information provided to the end consumer and, consequently, their lack of awareness of efficient solutions, including the cost-effectiveness of these solutions. Unlike the policy regulation criterion, which lies in the responsibility of the public sector, the lack of adequate information provided is an issue that can and should be addressed by the private sector first and foremost with the support of the government as appropriate. Another issue is that the end consumer does not understand the labelling scheme (e.g., product label A+), which should be easy enough to remedy with adequate information campaigns of which hundreds have successfully taken place around the world. Also, it seems that the end user tends to not fully understand the lifetime period approach; rather than looking at the long-term benefits, they compare the initial investment without considering the energy cost savings over a certain period or the lifetime of the system.

Figure 17: Market assessment considering qualitative data



HIGHLIGHT

Technology availability and cost-effectiveness offer opportunities for most EETs which can be complemented with new policies and by creating awareness to increase social acceptance. The most positively assessed EET is space heating systems, while for ventilation in particular, there remains work to do.

ACTION AREAS

Policies: Regarding the national plans, no clear no transparent objectives are being perceived by the interviewed experts – neither in the form of a mandatory plan nor an overall strategy. The updated NEEAP has been in place since 1 January 2018 and defines clear measures until 2023. However, there is no monitoring process in place. **Regarding the energy performance of existing buildings, there is a lack of inspection, quality control, supervision and audits.** In addition to the lack of control of the energy performance of a building, low priority is given to controlling the construction site and correct product implementation. Again, the ultimate responsibility lies with the private sector to guarantee the quality that guarantees satisfied customers, as much as it does with the public sector in terms of imposing sanctions on below-par quality products and constructions. During renovation there is a lack of supervision and audits by the responsible local administration. Regarding the producers, products and qualification of workers, there is a lack of quality control by both companies and administrators. The inspectors are typically paid by the project developer, which presents a potential conflict of interest that can be avoided by having independent inspectors. Finally, end consumers cannot compare efficiency of products. Similarly, improved enforcement of compliance with existing legally binding standards like TS 825 is urgently needed since experts' estimates indicate that a comparatively large ratio of buildings (over 10-20%) which should fall under compliance obligations with TS825 does not in fact adhere to the standard.

In order to overcome these obstacles, a number of actions are needed by the policy makers as well as private sector stakeholders. The government could support the process by starting public/stakeholder consultations. An institution or unit should be established and assigned to refine, implement and monitor the progress of the national energy efficiency targets. In addition, quality control and monitoring mechanisms should be established across several areas in the supply chain. A process to avoid conflicts of interest can be established that integrates an intermediate neutral body the main role of which (e.g. insurance system) is to avoid any direct payment flow. Labelling or certification schemes showing main performance indicators related to energy efficiency such as windows light transmission, G-values and U-values should be introduced.

Information and social acceptance: The general public's understanding and awareness of efficient solutions and their favourable economics, as well as of the labelling system need to be improved. In general, information campaigns should focus on raising awareness of efficient solutions and should be conceived in a tailor-made manner in order to reach the different target groups. Information campaigns should put a focus on explaining the lifetime approach. Information campaigns should include information on and explanations of the labelling scheme (e.g. product label A+ etc.).

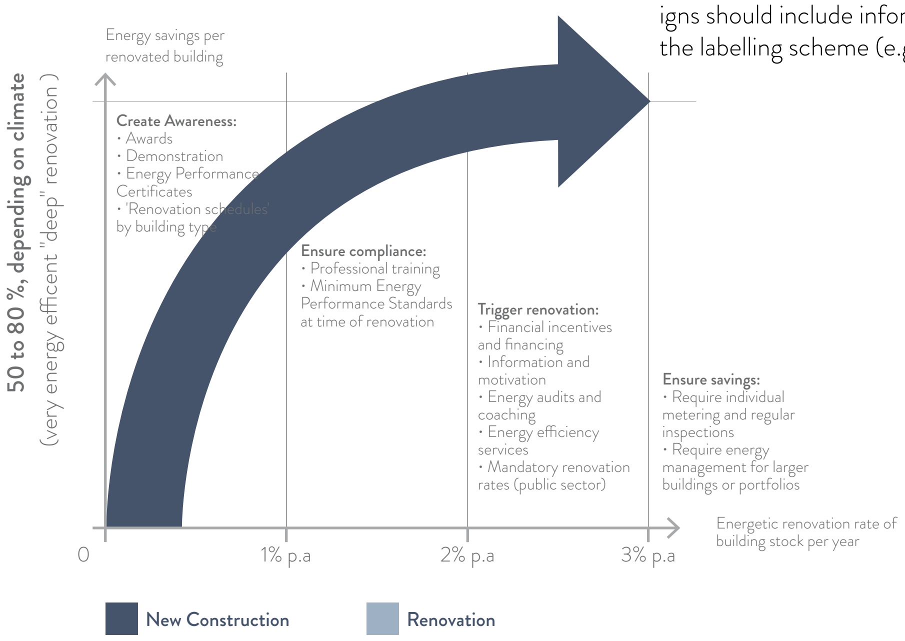
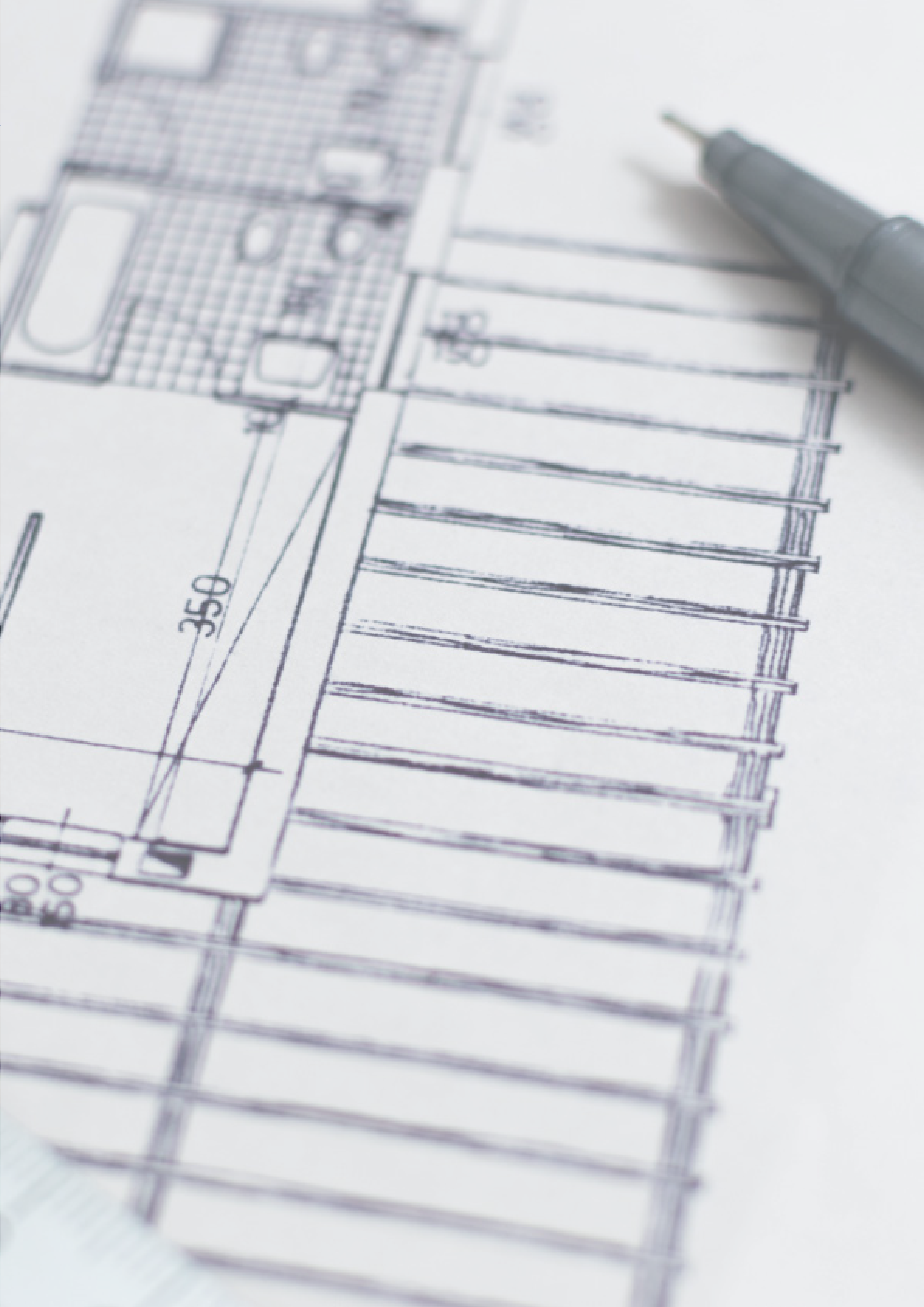


Figure 18: The interactions of policy instruments for energy efficiency in building renovation and operation
Source: Wuppertal Institute (2012)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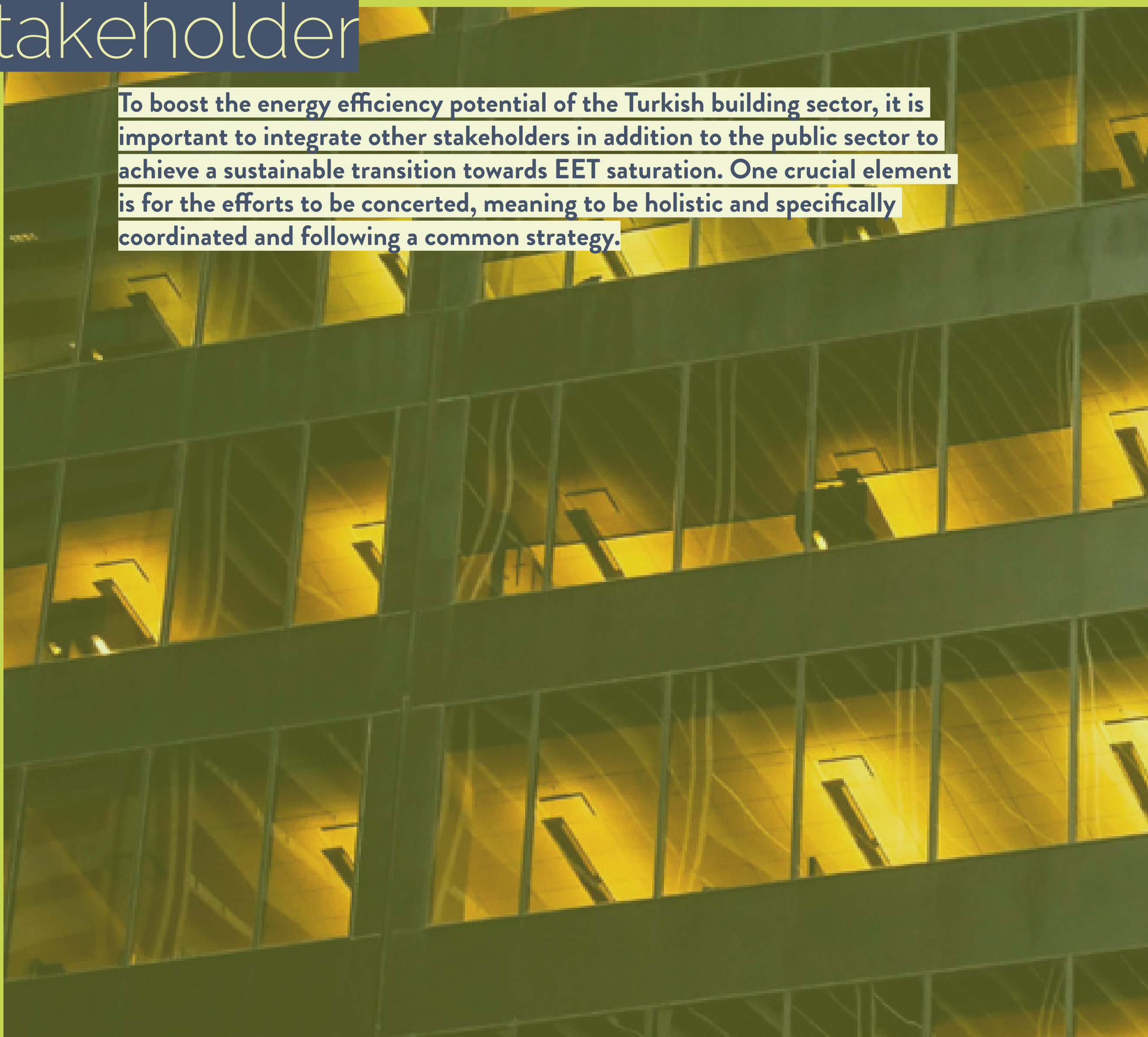
Action needs by stakeholder

To boost the energy efficiency potential of the Turkish building sector, it is important to integrate other stakeholders in addition to the public sector to achieve a sustainable transition towards EET saturation. One crucial element is for the efforts to be concerted, meaning to be holistic and specifically coordinated and following a common strategy.

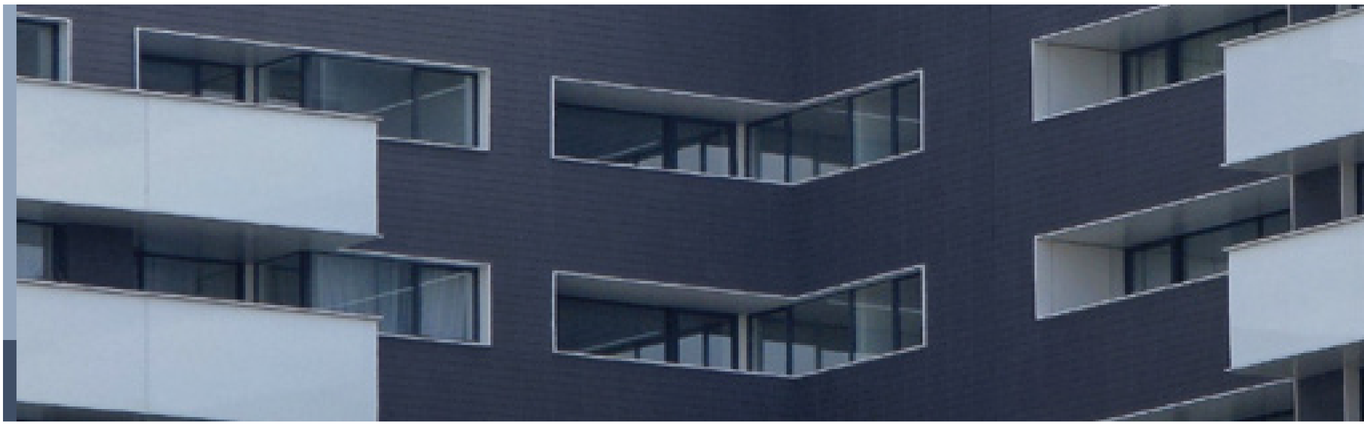


	Finance	Policy and technology	Awareness, social acceptance and policy integration	Capacity building, know-how and expertise
Policy-makers	Define scope for financing Research on cost-effectiveness Define financing schemes Implementation Monitoring and control	Vision Strategy Instruments Enforcement Monitoring and control systems	Streamline campaigns Focus on the right messaging	Education and training Investigate international best practices
Private sector	Technical feasibility of innovative technologies and system approaches Economic feasibility analyses to prove the "real" cost efficiency Demonstrate real thermal comfort gains of user	Install quality and control mechanisms Establish inspections & audits Control worker qualification & product quality Prioritise best available technologies	Support the formulation of streamlined campaigns · For the private sector · For craftsmen · For end-users	Support the formulation of training curricula, integrate real construction site experience. Support the transfer and adaptation of international best practice to the Turkish context. Investigate international best practices
EET manufacturers	Services: Consider the development of ESCOs to supply large-scale solutions and invent new sales streams (spin offs). Research on cost effectiveness. Involve banks, financial institutions and other industry players to incentivise EE technologies.	Support the promotion of new vision and strategies and their communication. Produce highly efficient technologies and supply top performers (improve minimum energy performance requirements through innovations). Create simple but meaningful labelling for EETs.	Support the formulation of streamlined campaigns (relevant for raising awareness). · For producers · For craftsmen · For end-user	Support regulated educational and training programme for craftsmen.
R&D institutions	Empiric research to understand financial barriers for investments in EETs Desktop research: perform cost optimality studies	Monitor pilot projects. Invent new and innovate solutions / continue to improve EETs (ideally in international collaborations)	Support the verification and update of the regulation (MEPS) on a regular basis Use cost optimality approach. Verify minimum requirements.	Support educational and training programme for all relevant involved stakeholders in the energy efficiency value chain in the building sector. Investigate international best practices.

HIGHLIGHT

Strategy example
Background: The German government has established a regular roundtable on sustainable construction (German: "Nachhaltiges Bauen") already in 2001, which aims at supporting the former Federal Ministry of Transport, Construction and City Planning on regulations with respect to sustainable construction.
Concept: The roundtable is made up of representatives from associations of the construction sector, the industry as well as from relevant administrative bodies for construction and the field of science. The overarching goal is to feed outcomes of the roundtables back into the development of sustainability strategies, guidelines for federal construction measures (e.g. finalisation of the guideline for sustainable construction) and into the principles and guidance for the acknowledgment of assessment systems for sustainable construction by the government. To do this, the participants can express their expectations and goals related to sustainable construction at the roundtable. In case of more complex topics working groups are implemented and their results are presented in the roundtable sessions.

Conclusions and next steps



This study has identified an investment gap of EUR 3.2 billion in Turkey's building sector if it would aim to implement the cost-effective potential of BATs for energy efficiency. This is on top of the current investment levels of EUR 6.2 billion. Based on these findings, the study highlights six priority areas and key messages:

- Energy efficiency technologies has a huge market potential in Turkey

- Renovation needs to continue to complement the opportunities from new energy efficient buildings

- Opportunities exist across all regions and building types

- Energy efficiency improvements will need to be enabled by new, innovative technologies and services

- Filling in the energy efficiency investment gap and the growing export opportunities will make Turkey's construction sector even stronger

- Utilising these potentials requires creating an enabling investment environment with new policies as well as private sector buy-in

Addressing these priority areas and developing the necessary technology, policy and finance conditions will be a continuous process. **In this process, it will be key to monitor the progress made in energy efficiency technologies in order to evaluate the effectiveness of new policies and update them when necessary.** Moreover, based on this study's findings, and in line with the needs and strategic direction of the policy makers for building-energy efficiency in Turkey, a number of next steps exist to complement the priority action areas:

- **Developing a technology and investment tracking framework to monitor progress** by considering criteria such as technology investments and sales, annual improvements in energy efficiency (also including emissions reductions), renovation rates, number of near/net zero energy and green buildings in stock, share of EETs and renewable energy technologies in buildings, developments in exports/imports, research and development investments, employment in the construction, energy efficiency and building sectors

- **Carrying out more specific potential and market studies for key and emerging EETs** that will be needed to close the investment gap

- **Expanding the analysis** to understand the market potential of the Turkish construction sector for EETs within the **global situation**

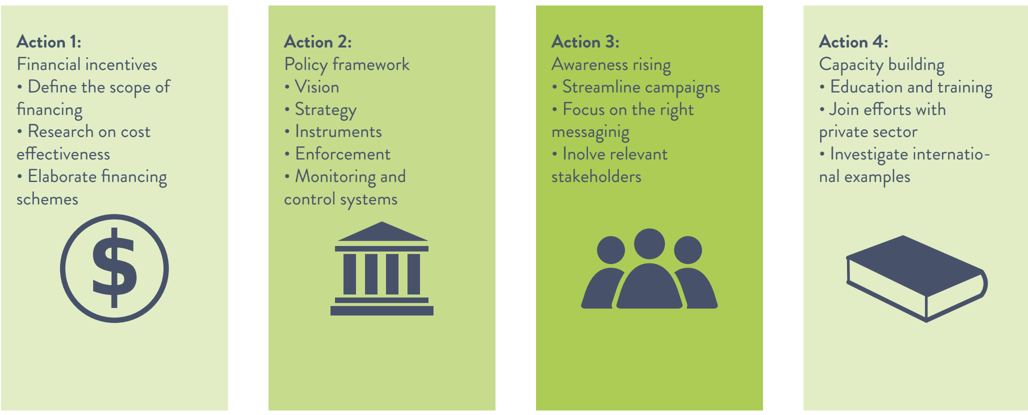
- **Developing an investor's guide for energy efficiency technology investments** that can also match the building investor with the technology industry with the aim of sourcing the BAT EETs at the most affordable prices

- **Developing a framework and roadmap for international cooperation tailored to the needs of each stakeholder** such as industry, academia and policy makers

Table 3: Key messages to private sector stakeholder

Category	Manufacturing sector	Implementing sector
Policy	- Support the promotion of a new vision and strategy for the Turkish building sector - Support the formulation of regulative framework	
Finance	- Promote ESCOs -Research cost effectiveness - Inolve financial institutions and others to incentivise EE technologies	- Economic feasibility, to prove the “real” cost efficiency - Analyse further co-benefits like thermal comfort gains for user
Technology	- Produce high efficient technologies and supply top performance - Create simple&meaningful labelling for EETs.	- Technical feasibilty of innovative technologies and system approaches
Awareness	- Support the formulation of streamlined campaigns (relevant for raising awareness)	
Trainings	Support regulated educational and training program for craftsmen. - Support the formulation of training curricula, integrate real construction site experience. - Support the transfer and adaption of international best practice to the Turkish context.	

Figure 19: Key messages to policy makers



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