

An overview of sustainability policies and strategies on buildings in Turkey

Keskin, Fatma Seyma; Martinez-Vazquez, Pedro; Baniotopoulos, Charalampos

DOI:

[10.1080/14786451.2020.1768094](https://doi.org/10.1080/14786451.2020.1768094)

License:

Other (please specify with Rights Statement)

Document Version

Peer reviewed version

Citation for published version (Harvard):

Keskin, FS, Martinez-Vazquez, P & Baniotopoulos, C 2020, 'An overview of sustainability policies and strategies on buildings in Turkey', *International Journal of Sustainable Energy*, vol. 39, no. 9, pp. 1.
<https://doi.org/10.1080/14786451.2020.1768094>

[Link to publication on Research at Birmingham portal](#)

Publisher Rights Statement:

This is an Accepted Manuscript of an article published by Taylor & Francis in *International Journal of Sustainable Energy* on 20/05/2020, available online: <https://www.tandfonline.com/doi/full/10.1080/14786451.2020.1768094>

General rights

Unless a licence is specified above, all rights (including copyright and moral rights) in this document are retained by the authors and/or the copyright holders. The express permission of the copyright holder must be obtained for any use of this material other than for purposes permitted by law.

- Users may freely distribute the URL that is used to identify this publication.
- Users may download and/or print one copy of the publication from the University of Birmingham research portal for the purpose of private study or non-commercial research.
- User may use extracts from the document in line with the concept of 'fair dealing' under the Copyright, Designs and Patents Act 1988 (?)
- Users may not further distribute the material nor use it for the purposes of commercial gain.

Where a licence is displayed above, please note the terms and conditions of the licence govern your use of this document.

When citing, please reference the published version.

Take down policy

While the University of Birmingham exercises care and attention in making items available there are rare occasions when an item has been uploaded in error or has been deemed to be commercially or otherwise sensitive.

If you believe that this is the case for this document, please contact UBIRA@lists.bham.ac.uk providing details and we will remove access to the work immediately and investigate.



An overview of sustainability policies and strategies on buildings in Turkey

Journal:	<i>International Journal of Sustainable Energy</i>
Manuscript ID	gSOL-2020-0068.R1
Manuscript Type:	Original paper
Date Submitted by the Author:	02-May-2020
Complete List of Authors:	Keskin, Fatma Seyma; University of Birmingham, Martinez-Vazquez , Pedro; University of Birmingham School of Civil Engineering Baniotopoulos, Charalampos; University of Birmingham School of Civil Engineering
Keywords:	sustainable buildings, energy policies, Turkey, sustainable building policies, sustainable building strategies

SCHOLARONE™
Manuscripts

An overview of sustainability policies and strategies on buildings in Turkey

Fatma Seyma Keskin^{a*}, Pedro Martinez-Vazquez^a and Charalampos Baniotopoulos^a

^aDepartment of Civil Engineering, University of Birmingham, Birmingham, United Kingdom

*F.S.Keskin.1@bham.ac.uk, Tel: +4401214145085, Fax: +4401214143675 Orcid iD: 0000-0001-6882-3757

Keywords: sustainable buildings; sustainable building policies; sustainable building strategies; energy policies; Turkey

An overview of sustainability policies and strategies on buildings in Turkey

Fatma Seyma Keskin^{a*}, Pedro Martinez-Vazquez^{a,b} and Charalampos Baniotopoulos^{a,c}

^aDepartment of Civil Engineering, University of Birmingham, Birmingham, United Kingdom

*F.S.Keskin.1@bham.ac.uk, Orcid iD: 0000-0001-6882-3757,

^bP.Vazquez@bham.ac.uk, ^cC.Baniotopoulos@bham.ac.uk

Policies on sustainability of buildings have been progressively gaining importance throughout the world. Turkey is a part of such international movements and is now striving to address its energy performance, by reducing emissions of contaminants derived from energy consumption of buildings, and through the protection of the environment. The present paper links these two elements of development, through the revision of building policies and strategies that take place in Turkey while contextualising worldwide sustainability targets and key trends. This is demonstrated with the aim of identifying the environment and energy goals that underpin the construction sector. As a result, specific actions, regarding policy and implementation arise. These could enable the reduction of energy usage and emission of pollutants, partially through the increase of renewable energy use and the promotion of building certification, as dictated by existing legislation.

Keywords: sustainable buildings; sustainable building policies; sustainable building strategies; energy policies; Turkey

Introduction

The building sector has become the largest sector responsible for world energy consumption and carbon dioxide (CO₂) emissions (IEA, 2019b). This is due to the inability of the building sector to keep up with other sectors in developing and enforcing sustainable methods, procedures and technologies. In developed countries, buildings

1
2
3 have become a priority for achieving energy efficiency due to their longevity, energy
4 consumption levels, and the number of technological products and services developed
5 under older environmental frameworks. Therefore, sustainable construction has become
6 a primary focus across scientific communities who try to address sustainable
7 development goals. In parallel, building policy-makers produce legislation towards
8 increasing energy efficiency whilst also minimising environmental impacts. Recent
9 evidence shows that the total energy use generated across construction industries
10 reached 36% of global final energy use in 2018. This includes energy use during
11 construction and operation. Furthermore, the sector is responsible for almost 40% of the
12 world's CO₂ emissions (IEA, 2019b).

13
14
15
16
17
18
19
20
21
22
23
24
25
26 In line with the above, improving energy efficiency is widely seen as a relatively
27 inexpensive way to decrease total energy consumption through its carbon dioxide (CO₂)
28 emissions (Azhar Khan, Zahir Khan, Zaman, & Naz, 2014). To further best practices in
29 the use of buildings, well-thought design standards and regulations need strict
30 enforcement at the time that relevant technical and technological developments emerge
31 and are integrated (Iwaro & Mwasha, 2010). Although international communities set
32 conditions for generating procedures and policies, different countries enforce these at
33 different levels, hence actions are taken regionally as opposed to globally (Al-Tamimi,
34 2017). As a result, nearly two-thirds of all countries do not have a building energy code
35 yet (IEA, 2019a). Those gaps have led some to believe that efficiency building codes
36 exist only on paper, particularly across developing countries (Deringer, Iyer, & Yu Joe
37 Huang, 2004). Evidently, there is no unique global perspective regarding how
38 sustainable development can be realised with the best practices. The fact that various
39 sustainability perspectives exist reflects the referred global asymmetries. Examples of
40 the various sustainability frameworks include those formulated by countries affiliated to
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 the Organisation for Economic Co-operation and Development (OECD), United
4 Nations Framework Convention on Climate Change (UNFCCC), Kyoto Protocol,
5 International Energy Agency (IEA), and United Nations Environment Programme
6 (UNEP). With the understanding that a more sustainable and clean environment for
7 everyone requires higher levels of engagement from all stakeholders, the European
8 Commission is taking a leading role, reaching wider audiences promoting the creation
9 of medium to long-term strategies or policy objectives that fulfil well-established
10 energy standards for practical use (IEA, 2019a). These would include the ISO
11 (International Organization for Standardization), IECC (International Energy
12 Conservation Code), ASHRAE (American Society of Heating Refrigerating and Air
13 Conditioning Engineering), CEN (European Committee for Standardisation) standards,
14 Nationally Determined Contributions (NDCs) under Paris Agreement, standards, and
15 the European Energy Performance in Buildings Directive (EPBD), to cite but a few.
16 These efforts have captured attention from countries such as Turkey, which strives to
17 develop legislation and operational infrastructure, enforce national energy performance
18 regulations, institute green building standards, and begins creating financial incentives
19 for those involved in the development of built environments to adopt the best practices.
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41

42 A few studies have addressed energy policies on buildings in Turkey (Elsland,
43 Divrak, Fleiter, & Wietschel, 2014; Evans, Yu, Staniszewski, Jin, & Denysenko, 2018);
44 however, these studies have not extensively explored and assessed present laws,
45 regulations, and strategies on buildings from a sustainability perspective. This paper is
46 therefore concerned with the critical assessment of regulations that support the
47 sustainable performance of buildings in Turkey from the energy, environmental and
48 design perspectives including their correlation with practices around the world. The
49 following discussion firstly scrutinises globally established policy and strategic actions.
50
51
52
53
54
55
56
57
58
59
60

1
2
3 It follows an overlook on current measures on sustainability, in Turkey and beyond, to
4 later focus on the evaluation of state policies and goals set to achieve sustainability
5 goals generated through international agreements. The investigation concludes with an
6 overall assessment of actions and improvements achieved so far in Turkey.
7
8
9
10
11
12

13 **Policy and Strategy Actions on Sustainability of Buildings at a Global Level**

14 ***Policy Actions***

15
16
17 Countries are in a continuous improvement and renewal process regarding sustainability
18 policies. Building certifications and legislation on the sustainability of buildings mostly
19 includes energy efficiency and environmental impacts. To date, building energy codes
20 are in use across 69 countries. This also means that energy codes do not exist in
21 approximately 2/3 of the countries worldwide (IEA, 2018). The term building energy
22 code is generic for what countries call *energy efficiency building code, thermal building*
23 *regulation, or energy standards of buildings* (Nejat, Jomehzadeh, Taheri, Gohari, &
24 Muhd, 2015). These codes have different levels of enforcement widely ranging between
25 mandatory and voluntary (Iwaro & Mwasha, 2010). Mandatory standards are common
26 in European countries, and also Russia, Turkey, Japan, China and Australia whereas
27 code enforcement is partial in countries like India, Ukraine, Iran, Argentina and Mexico
28 (IEA, 2018). Overall, European countries hold the highest proportion of mandatory
29 energy standards whereas Latin America, Africa and the Middle East concentrate the
30 lowest proportion of the available energy codes. Asian countries have a mix between
31 mandatory, voluntary, and no code enforcement. According to Iwaro (2010), building
32 codes can be mandatory or voluntary for new and/or existing buildings but in some
33 countries, the term 'mandatory' just applies to the new building. The level of stringency
34 in law enforcement, therefore, varies from country to country. According to Berardi
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 (2015), energy policies of developing countries have only been established recently,
4
5 while developed countries have relatively more advanced policies in comparison.
6

7
8 It is recorded that over the period 2000 to 2017 and beyond there has been a
9
10 continuous increase in the number of practices adopted promoting efficiency
11
12 worldwide. This figure passed from 38% in 2017 to nearly 40% in 2018. As seen in
13
14 Figure 1, lighting has a larger share globally in mandatory policy coverage than space
15
16 cooling/heating, water heating and appliances (IEA, 2019a). However, many countries
17
18 fall behind in their implementation of energy policies, which directly affects the
19
20 growing building stock in those regions.
21
22

23
24 Since around 1990, energy efficiency is enforced with tools such as BREEAM
25
26 and LEED certifications - these are the most commonly used building certification
27
28 systems in Turkey (Aktas & Ozorhon, 2015). These accomplish three key steps:
29
30 assessing, rating and certifying. Currently, 85 countries are certifying buildings energy
31
32 performance; however, most of these certifying processes are not mandatory (IEA,
33
34 2018). As of 2020 in Turkey, energy performance certification became mandatory for
35
36 buildings built after 2011.
37
38

39
40 Throughout the world, as in Turkey, building certification procedures and
41
42 focuses update regularly. Those procedures are driven by energy performance and
43
44 optimisation as covered by 2010/31/EU European Energy Performance of Buildings
45
46 Directive (EPBD) (EPBD, 2010). The main policy drivers affecting the building sector
47
48 and energy efficiency practices in the European Union (EU) are energy-, climate-and
49
50 product-oriented (ATCMP, 2014). In addition, the EPBD (2010) energy performance
51
52 certification is mandatory when selling and renting buildings. Such policies manifest
53
54 themselves in different forms in member states. For example in Germany, the state that
55
56 arguably stands as environmentally “stricter” within the European community (Nejat et
57
58
59
60

1
2
3 al., 2015), building energy codes abide by the Energy Saving Act (EnEG) and the
4
5 Energy Ordinance (EnEV) for minimum energy performance in buildings and
6
7 certification. As for product-orientated policies, in 2016 requirements were brought by
8
9 25% and 20 %, respectively for improvements on energy-saving and insulation of new
10
11 buildings. Such policies enabled a 75% improvement in energy savings from heating in
12
13 Germany since 1975 (IEA, 2018). Rather less direct methods take place in Denmark and
14
15 Portugal, where certifications are issued by independent reviewers, although some good
16
17 practice arises when noting that buildings' energy efficiency must be justified before
18
19 construction (Laustsen, 2008). Notwithstanding differences with Germany in terms of
20
21 approaches, Denmark is perhaps the most successful European leader enforcing the zero
22
23 energy target buildings (Zhang, Zhou, Hinge, Feng, & Zhang, 2016). An example of
24
25 this is the 27% reduction in their total greenhouse emissions achieved between 1990 and
26
27 2015 (DEA, 2017). Building on those examples, France certified 500 000 and 800 000
28
29 housing units with "High Quality Environmental" (HQE) standard and "EFFINERGY",
30
31 respectively, also certifying 50 000 house unit with "NF habitat HQE" annually (IEA,
32
33 2018). In the EU, long-term energy renovation for existing buildings is encouraging to
34
35 achieve nearly zero energy building stock by 2050 revised in EPBD, recently (EPBD,
36
37 2018). Up to now, these renovations via energy retrofitting have provided significant
38
39 benefits to the world, resulting in 50-90% energy savings. Besides the energy
40
41 retrofitting of buildings, structural retrofitting in seismic prone areas of the EU is also
42
43 considered by incorporating it alongside other sustainability measures (Lucon & Üрге-
44
45 Vorsatz, 2014).

52
53
54 The Asian continent is also proactive in enforcing developments of sustainable
55
56 infrastructure. South Korea uses a building energy efficiency rating system mapped
57
58 from the Green Building Act, the Green Building Certification system and financial
59
60

1
2
3 incentives (Koo, Hong, Lee, & Seon Park, 2014; Nejat et al., 2015). China implemented
4 energy efficiency standards tailored to different climates (Laustsen, 2008). Likewise, for
5
6 the most prominent European countries, the building energy code is compulsory. Since
7
8 1996, China has issued numerous guidelines and legislation on green buildings to
9
10 finally issue its first national green building standard in 2006 (Geng, Dong, Xue, & Fu,
11
12 2012). Currently, green building labelling is voluntary. Should construction companies
13
14 fail to comply with these mandatory requirements; they would have to pay between 2%
15
16 and 4% of the contract price as a penalty (Li & Shui, 2015). Despite the increased floor
17
18 area and electrical appliances that result from rapid urbanization and population, China
19
20 has the potential to reduce its energy consumption to 54% (ATCMP, 2014). In Japan,
21
22 the first energy law set in 1979 states that when the built surface is greater than 2000m²
23
24 compliance energy use should be strictly checked against the relevant standards.
25
26 Additionally, in 2012 the Innovative Strategy for Energy and the Environment (ISEE)
27
28 established a road map to guide urban developers. This relatively new policy became
29
30 mandatory by 2010, detailing for every building type to determine energy performance
31
32 (IEA, 2013a). Hence, their Comprehensive Assessment System for Building
33
34 Environmental Efficiency (CASBEE) will absorb the Green Building Rating System
35
36 (Laustsen, 2008). The Japanese government also encourages voluntary labelling as per
37
38 building energy performances. This is done through a programme called Top Runner,
39
40 which also provides guidance on the use of technology for achieving high-energy
41
42 performance (Kimura, 2010). Japan also integrated its building energy code with
43
44 building structural performance code in its building certification (IEA, 2018).
45
46
47
48
49
50
51
52
53

54 In North America, energy efficiency is promoted through the International
55
56 Energy Conservation Code 2004 (IECC), guidance provided by the ASHRAE, and the
57
58 Canadian National Building (Nejat et al., 2015). These countries also provide tax
59
60

1
2
3 incentives to encourage the best practices amongst constructors (Laustsen, 2008). The
4
5 USA takes further actions to support sustainability in the built environment such as
6
7 technological developments and renovations for government building and low-income
8
9 housing, in addition to a voluntary labelling and investments scheme (IEA, 2013b).
10
11 Their building energy performance plan ENERGY STAR strengthens capacity by
12
13 enabling energy savings on the order of 20% (Nejat et al., 2015). As a result, they
14
15 achieved a decrease in energy intensity of 19% and 15% in residential and commercial
16
17 buildings, respectively between 2007 and 2017 (Leung, 2018). Canada upgraded
18
19 ENERGY STAR procedures for Ontario new homes and energy efficiency requirements
20
21 to 20% in 2017 (IEA, 2018). In addition, they upgraded the performance standards of
22
23 energy appliances in 20 categories in 2016 (IEA, 2017b). Joining the region initially
24
25 through NAFTA, Mexico started to adopt local codes and building energy performance
26
27 tools, and it has been applied to 230 000 buildings in the last three years (IEA, 2018).
28
29
30
31
32

33 Most of the energy code policies focus on the building envelope (IEA, 2017b).
34
35 However, heating and cooling of buildings also need to be considered. One of the
36
37 reasons for this is that the energy demand for building cooling is to triple by 2050 if the
38
39 current policies do not change. In contrast, energy investments in buildings are
40
41 decreasing, that fell from 11% in 2016 to 4.7% in 2017 (IEA, 2018).
42
43
44
45

46 ***Strategy Actions***

47
48 Specific energy and emission targets on buildings are essential to produce more
49
50 effective and strict building sustainability policies. It is a general fact that the level of
51
52 policy enforcement varies across countries. Local targets address local requirements,
53
54 which naturally differ from international practices (Deringer et al., 2004). Table 1
55
56 shows examples of country-specific targets around the world, under four headings:
57
58 energy saving, emissions reduction, renewable energy sources and nearly zero energy.
59
60

1
2
3 The table is differentiated from the general strategies that countries created on
4 sustainability and consists of strategies targeting only of the building sector.
5
6

7
8 Most targets clearly rely on reducing energy consumption from buildings.
9
10 Renewable energy is seen as imperative in energy-saving goals (EPBD, 2018). In
11 addition to that, technological clean energy solutions with low-carbon power generation
12 can potentially reduce CO₂ emissions by nearly 90% by 2050 in the world (IEA, 2019c).
13
14 For example, solar power technology has the potential to supply carbon-free heat to
15 about 3 billion people by 2050 in the world (IEA, 2019c). This reduction in energy
16 consumption is critical to achieving the goal of the Intergovernmental Panel on Climate
17 Change (IPCC) to reduce the planet's carbon footprint by 77% by 2050 (Keskin, 2010).
18
19
20
21
22
23
24
25

26 Developed countries started developing city-specific targets towards more
27 efficient use of energy in buildings. For example, Van Couver, Canada introduced a
28 Zero Emissions Building Plan, which aims at improving education in construction.
29
30 Overall, 18 cities in the world set regional targets. Their objectives include achieving
31 net zero carbon by 2030 while enforcing 100% electricity supply from renewables by
32 2035 (IEA, 2018). It is believed that better construction practices have the potential to
33 decrease energy consumption worldwide by almost 30% by 2050 (IEA, 2019c).
34
35
36
37
38
39
40
41

42 Examples of the impact of having implemented ambitious targets include EU
43 decarbonisation and nearly zero energy, which enabled reducing energy consumption at
44 above 2%/year across some EU countries (Romania, Poland and Estonia households)
45 (Berardi, 2015). The challenges to achieving global targets, however, remain. The
46 global average building energy use per person needs to pass from 5 MWh to 4.5 MWh
47 to meet global temperature raising below the 2⁰C target by 2025 according to the IEA,
48 which is equivalent to 30% improvement in energy intensity per square meter of the
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 built floor area (IEA, 2017b). These targets are set out as a global action plan in the
4
5 2015 Paris Climate Conference (COP21) (IEA, 2017c).
6
7

9 **Turkey Landscape of Buildings' Sustainability**

10
11 Energy underpins production, and world energy production and consumption are
12
13 increasing with investments towards industrialisation. In Turkey, although, energy
14
15 consumption has decreased in the building sector between 2012 and 2014, buildings had
16
17 the largest share of the sectoral energy consumption in the same period with 34%,
18
19 which account for 30 Ktoe, as seen in Figure 2 (MENR, 2016b). Following, in 2015,
20
21 24.8% of primary energy supply was provided to the building sector (MENR, 2016a),
22
23 which was the second-largest share compared to other sectors. On the global scale,
24
25 although energy usage from buildings is decreasing, buildings have the biggest share of
26
27 energy consumption. Between 2015 and 2018, the speed of decrease in energy intensity
28
29 in the building sector has fallen from 2% to 0.6% (IEA, 2019a). Despite the downward
30
31 trend in energy, if adequate measures are not taken, the energy demand in the building
32
33 sector will reach 50% by 2050 globally (IEA, 2013b). Furthermore, in Turkey, 18% of
34
35 carbon dioxide emissions derive from the building sector (ATCMP, 2014), whereas
36
37 Figure 2 shows that emissions caused by building sector nearly doubled in 10 years, and
38
39 reached almost 53 million tons of CO₂ by 2014. Regarding the residential sector,
40
41 between 2015 and 2017, fuel-related carbon emissions increased to 32% (TSI, 2019).
42
43 As highlighted above, the building sector has great potential for emission and energy
44
45 savings. The first national statement submitted to the UNFCCC concluded that
46
47 investment in energy efficiency for emission reduction is more cost-effective than
48
49 implementing renewable energy technologies (Keskin, 2010). The potential for energy
50
51 saving in residential and commercial buildings are 46% and 20%, respectively
52
53
54
55
56
57
58
59
60 (ATCMP, 2014).

1
2
3 Factors that can influence the sustainability of buildings include energy supplies
4 for space heating or cooling devices, architectural or structural components (materials),
5 and mechanical systems (for lighting, water heating, etc.). Attenuating factors account
6 for the increase of population; hence the volume of building stock and the sophistication
7 of mechanical and digital systems that facilitate building management also increase.
8 These rise energy consumption at a rate of around 3% annually worldwide and is
9 seemingly going to continue in the foreseeable future (IEA, 2019b). In 2010, the
10 breakdown of energy consumption in Turkey, considering space heating, water heating,
11 cooking and appliances was 43%, 26%, 10% and 21% respectively (Toklu, Güney, Işık,
12 Comaklı, & Kaygusuz, 2010).

13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
Turkey is importing energy from neighbouring countries to cope with the
internal energy demand. Its dependence on external sources makes this country the
sixth-largest dry natural gas importer (EIA, 2019) while nearly 75% of all imported
resources go to non-domestic activities. To mitigate this, the country put effort into
establishing nuclear energy plants whose construction is due to start in 2023 (MENR,
2019).

Notably, more than one-third of the energy in Turkey is spent on heating and
cooling (Keskin, 2010) while, limited to the built environment, 75% of the building's
energy is spent on heating (World Bank, 2010). Until 2014, natural gas and coal
products represented respectively 32.3% and 32.2% of the total consumption allocated
to the heating of Turkish buildings (TSI, 2016c).

In 2017, natural gas energy demand for construction sector raised to 44%, as
seen in Figure 3 (MENR, 2017). On the other side of the spectrum, Turkey has
significant potential for generating renewable energy. As an example of this, nearly 1%
of the world's total hydropower and high wind power can be developed in this country

(Toklu et al., 2010). According to Toklu (2010), an increase in geothermal, solar thermal and hydropower energy use are observed since 1990; however, because of its high potential, Turkey also needs to increase its solar and wind energy harvesting. This country registered an installed capacity of 40% for generating renewable energy, from where electricity generation totalled 29% in 2013 (NREAP, 2014). A projection made in 2009 suggested that the building sector had a potential saving of 7.1 Mtoe (EC, 2015).

Population Growth and Building Stock in Turkey

Population and the rapid pace of urbanisation are the critical drivers for demands in energy and resources. Turkey's population reached nearly 80 million by the end of 2016, and the population density increased to 104 people per square kilometre (TSI, 2016b). According to the Turkish Statistical Institute (TSI), the population by 2023 and 2050 will be of 84 and 93 million nationwide (TSI, 2013). Turkey's rapidly growing population transforms the building stock. To date, there are 9.1 million buildings in the country, from which approximately 87% are residential (NEEAP, 2018). However, that figure is unstable. Each year more than 100,000 new building is added to the building stock, see figure 4, (NEEAP, 2018) while, according to Turkish Standard Institute (TSI) (2017), 92.4% of these dwellings owned by the private sector, and 20.9% of them located in Istanbul. According to TSI data, more than 100km² floor area is adding every year, and this rate is gradually increasing, as seen in figure 4. Similarly worldwide, because of this rapid construction, 230 000 km² are expected to be occupied by new construction sites after over 40 years (IEA, 2017b).

The potential for the occurrence of earthquakes in the region imposes additional constraints to Turkish building developments. Earthquake regions of high seismic activity include 72% of the population, occupying 66% of existing dwellings (Ergunay,

1
2
3 2007). In Istanbul alone (with its 400 neighbourhoods), more than one million buildings
4 need to be demolished or strengthened (Gibson & Goksin, 2016). According to Gurlesel
5 (2012), the urbanisation rate will reach 84% in 2023. Alongside this, the building stock
6 will increase to 25.56 million from 22 million in January 2016, and Turkey's total
7 demand of housing stock (housing to be newly built) will amount 7.56 million units
8 (with minimum C energy class) for the 12 years between 2012 and 2023 (Gurlesel,
9 2012). This increase would translate into a surge in demand for energy and emphasises
10 the importance of energy-saving measures, especially in residential buildings. Existing
11 buildings, therefore, need upgrading while new buildings need to abide by modern
12 design standards (NEEAP, 2018).

13
14
15
16
17
18
19
20
21
22
23
24
25
26 The biggest problem of housing in the country, as recorded by TSI (2016a) in
27 2015, is heating inefficiency due to poor insulation, decay in the floors and frames,
28 humid walls, floors and foundations, and insufficient daylight. Those problems affect
29 43%, 39%, and 20.6% of dwellings, respectively. The solution to such issues would
30 include various factors, such as enhancing the capacity of the heat insulation domestic
31 market, that is currently about 1.25 billion USD and unable to insulate more than 400
32 000 average houses per year (EESP, 2012). Besides mechanical and physical
33 improvements in buildings, the impact of building materials should also take into
34 account for construction in rapidly growing countries. Production of building materials
35 is responsible for 20% of world's fuel consumption (Dixit, Fernández-Solís, Lavy, &
36 Culp, 2010) and nearly 18% of emissions for any construction project (Ibn-Mohammed,
37 Greenough, Taylor, Ozawa-Meida, & Acquaye, 2013).

Turkey's Present Policy and Strategy Actions on Sustainability of Buildings

Policy Actions in Turkey

The section addresses actions towards sustainability in Turkey via *policy* linked to building regulations and law. Turkey is trying to keep pace with cutting-edge international developments to issue building energy regulations and guidelines. These would enable the optimisation of the use of devices to manage energy, at the time of providing incentives such as tax credits for the planning and development of dwellings. These innovations underpin the zero energy target set for urban development (NCCAP, 2011). The first regulation for reducing heat losses and gains in building refers to the Standard of Thermal Insulation Requirements (TS 825), first known in 1970 and revised in 1981, 1985, and in 1998. The Thermal Insulation Regulations of The Buildings superseded previous norms from 2000 (RTOG, 2000b). Turkish authorities labelled the new regulatory framework as *mandatory* and defined a remit that covers infrastructure built after 2000. A feature of the norm relates to the ambitious target of reducing by 50% heat losses permeating through façades (Keskin, 2010). Linked to that, the Turkish Heat Requirement Identification Certificate became compulsory for constructions since 2008 (RTOG, 2008a). The Energy Performance Building Regulation (EPBR) published in 2008, it became an additional instrument to mitigate energy loss in buildings of Turkey (RTOG, 2008b). EPBR derives from the Energy Performance of Building Directive 2002/91/EC formulated by the European Union for optimising the use of primary energy and limit CO₂ emissions (BEP, 2019). It is also a target of EPBR and for the Regulation on Improving Efficiency in the Use of Resources and Energy (RIEURR), to minimise heat loss with thermal insulation (RTOG, 2008c, 2008b). These provide detailed guidance to achieve sustainability targets, for example, by making mandatory the use of double-glazing with heat control/coating and prevention of air

1
2
3 leakage from windows as well as the implementation of revolving doors and double
4 doors in public buildings (RTOG, 2008c). Architectural solutions that considering
5 meteorological data for preventing unwanted heat gains and losses and unwanted solar
6 gains in summer also included in EPBR (RTOG, 2008b). According to projections,
7 nearly 2 billion dollars could be saved out of 500,000 buildings designed according to
8 modern regulations (Toklu et al., 2010).
9

10
11
12
13
14
15
16
17 Energy Efficiency Law first proclaimed in 2007. That legal instrument obliged
18 the monitoring of energy performance in industrial establishments and buildings that
19 later became the primary source of further technological developments (RTOG, 2007).
20
21
22
23 The framework aims at saving a minimum of 15% of energy use in public buildings that
24 have 250 TEP annual energy consumption and above or 1000m² total construction area
25 and above. Later this target revised to at least 20% reduction overall, compared to 2010
26 (RTOG, 2011).
27
28
29
30
31
32

33
34
35 The regulatory framework proposed by EPBR later progressed into IT tools for
36 the use of energy identification and certification (RTOG, 2008b) such as the National
37 Energy Performance Certification Software BEP-TR adopted by the Turkish
38 government, which enables assessing the energy performance of buildings of uses
39 varied: residential, office, hotels, shopping, educational, commercial and health care.
40
41
42 Furthermore, elements of EPBR fed into the Energy Efficiency Law formulated in
43 2007, which is including the minimum energy requirement for electrical devices
44 (RTOG, 2007). In 2010, the Building Energy Performance National Calculation Method
45 first appeared to the public. This law defines how to quantify energy consumption
46 related to building heating, cooling, ventilation, lighting and hot water supply (RTOG,
47 2010b). It also sets direction about ways to evaluate energy efficiency addressing all
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 parameters affecting the building's energy consumption, according to an energy
4
5 performance classification.
6

7
8 The analysis above highlight examples where policy and law inevitably merge.
9
10 These enforcements are particularly evident when it comes to certification. Regulations
11
12 on certification of sustainable green buildings and settlements are also available as
13
14 (RTOG, 2014) and (RTOG, 2017b). TSI and related non-governmental organisations
15
16 are working to establish a standard for green buildings, which are becoming
17
18 increasingly popular in the local construction sector (NREAP, 2014). During a
19
20 transition period, the green certificate is voluntary to have (RTOG, 2017b).
21
22

23
24 The Turkish certification programme is, in various forms, based on labelling
25
26 systems. An example of that is the Energy Identification Certificate (EIC). In that
27
28 scheme, A and G identify the highest and lowest energy consumption level, respectively
29
30 (RTOG, 2010b). The way it works is as follows; energy performance amounts compare
31
32 against target annual energy consumption per m² of construction and associated CO₂
33
34 emissions (BEP, 2019). Specific procedures to work out comparison against
35
36 benchmarks appear on the EIC while referring users to the BEP-TR nationally adopted
37
38 tool. The metrics for quantification also include the use of renewable energy -
39
40 incorporating, for example, building orientation, heat insulation, passive heating and
41
42 cooling, and the use of daylighting and natural ventilation (RTOG, 2008b, 2010b). To
43
44 facilitate the interpretation of the norm while enabling working out quantifications,
45
46 transparent methodologies to determine the energy performance class of the subject
47
48 building appeared published in 2010 (RTOG, 2010b). Its reviewed versions, issued in
49
50 2010 and 2017, also disseminated (RTOG, 2010a, 2017a). There are barriers and
51
52 enablers to that movement. The latter includes the revised regulation of EPBR that
53
54 delayed until 2020 certifications for buying, selling and renting. While new buildings
55
56
57
58
59
60

1
2
3 and existing buildings built after 2011 have to categorise with a C label, older buildings
4 do not have a labelling requirement at all (RTOG, 2010a). Enablers take the form of
5 ministerial supervision of activity related to EIC while revisions of the normative
6 framework take place in parallel to EU oncoming regulations (EESP, 2012), such as,
7 (RTOG, 2014), (RTOG, 2017a) and (RTOG, 2017b).
8
9

10
11
12
13
14
15 The current framework on sustainability regulatory for buildings is examined
16 under eight-building design practices and shows in Table 2. The change in these
17 building design practices between 2000 and 2018 illustrates in Figure 5. Regarding
18 space heating, several regulations have included this practice as a priority, as seen in
19 Figure 5. According to Toklu (2010), the building sector causes a considerable amount
20 of energy losses, particularly in space heating, afterwards water heating and cooking in
21 Turkey. Regulations, such as; (RTOG, 2000a) and (RTOG, 2008b), widely promote the
22 use of automatic control devices for fuel-saving and heating insulation. Furthermore,
23 EPBR recommends steam mechanisms for water heating (RTOG, 2008b) or solar
24 energy (RTOG, 2017a). According to this, after January 2020, having a central water
25 heating system plan fuelled with solar energy is to become mandatory for non-
26 residential buildings that have more than 1000 m² floor area (RTOG, 2017a).
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41

42 Therefore, in Turkey new buildings with the central heating system must use
43 central or local heat or temperature control devices and systems that share heating costs
44 depending on the amount of heat usage (RTOG, 2000a). Thereafter, heating control
45 devices became mandatory in central heating buildings in 2007 to reinforce that
46 (RTOG, 2007). According to EPBR(2008b), automatic control system became
47 compulsory for fuel and gas boiler for fuel-saving, and condensing heating devices is
48 obligated for individual gas heating buildings in 2008. In 2010, the central heating
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 application became obligated for new buildings with more than 2000m² useful area
4
5 (RTOG, 2010a).
6

7
8 On the other side of the spectrum, we have space cooling, which is on higher
9
10 demand by the increase in outdoor temperatures seen recently over the summer. As a
11
12 result, cooling spaces now costs 3- 6 times more than space heating (Keskin, 2010). The
13
14 item, therefore, appears on the regulations regarding ventilation (RTOG, 2000b, 2008a).
15
16 For public buildings, specific regulations there exist to address air conditioning, class
17
18 and temperature setting (RTOG, 2008c, 2011), and central cooling designs have to be in
19
20 place for non-residential buildings whose energy demand exceeds 250Kw (RTOG,
21
22 2010a).
23
24

25
26 In Turkey, polices on lighting differ from world trends. As seen in Figure 5, a
27
28 limited number of regulations advice on this practice. Notwithstanding, from 2008, it is
29
30 compulsory in the country to use high-efficiency fluorescent and LED lamps in public
31
32 buildings. Building administrators should also use sensor control and automatic daylight
33
34 control system (RTOG, 2008c). Furthermore, EPBR (2008b) advises on the use of
35
36 sensors lamps, promotes inducing solar power and optimise the use of daylight. This
37
38 branches out to daylight photoelectric switches and ultra-controlled remote-control
39
40 switches.
41
42
43

44
45 Energy Labels for Households Appliances accelerated the transformation of
46
47 white appliances to A and over labelled devices. To keep the change going, RIEURR
48
49 (2008c) obliged Energy Star labelling of computers and similar devices in public
50
51 buildings (RTOG, 2011). This efficient transformation of electrical devices reinforced
52
53 with procedures on ecological profiles and environmentally friendly designs of products
54
55 (RTOG, 2010c). The enforcement widened when EPBR included the use of automatic
56
57 systems and central control systems for managing of air-conditioning and cooling.
58
59
60

1
2
3 Furthermore, computer-controlled building automation is now mandatory for facilities
4 whose total built area exceeds 10.000m². RIEURR (2008c) also promotes the use of
5 commercially available high-energy household appliances, primarily air conditioners,
6 refrigerators, lamps, and bulbs (RTOG, 2011).
7
8
9
10

11
12 In recent years, legislation for increasing the share of renewable sources in the
13 building sector, increased. According to EPBR (2008b), ways to produce renewable
14 energy should explore for buildings with usage area above 1000m². The regulation
15 advises developing alternative architectural solutions for buildings of this kind to have
16 local renewable sources in their locality. In the design stage, developers of new
17 buildings that have more than 20.000m² area should analyse renewable energy systems
18 for heating, cooling, ventilation, water heating, electricity and lighting to upgrade the
19 investment on green energy solutions to a minimum of 10% of the total cost of the
20 building (RTOG, 2010a). In addition to that, the Law on the Transformation of Natural
21 Disaster Risk Areas contains provisions on the restructuring and reconstruction of urban
22 areas at risk of natural disasters. This arrangement offers a considerable opportunity for
23 increasing the use of renewable energy and energy efficiency in the urban
24 transformation areas under risk of disaster (NREAP, 2014).
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41

42 Disseminating progress across stakeholders is also important. To that end,
43 training programmes for building owners and employees there exist, for more efficient
44 use of energy (RTOG, 2008b). The EIP (Efficiency Increasing Project) initiative is now
45 under preparation for implementing measures to eliminate energy wastes, losses and
46 uncertainties in buildings and industrial enterprises. Other initiatives include conducting
47 Energy Manager Training Programs and authorising Energy Efficiency Consultancy
48 companies. Energy manager's duties and responsibilities now reflect in several pieces
49 of legislation (RTOG, 2008c), (RTOG, 2008d) and (RTOG, 2011). As an example of
50
51
52
53
54
55
56
57
58
59
60

1
2
3 the way this articulates, schools affiliated to the Ministry of National Education and
4
5 buildings - affiliated to the general directorate of the Ministry of Energy and Natural
6
7 Resources, toned to appoint energy managers to increase efficiency in the use of energy
8
9 (RTOG, 2009, 2011). Also, within the framework of the Energy Efficiency Law
10
11 (RTOG, 2007), there are requirements for the appointment of an energy manager for the
12
13 buildings, the introduction of an energy identity certificate for buildings, and the
14
15 determination of minimum performance requirements for electrical devices (RTOG,
16
17 2007).

21 22 23 ***Strategy Actions in Turkey***

24
25 The first nationwide institution fomenting sustainable infrastructure developments was
26
27 the Environmentally Friendly Green Building Council (Cedbik) established in 2007.
28
29 The short to medium-term council strategic plan included an initial assessment to
30
31 identify enablers and barriers for implementing energy-saving guidelines and policies.
32
33 In addition to that recently, B.E.S.T. Housing certification system has created, which is
34
35 appropriate for Turkey conditions, to implement in new housing projects (Cedbik,
36
37 2017).

38
39
40
41 This country is a member of The United Nations Framework Convention on
42
43 Climate Change (UNFCCC). It takes part in international efforts for reducing
44
45 greenhouse gas emission, adaptation to climate change and mitigation to global
46
47 warming (MFA, 2019). The international collaboration has also been reflected in the
48
49 2012 National Climate Change Action Plan, underpinned by the National Climate
50
51 Change Plan 2011-2023, which followed the UNFCCC meeting that year (NCCAP,
52
53 2011). Turkey's internal and external affairs have crystallised in a project for improving
54
55 sustainability in new and existing buildings, following EU norms and EPBR regulation.
56
57 Table 3 shows specific targets per strategic initiative(s) nationwide.
58
59
60

1
2
3 In 2012, limitations and sanctions to those overruling regulations regarding the
4 efficiently use of energy and natural resources, CO₂ emissions, clean energy production,
5 commercialisation of products and technology that mitigates damages to the
6 environment, were established via the Energy Efficiency Strategy Paper (EESP) (EESP,
7 2012). Those strategy actions were reinforced by the National Renewable Energy
8 Action Plan (2013-2023) (NREAP) while informed by the 2009/28/EC European
9 Parliament Directive in 2014 (NREAP, 2014), as well as by The Tenth Development
10 Plan (2014-2018) Energy Efficiency Improvement Program Action Plan. The latter
11 directed to old buildings that need upgrading (TTDP, 2014). Also, the Strategy Paper
12 expands on building rehabilitation for reducing emissions and energy consumption.
13 Another critical element in the strategic plan relates to the National Energy Efficiency
14 Action Plan (NEEAP) which priorities EU efficiency target for 2020 as well as the
15 2009/125 / EC and 2010/30 / EU Directives (NEEAP, 2018).

16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33 Executive decisions are paving the way for a sustained reduction in the use of
34 energy. This enables establishing specific targets with a focus on energy consumption,
35 CO₂ emissions and the enhancement of renewable energy sources. All this under the
36 umbrella of the EU zero energy target (BEP, 2019; NEEAP, 2018; NREAP, 2014). The
37 vehicles to achieve these targets include the EIC of buildings that is mandatory for
38 selling, buying and renting of the buildings and requires renewal every ten years
39 (RTOG, 2010b). The certificate label should be minimum C for new buildings. The
40 legislation builds on the strategic objective of transforming at least one-quarter of the
41 building stock into a sustainable building by 2023 to expand sustainable,
42 environmentally friendly buildings that use renewable energy resources. At the same
43 time, it aims at reducing the energy intensity of the country by 20% until 2023. Public
44 housing and urban regeneration projects provide significant opportunities to achieve this
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 goal. In this process, coordination between national and international organisations is
4
5 important, and this coordination is planning by NCCAP to provide for renewable
6
7 energy, energy efficiency by 2023. NCCAP has also set strategic targets for increasing
8
9 energy efficiency by reducing losses in electricity distribution and transmission by 15%
10
11 at 2030 and renewable energy usage by increasing electricity production capacity of
12
13 solar power and wind power to 10 GW and 16 GW by 2030, respectively. An
14
15 additional objective is to reduce total greenhouse gas emissions by 21% below its
16
17 business-as-usual level between 2012 and 2030.
18
19
20

21
22 Similarly, the National Renewable Energy Action Plan (NREAP) aims at
23
24 lowering emissions and improve energy efficiency by increasing renewable energy
25
26 capacity to 5GW solar power, 20 GW wind energy, 34 GW hydropower, 1 GW
27
28 geothermal and 1 GW biomass. In this context, the installation of solar water heaters
29
30 across 50% of existing households would enable nearly 9TWh annual save from coal,
31
32 oil and gas and 2TWh annual save from electricity and 5 million tons CO₂. Such
33
34 savings account approximately 1% decrease in the total CO₂ emissions in Turkey
35
36 (Toklu et al., 2010). The NREAP action plan does not detail pathways to promote
37
38 renewable energy use in buildings. However, NEEAP does include actions to promote
39
40 on-site production and renewable energy use in buildings. NEEAP also seeks to develop
41
42 guidelines for each of the different materials, equipment and technologies used in new
43
44 or refurbished buildings, including energy performance criteria and efficiency analysis
45
46 until 2019.
47
48
49
50

51
52 The common target for the policy items is training which is for managers to
53
54 increase the current knowledge level on EPBR and energy efficiency measures. These
55
56 training are essential for new and required targets to progress. The energy management
57
58 program and building energy certification system are at the core of the agenda managed
59
60

1
2
3 by the Ministry of Energy and Natural Resources. Currently, the state sets the strategic
4 targets for increasing energy efficiency and is looking into ways to ensure their effective
5 implementation and promotion all over the country (NEEAP, 2018).
6
7
8
9

10 11 **Discussion**

12
13
14 The targets that highlight the energy efficiency of buildings for sustainability have
15 drawn attention, as seen in Table 1. In this context, some countries such as EU,
16 Denmark, and Canada have highlighted the target of renovating buildings in order to
17 increase energy performance, while other countries have mostly aimed at saving energy
18 in new buildings in Table 1. In specific, Turkey's policies on energy efficiency are in
19 many forms driven by world developments. Even so, the country has defined action
20 plans tailored to their own needs. These actions mostly customised for the public,
21 residential or commercial buildings. Until 2023, 20% energy saving target for public
22 buildings came to the fore. This target is followed by the renovation of the existing
23 building stock, thermal insulated and energy-efficient 1 million buildings, and one-
24 quarter sustainable building stock by 2023, as seen in Table 3. A projection made in
25 2009 suggested potential savings across the building sector that amount 7.1 Mtoe (EC,
26 2015) that, according to NEEAP (2018), has been reached within the period 2000-2015.
27 In addition to that, between 2012 and 2014, a %3 reduction in energy consumption was
28 observed for the building sector (MENR, 2016b). From this situation, strict regulations
29 can be effective. For example, the thermal insulation plan has started to implement in
30 new buildings as a mandatory document for every construction permit in 2000 and then
31 Turkish Heat Requirement Identification Certificate in 2008. Finally, EIC certificate
32 released in 2010, which has strict regulations on reducing heat losses in the envelope
33 (RTOG, 2008a, 2008b, 2008c).
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 European countries have set escalated targets to decrease greenhouse gas
4
5 emissions. These should accomplish results by 2020, 2030, 2040 and 2050 (EPBD,
6
7 2018). EU's predominant aim set to 2050, which contrasts with milestones established
8
9 by South Korea, Denmark, Japan, and Turkey, where emission targets prioritise the
10
11 projection 2030. Turkey now works against the ambitious milestone of reducing total
12
13 greenhouse gas emissions by 21% below its business-as-usual level between 2012 and
14
15 2030. Statistical information suggests a 10% decrease between 2012 and 2014, as seen
16
17 in figure 2. In order to continue this decline, stringent administrative sanctions started to
18
19 implement from 2017, regarding threshold values linked to emissions. In addition, some
20
21 of the emission reduction targets also privatized for public buildings.
22
23
24
25

26 Turkey's strategic plan to reducing greenhouse gas emissions relies on the
27
28 adoption of best practices ranging from clean energy generation to policy and
29
30 legislation. Although natural gas use has grown in the country, fuel-related emissions
31
32 are still increasing (TSI, 2019). The country aims at reducing the use of energy in 8-
33
34 10% annually with the potential to raise savings to 20% by 2020 (Toklu et al., 2010).
35
36 NCCAP (2011) aims to meet at least 20% of the annual energy needs of new buildings
37
38 with renewable energy sources by starting from 2017. According to NEEAP (2018),
39
40 these objectives could realise if site energy production develops. Turkey has set specific
41
42 targets to promote the use of renewable energy in buildings via EESP, NCCAP and
43
44 NEEAP while infrastructure development derives from the EPBR suite of guidance.
45
46 There is also evidence for exploring alternative clean energy sources. For example,
47
48 between 2002 and 2015, the use of geothermal sources for heating in buildings and
49
50 thermal facilities increased by 281% (MENR, 2016b). Moreover, to date, 260 000
51
52 households use geothermal heating, whereas applications of a similar nature could
53
54 upgrade the heating of 500 000 houses and the cooling of 50 000 additional ones
55
56
57
58
59
60

1
2
3 (TTDP, 2014). Building on this, according to (Yüksel & Arman, 2014), Turkey has the
4 potential to increase its geothermal energy capacity to 1.2 million houses by 2020.
5

6
7 Particular attention is to be paid to hydroelectric re-development, which so far exploits
8 as much as 35% of its potential (Yüksel & Arman, 2014). Turkey has yet to overcome
9 financial constraints to progress its potential (Toklu et al., 2010).
10
11
12
13

14 In view of the ambitious energy optimisation targets outlined above, policy
15 stringency levels are to increase in the short-medium term. EU nations, the UK, US and
16 Japan envisage making regulations compulsory after 2020 to achieve nearly zero targets
17 for buildings. South Korea adopted the zero target by 2025 through more strict
18 regulations (IEA, 2017a). China would also have strict policies in place or in
19 preparation, to fulfil their commitments. Turkey has not yet established clear milestones
20 for raising stringency levels for zero energy buildings and is more focused on the
21 identification and dissemination of requirements (NCCAP, 2011). However, public and
22 private buildings built after 2020 planned to be nearly zero-energy (NEEAP, 2018). In
23 NCCAP, assessment of performances of real and model buildings intends to fine-tune
24 the EPBR with BEP-TR tool and algorithm to accomplish energy efficiency milestones
25 set by 2018. To support that objective, the Green Building certification came into force
26 in 2017- with the private sector now heading on further green building activities (Aktas
27 & Ozorhon, 2015). Furthermore, as per the Tenth Development Plan (2014), licensing
28 procedures of the buildings having heat insulation are exempt from taxes and charges by
29 the local administrations. This is an ongoing plan, which has produced some positive
30 outcomes. For example, according to statistical data, 329 063 buildings have obtained
31 the EIC (BEP, 2019). It is predicted that one fourth of the existing building stock, and
32 7.56 million new dwellings will have been categorised with C label by 2023 (Gurlesel,
33 2012).
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 Significant improvements in the energy efficiency of household appliances have
4 occurred. With the enactment of the Energy Labels for Households Appliances Law, the
5 energy consumption reduced by up to 60% over ten years (Keskin, 2010). In addition to
6 that, automatic systems and central control systems, regulatory frameworks promote
7 expanding such technology to optimise heating, cooling, air-conditioning and lighting
8 systems of buildings.
9

10
11
12 Energy manager training is getting attention and noting that the number of
13 certified energy managers of buildings reached 2205 entries in 2018. Also, education
14 seminars have run for employees, households and students, for raising public awareness
15 and literacy on energy efficiency and renewable energy sources and usage. The
16 sustainable renovation of the buildings, driven by the public sector, adds up towards
17 generalising green and sustainable buildings (Aktas & Ozorhon, 2015).
18

19
20
21 Within the remit of the Energy Efficiency Etude and Energy Identity Certificate
22 for Public Buildings, a partial amount of 352 properties have upgraded until 2018, out
23 of which 55% relate to estates facilities. More in-depth studies show a reduction of
24 1.5% per m² of energy consumption across the referred subset while the monitoring of
25 energy efficiency of additional 1430 buildings continues (MENR, 2018). Turkey's
26 implementation of policies and strategies seems synchronised with the move by
27 stakeholders to adopt best practices. For example, in 2010, Turkey launched its Market
28 Transformation of Energy Efficient Appliances campaign, which supports directives set
29 by EU eco-design and energy labelling systems. According to (MENR, 2016b) this has
30 accelerated labelling while popularised training during 2015.
31

32
33
34 High-energy building performance is becoming a common target for countries
35 worldwide. To engage in that movement, Turkey has been developing policy and
36 legislation to cover both passive and active design strategies such as the implementation
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 of sustainable insulation systems and automated management of heating and cooling.
4
5 This trend could intensify if low- carbon emission materials and higher efficiency
6
7 technologies were in the market as well as considered in the strategy and policy papers.
8
9
10 Through the implementation of upgraded regulations, one could expect seen around 7.5
11
12 million isolated houses by 2023, which would derive in a fall of energy consumption to
13
14 pass from 44 kWh/m² recorded in 2012, to 20.5 kWh/m² by 2023 (ATCMP, 2014). In
15
16 such a scenario, nearly half of the 25.56 million existing domiciles would be energy
17
18 efficient by 2023 (Gurlesel, 2012). The renovation of the building is also a core
19
20 objective across EU nations. Investors and developers now engage in financial
21
22 strategies involving long-term payback periods for the transformation of existing
23
24 building stocks into nearly zero existing buildings beyond 2020 (original milestone).
25
26 Recently, some EU countries located in seismic areas, and Japan, integrated safety and
27
28 sustainability of their infrastructure in building codes. Turkey is to follow such action,
29
30 given its susceptibility to tectonic motions that often results in large numbers of
31
32 damaged buildings.
33
34
35
36

37
38 Worldwide eco-trends are uniformising. Constraints to achieving this include
39
40 obvious differences that distinguish culture, education, economy and engineering
41
42 practice. According to Iwaro & Mwashu and Lucon & Urge-Vorsatz (2010; 2014), the
43
44 greatest obstacles that are preventing developing countries from engaging with
45
46 international movements include low awareness levels, limited access to technology and
47
48 qualified labour. Turkey is not free from such constraints, although its developed
49
50 strategies are driving a change (Keskin, 2010). To mitigate financial issues, Turkey
51
52 introduced two programmes: the Sustainable Energy Financing Program (TSEFP) and
53
54 the Residential Energy Efficiency Financing Program (REEFPT), in addition to one
55
56 credit scheme to protect energy and labour (Şekerbank EKOkredi). According to
57
58
59
60

1
2
3 (ATCMP, 2014), the latter has already prevented more than 2.5 million tons of carbon
4
5 emissions.
6

7
8 Turkey, is, therefore, driving change through the merging of policy and
9
10 legislation into concise strategies to progressing their sustainability goals.
11
12

13 14 **Conclusions**

15
16 The current policies and strategies in Turkey have been investigated with respect to the
17
18 sustainability of buildings. Factors playing a role in the country's development include
19
20 stringency and scope of the policies & strategies. These, together with the adoption of
21
22 examples of good practice across the world, have contributed to shaping the national
23
24 action plan for the efficient utilisation of sustainability. It turns out that leading
25
26 countries in this subject across continents demonstrate a high level of engagement with
27
28 policymaking and enforcing. These factors can translate into strong regulations,
29
30 financial stimuli, and commitment, supported by law, strategy and transparency. With
31
32 increasing urbanisation and population, it is inevitable that the number of new buildings
33
34 will increase. For this reason, it is critical to ensure that new designs reflect
35
36 sustainability attributes. Turkey is taking concrete actions to raise their performance
37
38 levels and is starting to raise the level of stringency via certification and legislation, set
39
40 to be mandatory after 2020.
41
42
43
44
45
46
47

48 **Acknowledgements**

49
50 The first author would like to acknowledge the Turkish Government for the financial
51
52 support of the present research project.
53
54
55

56 **References**

57
58 Aktas, B., & Ozorhon, B. (2015). Green building certification process of existing
59
60 buildings in developing countries: Cases from Turkey. *Journal of Management in*

- 1
2
3 *Engineering*, 31(6). [https://doi.org/10.1061/\(ASCE\)ME.1943-5479.0000358](https://doi.org/10.1061/(ASCE)ME.1943-5479.0000358)
4
5 Al-Tamimi, N. (2017). A state-of-the-art review of the sustainability and energy
6 efficiency of buildings in Saudi Arabia. *Energy Efficiency*.
7
8 <https://doi.org/10.1007/s12053-017-9507-6>
9
10
11
12 ATCMP. (2014). *Association of Turkish Construction Materials Procedures|Report on*
13
14 *Energy Efficiency and Financing in Buildings*. Retrieved from
15
16 https://www.imsad.org/Uploads/Files/imsad_bev_rap_kasim_2014.pdf
17
18
19 Azhar Khan, M., Zahir Khan, M., Zaman, K., & Naz, L. (2014). Global estimates of
20 energy consumption and greenhouse gas emissions. *Renewable and Sustainable*
21
22 *Energy Reviews*. <https://doi.org/10.1016/j.rser.2013.08.091>
23
24
25
26 BCA. (2017). *Building and Construction Authority|Healthier and Greener Buildings in*
27
28 *Next Lap of Singapore's Green Building Journey*. Retrieved from
29
30 [https://www.gov.sg/~/sgpcmedia/media_releases/bca/press_release/P-20170912-](https://www.gov.sg/~/sgpcmedia/media_releases/bca/press_release/P-20170912-1/attachment/Media%20release%20SGBW%202017_12%20Sept%202017.pdf)
31
32 1/attachment/Media release SGBW 2017_12 Sept 2017.pdf
33
34
35
36 BEP. (2019). Building Energy Performance. Retrieved October 15, 2019, from
37 Department of Energy Efficiency website:
38
39 http://www.bep.gov.tr/BEPTRWEB/#.WYRz_k2WyUk
40
41
42 Berardi, U. (2015). Building Energy Consumption in US, EU, and BRIC Countries.
43
44 *Procedia Engineering*, 118, 128–136.
45
46 <https://doi.org/10.1016/J.PROENG.2015.08.411>
47
48
49 Cedbik. (2017). Environmentally Friendly Green Building Council. Retrieved October
50
51 15, 2019, from <https://cedbik.org/>
52
53
54 DEA. (2017). *Danish Energy Agency|Denmark's Energy and Climate Outlook 2017*.
55 Retrieved from
56
57 https://ens.dk/sites/ens.dk/files/Analyser/denmarks_energy_and_climate_outlook_
58
59
60

2017.pdf

- Deringer, J., Iyer, M., & Yu Joe Huang, Y. J. (2004). Transferred just on paper? Why doesn't the reality of transferring/adapting energy efficiency codes and standards come close to the potential. *In Proceedings of the Proc. 2000 ACEEE Summer Study on Energy Efficiency in Buildings*.
- Dixit, M. K., Fernández-Solís, J. L., Lavy, S., & Culp, C. H. (2010). Identification of parameters for embodied energy measurement: A literature review. *Energy and Buildings*, 42(8), 1238–1247. <https://doi.org/10.1016/J.ENBUILD.2010.02.016>
- EC. (2015). *European Commission|Turkey Energy Action Document 2015, Instrument for Pre-Accession Assistance (IPA II) 2014-2020*. Retrieved from <https://ec.europa.eu/neighbourhood-enlargement/sites/near/files/pdf/turkey/ipa/2015/ipa2015-038-405.7-energy.pdf>
- EESP. (2012). *Energy efficiency Strategy Paper 2012-2023*. Retrieved from <http://www.lse.ac.uk/GranthamInstitute/wp-content/uploads/laws/1719.pdf>
- EIA. (2019). Energy Information Administration: Turkey's Key Energy Statistics. Retrieved October 2, 2019, from <https://www.eia.gov/beta/international/country.php?iso=TUR>
- Elsland, R., Divrak, C., Fleiter, T., & Wietschel, M. (2014). Turkey's Strategic Energy Efficiency Plan – An ex ante impact assessment of the residential sector. *Energy Policy*, 70, 14–29. <https://doi.org/10.1016/J.ENPOL.2014.03.010>
- EPBD. (2010). *Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings*. Retrieved from <https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:153:0013:0035:EN:PDF>
- EPBD. (2018). Directive (EU) 2018/844 of the European Parliament and of the council of 30 May 2018 amending Directive 2010/31/EU on the Energy Performance of

- Buildings and Directive 2012/27/EU on energy efficiency. Retrieved October 8, 2019, from European Union website: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2018.156.01.0075.01.ENG
- Ergunay, O. (2007). Disaster Profile of Turkey. *TMMOB Disaster Symposium*. Retrieved from <http://www.imo.org.tr/resimler/ekutuphane/pdf/3885.pdf>
- Evans, M., Yu, S., Staniszewski, A., Jin, L., & Denysenko, A. (2018). The international implications of national and local coordination on building energy codes: Case studies in six cities. *Journal of Cleaner Production*, *191*, 127–134. <https://doi.org/10.1016/J.JCLEPRO.2018.04.142>
- Geng, Y., Dong, H., Xue, B., & Fu, J. (2012). An Overview of Chinese Green Building Standards. *Sustainable Development*, *20*(3), 211–221. <https://doi.org/10.1002/sd.1537>
- Gibson, M., & Goksin, Z. A. (2016). *Neighbourhood Regeneration in Istanbul – from Earthquake Mitigation to Planned Displacement and Gentrification* (C. Hein, Ed.). <https://doi.org/10.7480/iphs.2016.2.1243>
- Gurlesel, C. F. (2012). Real Estate Sector in the Vision of 2023. In *The Association of Real Estate Investment Companies*. Istanbul.
- Ibn-Mohammed, T., Greenough, R., Taylor, S., Ozawa-Meida, L., & Acquaye, A. (2013). Operational vs. embodied emissions in buildings—A review of current trends. *Energy and Buildings*, *66*, 232–245. <https://doi.org/10.1016/J.ENBUILD.2013.07.026>
- IEA. (2013a). *International Energy Agency (IEA)|Tracking Clean Energy Progress 2013*.
- IEA. (2013b). Transition to sustainable buildings: Strategies and opportunities to 2050. In *OECD*. <https://doi.org/10.1787/9789264202955-en>

- 1
2
3 IEA. (2017a). IEA - Renewable Portfolio Standard (RPS): Korea. Retrieved October 10,
4
5 2019, from International Energy Agency website:
6
7 [https://www.iea.org/policiesandmeasures/pams/korea/name-39025-](https://www.iea.org/policiesandmeasures/pams/korea/name-39025-en.php?s=dHlwZT1yZSZzdGF0dXM9T2s&s=dHlwZT1yZSZzdGF0dXM9T2s)
8
9 [en.php?s=dHlwZT1yZSZzdGF0dXM9T2s&s=dHlwZT1yZSZzdGF0dXM9T2s](https://www.iea.org/policiesandmeasures/pams/korea/name-39025-en.php?s=dHlwZT1yZSZzdGF0dXM9T2s&s=dHlwZT1yZSZzdGF0dXM9T2s)
10
11
12 IEA. (2017b). *International Energy Agency (IEA)|Global Status Report 2017*. Retrieved
13
14 from [https://www.worldgbc.org/sites/default/files/UNEP_188_GABC_en_\(web\).pdf](https://www.worldgbc.org/sites/default/files/UNEP_188_GABC_en_(web).pdf)
15
16
17 IEA. (2017c). *International Energy Agency (IEA)|Tracking Clean Energy Progress*
18
19 *2017*. Retrieved from www.iea.org/etp/tracking
20
21
22 IEA. (2018). *International Energy Agency (IEA)|Global Status Report 2018*.
23
24 IEA. (2019a). Buildings: Tracking Clean Energy Progress. Retrieved October 2, 2019,
25
26 from <https://www.iea.org/tcep/buildings/>
27
28
29 IEA. (2019b). International Energy Agency (IEA)|Energy Efficiency: Buildings.
30
31 Retrieved September 7, 2019, from
32
33 <https://www.iea.org/topics/energyefficiency/buildings/>
34
35
36 IEA. (2019c). *Perspectives for the Clean Energy Transition*. Retrieved from
37
38 <https://www.iea.org/publications/reports/PerspectivesfortheCleanEnergyTransition>
39
40 /
41
42 Iwano, J., & Mwashu, A. (2010). A review of building energy regulation and policy for
43
44 energy conservation in developing countries. *Energy Policy*.
45
46 <https://doi.org/10.1016/j.enpol.2010.08.027>
47
48
49 Keskin, T. (2010). *Building Sector Current Situation Assessment Report*. Retrieved
50
51 from [http://iklim.cob.gov.tr/iklim/Files/Binalar_Sektoru_Mevcut_Durum](http://iklim.cob.gov.tr/iklim/Files/Binalar_Sektoru_Mevcut_Durum_Degerlendirmesi_Raporu.pdf)
52
53 [Degerlendirmesi Raporu.pdf](http://iklim.cob.gov.tr/iklim/Files/Binalar_Sektoru_Mevcut_Durum_Degerlendirmesi_Raporu.pdf)
54
55
56 Kimura, O. (2010). *Japanese Top Runner Approach for energy efficiency standards*.
57
58 Retrieved from <http://criepi.denken.or.jp/jp/serc/discussion/index.html>.
59
60

- 1
2
3 Koo, C., Hong, T., Lee, M., & Seon Park, H. (2014). Development of a new energy
4 efficiency rating system for existing residential buildings. *Energy Policy*, *68*, 218–
5 231. <https://doi.org/10.1016/J.ENPOL.2013.12.068>
6
7
8
9
10 Laustsen, M. J. (2008). *Energy Efficiency Requirements in Building Codes, Energy*
11 *Efficiency Policies for New Buildings. IEA Information Paper in Support of the G8*
12 *Plan of Action*. Retrieved from <http://www.iea.org/Textbase/about/copyright.asp>
13
14
15
16
17 Leung, J. (2018). *Decarbonizing U.S. Buildings Climate Innovation*. Retrieved from
18 <https://www.eia.gov/outlooks/aeo>.
19
20
21
22 Li, J., & Shui, B. (2015). A comprehensive analysis of building energy efficiency
23 policies in China: status quo and development perspective. *Journal of Cleaner*
24 *Production*, *90*, 326–344. <https://doi.org/10.1016/J.JCLEPRO.2014.11.061>
25
26
27
28
29 Lucon, O., & Üрге-Vorsatz, D. (2014). Buildings. In *Climate Change 2014: Buildings*.
30 *In: Climate Change 2014: Mitigation of Climate Change. Contribution of Working*
31 *Group III to the Fifth Assessment Report of the Intergovernmental Panel on*
32 *Climate Change*. Retrieved from
33 https://www.ipcc.ch/site/assets/uploads/2018/02/ipcc_wg3_ar5_chapter9.pdf
34
35
36
37
38
39
40 MENR. (2016a). *Republic of Turkey|Ministry of Energy and Natural Resources|2017*
41 *Budget Presentation*.
42
43
44
45 MENR. (2016b). *Republic of Turkey|Ministry of Energy and Natural*
46 *Resources|Purpose and Activities of the Ministry of Energy and Natural Resources*
47 *and Related Institutions*. Retrieved from
48
49 <https://www.enerji.gov.tr/File/?path=ROOT%2F1%2FDocuments%2FMavi>
50 <https://www.enerji.gov.tr/File/?path=ROOT%2F1%2FDocuments%2FMavi>
51 <https://www.enerji.gov.tr/File/?path=ROOT%2F1%2FDocuments%2FMavi>
52 <https://www.enerji.gov.tr/File/?path=ROOT%2F1%2FDocuments%2FMavi>
53 <https://www.enerji.gov.tr/File/?path=ROOT%2F1%2FDocuments%2FMavi>
54 <https://www.enerji.gov.tr/File/?path=ROOT%2F1%2FDocuments%2FMavi>
55 <https://www.enerji.gov.tr/File/?path=ROOT%2F1%2FDocuments%2FMavi>
56 <https://www.enerji.gov.tr/File/?path=ROOT%2F1%2FDocuments%2FMavi>
57 <https://www.enerji.gov.tr/File/?path=ROOT%2F1%2FDocuments%2FMavi>
58 <https://www.enerji.gov.tr/File/?path=ROOT%2F1%2FDocuments%2FMavi>
59 <https://www.enerji.gov.tr/File/?path=ROOT%2F1%2FDocuments%2FMavi>
60 <https://www.enerji.gov.tr/File/?path=ROOT%2F1%2FDocuments%2FMavi>
<https://www.enerji.gov.tr/File/?path=ROOT%2F1%2FDocuments%2FMavi>

- 1
2
3 <https://www.enerji.gov.tr/File/?path=ROOT/1/Documents/EİGM Periyodik>
4
5 [Rapor/2017_Yılı_Genel_Enerji_Denge_Tablosu - revize.xlsx](https://www.enerji.gov.tr/File/?path=ROOT/1/Documents/EİGM Periyodik)
6
7 MENR. (2018). *Republic of Turkey|Ministry of Energy and Natural Resources|2018*
8 *Annual Report*. Retrieved from
9
10 <https://www.enerji.gov.tr/File/?path=ROOT%2F1%2FDocuments%2FFaaliyet>
11 [Raporu%2FETKB 2018 Yılı İdare Faaliyet Raporu.pdf](https://www.enerji.gov.tr/File/?path=ROOT%2F1%2FDocuments%2FFaaliyet)
12
13 MENR. (2019). Republic of Turkey Ministry of Energy and Natural Resources: Nuclear
14 Energy. Retrieved October 2, 2019, from [https://www.enerji.gov.tr/en-](https://www.enerji.gov.tr/en-US/Pages/Nuclear-Energy)
15 [US/Pages/Nuclear-Energy](https://www.enerji.gov.tr/en-US/Pages/Nuclear-Energy)
16
17 MFA. (2019). United Nations Framework Convention on Climate Change (UNFCCC)
18 and the Kyoto Protocol. Retrieved October 15, 2019, from Republic of Turkey,
19 Ministry of Foreign Affairs website: [http://www.mfa.gov.tr/united-nations-](http://www.mfa.gov.tr/united-nations-framework-convention-on-climate-change-_unfccc_-and-the-kyoto-protocol.en.mfa)
20 [framework-convention-on-climate-change-_unfccc_-and-the-kyoto-](http://www.mfa.gov.tr/united-nations-framework-convention-on-climate-change-_unfccc_-and-the-kyoto-protocol.en.mfa)
21 [protocol.en.mfa](http://www.mfa.gov.tr/united-nations-framework-convention-on-climate-change-_unfccc_-and-the-kyoto-protocol.en.mfa)
22
23 NCCAP. (2011). *National Climate Change Action Plan*. Retrieved from
24 <http://www.dsi.gov.tr/docs/iklim-degisikligi/idepeng.pdf?sfvrsn=2>
25
26 NEEAP. (2018). *National Energy Efficiency Action Plan 2017-2023*. Retrieved from
27 www.yegm.gov.tr
28
29 Nejat, P., Jomehzadeh, F., Taheri, M. M., Gohari, M., & Muhd, M. Z. (2015). A global
30 review of energy consumption, CO2 emissions and policy in the residential sector
31 (with an overview of the top ten CO2 emitting countries). *Renewable and*
32 *Sustainable Energy Reviews*, Vol. 43, pp. 843–862.
33
34 <https://doi.org/10.1016/j.rser.2014.11.066>
35
36 NREAP. (2014). *National renewable energy action plan for Turkey*.
37
38 RTOG. (2000a). *Republic of Turkey Official Gazette|Regulation on Performance of*
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 *Heat Generators Used for Hot Water Production and Space Heating in New or*
4 *Existing Non-Industrial Buildings, and Implementing of Internal Hot Water*
5 *Distribution and Thermal Insulation in Non.* Retrieved from

6
7
8
9
10 <https://www.resmigazete.gov.tr/eskiler/2000/12/20001214.htm#8>

11
12 RTOG. (2000b). *Republic of Turkey Official Gazette|The Thermal Insulation*
13 *Regulations of The Buildings.* Retrieved from

14
15
16
17 <https://www.resmigazete.gov.tr/arsiv/24043.pdf>

18
19 RTOG. (2007). *Republic of Turkey Official Gazette|Energy Efficiency Law.* Retrieved
20
21 from <https://www.resmigazete.gov.tr/eskiler/2007/05/20070502-2.htm>

22
23 RTOG. (2008a). *Republic of Turkey Official Gazette|(Renewed) The Thermal Insulation*
24 *Regulations of The Buildings.* Retrieved from

25
26
27
28 <https://www.resmigazete.gov.tr/eskiler/2008/10/20081009-2.htm>

29
30 RTOG. (2008b). *Republic of Turkey Official Gazette|Energy Performance of Buildings*
31 *Regulation.* Retrieved from

32
33
34
35 <https://www.resmigazete.gov.tr/eskiler/2008/12/20081205-9.htm>

36
37 RTOG. (2008c). *Republic of Turkey Official Gazette|Regulation on Improving*
38 *Efficiency in the Use of Resources and Energy.* Retrieved from

39
40
41
42 <https://www.resmigazete.gov.tr/eskiler/2008/10/20081025-4.htm>

43
44 RTOG. (2008d). *Republic of Turkey Official Gazette|Regulation on the Distribution of*
45 *Heating and Sanitary Hot Water Expenses in Central Heating and Sanitary Hot*
46 *Water.* Retrieved from

47
48
49
50
51 <https://www.resmigazete.gov.tr/eskiler/2008/04/20080414M1-3.htm>

52
53 RTOG. (2009). *Republic of Turkey Official Gazette|Regulation on the Administration of*
54 *Energy Manager in Schools Department of the Ministry of National Education.*

55
56
57
58 Retrieved from <https://www.resmigazete.gov.tr/eskiler/2009/04/20090417-3.htm>

- 1
2
3 RTOG. (2010a). *Republic of Turkey Official Gazette*|(Revised) *Energy Performance of*
4
5 *Buildings Regulation*. Retrieved from
6
7
8 <https://www.resmigazete.gov.tr/eskiler/2010/04/20100401-5.htm>
9
- 10 RTOG. (2010b). *Republic of Turkey Official Gazette*|*Building Energy Performance*
11
12 *National Calculation Method*. Retrieved from
13
14
15 <https://www.resmigazete.gov.tr/eskiler/2010/12/20101207M1-1.htm>
16
- 17 RTOG. (2010c). *Republic of Turkey Official Gazette*|*Implementing Regulation on*
18
19 *Environmentally Friendly Design of Energy Related Products*. Retrieved from
20
21
22 <https://www.resmigazete.gov.tr/eskiler/2010/10/20101007-7.htm>
23
- 24 RTOG. (2011). *Republic of Turkey Official Gazette*|(Renewed) *Regulation on*
25
26 *Improving Efficiency in the Use of Resources and Energy*. Retrieved from
27
28
29 <https://www.resmigazete.gov.tr/eskiler/2011/10/20111027-5.htm>
30
- 31 RTOG. (2014). *Republic of Turkey Official Gazette*|*Regulation on Certification of*
32
33 *Sustainable Green Buildings and Sustainable Settlements*. Retrieved from
34
35
36 <https://www.resmigazete.gov.tr/eskiler/2014/12/20141208-2.htm>
37
- 38 RTOG. (2017a). *Republic of Turkey Official Gazette*|(Revised) *Energy Performance of*
39
40 *Buildings Regulation*. Retrieved from
41
42
43 <https://www.resmigazete.gov.tr/eskiler/2017/04/20170428-1.htm>
44
- 45 RTOG. (2017b). *Republic of Turkey Official Gazette*|*Green Certificate Regulation for*
46
47 *Buildings and Settlements*. Retrieved from
48
49
50 <https://www.resmigazete.gov.tr/eskiler/2017/12/20171223-3.htm>
51
- 52 Toklu, E., Güney, M. S., Işık, M., Comaklı, O., & Kaygusuz, K. (2010). Energy
53
54 production, consumption, policies and recent developments in Turkey. *Renewable*
55
56 *and Sustainable Energy Reviews*, 14(4), 1172–1186.
57
58
59 <https://doi.org/10.1016/J.RSER.2009.12.006>
60

- 1
2
3 TSI. (2013). Population Projections 2013-2075. Retrieved October 10, 2019, from
4
5 Turkish Statistical Institute website:
6
7 <http://www.turkstat.gov.tr/PreHaberBultenleri.do?id=15844>
8
9
- 10 TSI. (2016a). Income and Living Conditions Survey 2015. Retrieved October 11, 2019,
11
12 from Turkish Statistical Institute website:
13
14 <http://www.turkstat.gov.tr/PreHaberBultenleri.do?id=21584>
15
16
- 17 TSI. (2016b). The Results of Address Based Population Registration System 2016.
18
19 Retrieved October 10, 2019, from Turkish Statistical Institute website:
20
21 <http://www.turkstat.gov.tr/PreHaberBultenleri.do?id=24638>
22
23
- 24 TSI. (2016c). Turkish Statistical Institute: Sectoral Energy Consumption Statistics,
25
26 2014. Retrieved October 2, 2019, from
27
28 <http://www.turkstat.gov.tr/PreHaberBultenleri.do?id=21587>
29
30
- 31 TSI. (2017). Building Permits January-June, 2017. Retrieved October 10, 2019, from
32
33 Turkish Statistical Institute website:
34
35 <http://www.turkstat.gov.tr/PreHaberBultenleri.do?id=24722>
36
37
- 38 TSI. (2019). *Turkish Statistical Institute|Turkish Greenhouse Gas Inventory 1990 -*
39
40 *2017:National Inventory Report for submission under the United Nations*
41
42 *Framework Convention on Climate Change.*
43
44
- 45 TTDP. (2014). *The Tenth Development Plan 2014-2018*. Retrieved from
46
47 [http://www.sbb.gov.tr/wp-](http://www.sbb.gov.tr/wp-content/uploads/2018/11/The_Tenth_Development_Plan_2014-2018.pdf)
48
49 [content/uploads/2018/11/The_Tenth_Development_Plan_2014-2018.pdf](http://www.sbb.gov.tr/wp-content/uploads/2018/11/The_Tenth_Development_Plan_2014-2018.pdf)
50
51
- 52 World Bank. (2010). *Tapping the potential for energy savings in Turkey (English)*.
53
54 Retrieved from
55
56 [http://documents.worldbank.org/curated/en/838031468122365862/Tapping-the-](http://documents.worldbank.org/curated/en/838031468122365862/Tapping-the-potential-for-energy-savings-in-Turkey)
57
58 [potential-for-energy-savings-in-Turkey](http://documents.worldbank.org/curated/en/838031468122365862/Tapping-the-potential-for-energy-savings-in-Turkey)
59
60

1
2
3 Yüksel, I., & Arman, H. (2014). Energy and environmental policies in turkey. *Energy*
4
5 *Sources, Part B: Economics, Planning and Policy*, 9(1), 57–69.

6
7 <https://doi.org/10.1080/15567241003681874>
8
9

10 Zhang, J., Zhou, N., Hinge, A., Feng, W., & Zhang, S. (2016). *Building Research &*
11
12 *Information Governance strategies to achieve zero-energy buildings in China*
13
14 *Governance strategies to achieve zero-energy buildings in China.*

15
16 <https://doi.org/10.1080/09613218.2016.1157345>
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

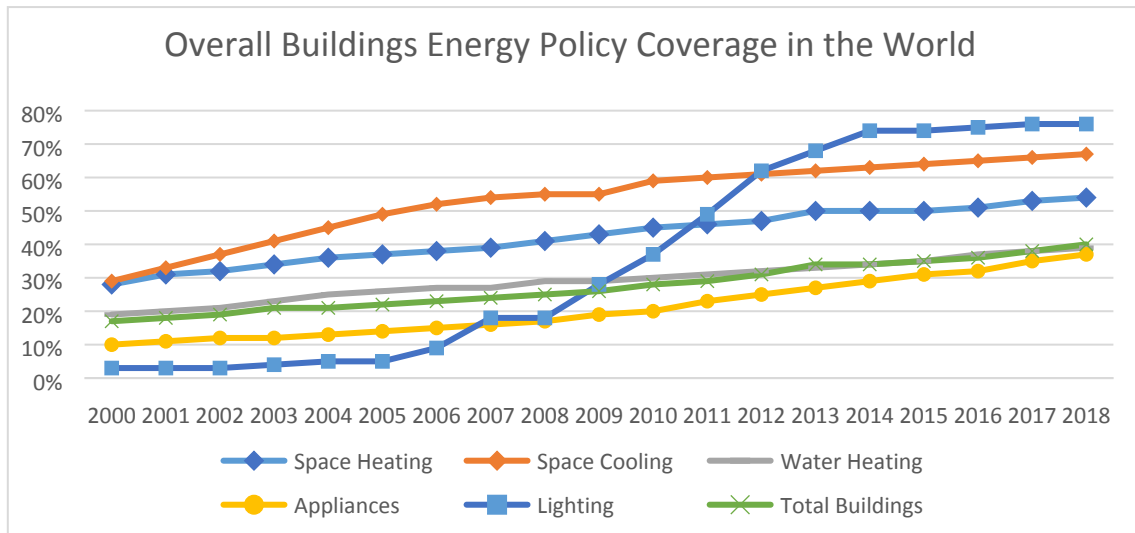


Figure 1. Global energy policy coverage on buildings. Sources: (IEA, 2019a).

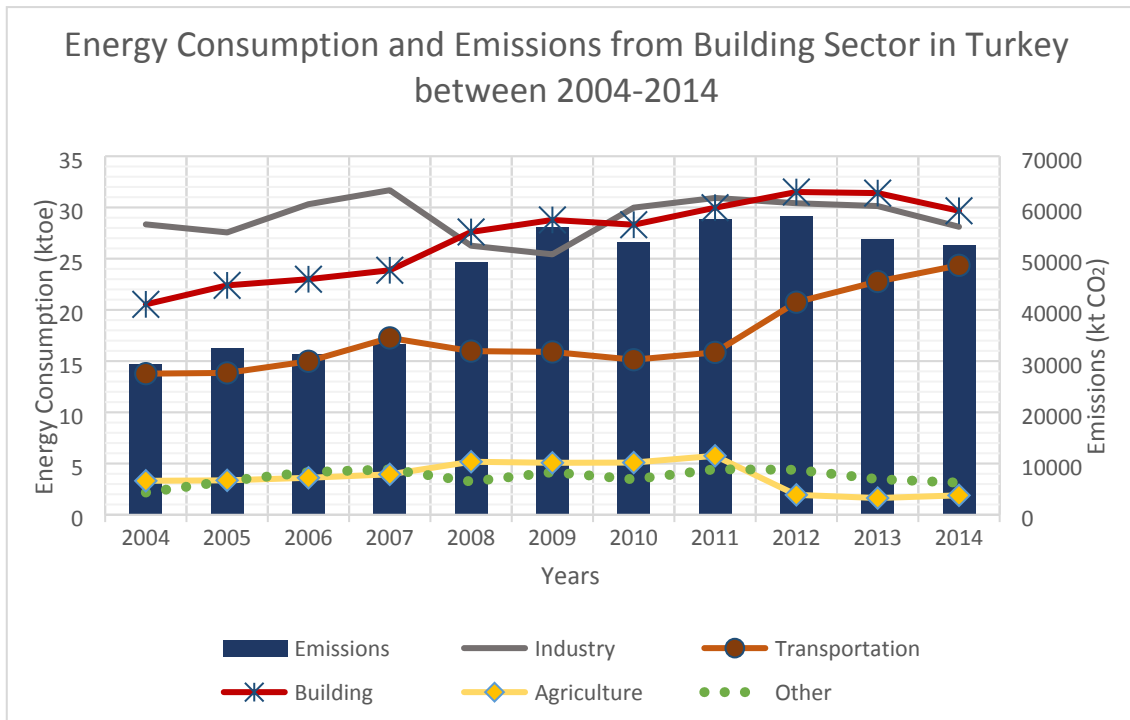


Figure 2. Sectoral distribution of energy consumption and building sector emissions in Turkey. Sources: (MENR, 2016b; TSI, 2019b).

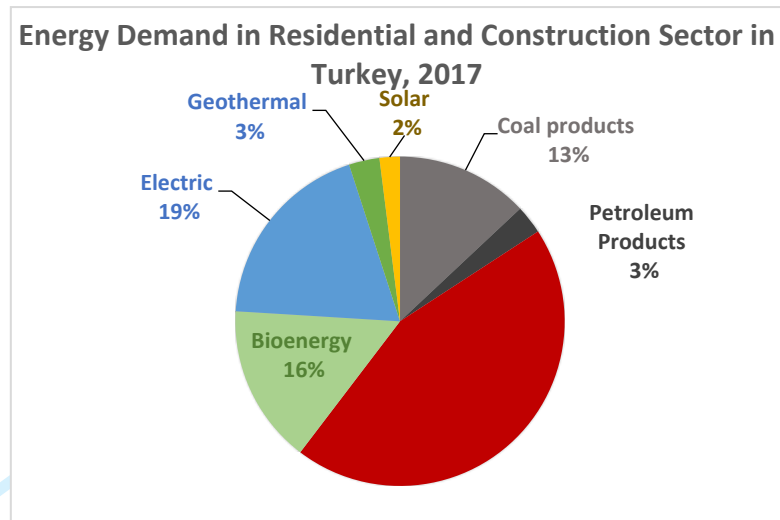


Figure 3. Energy demand breakdown in residential and construction sector of Turkey in 2017. Sources: (MENR, 2017).

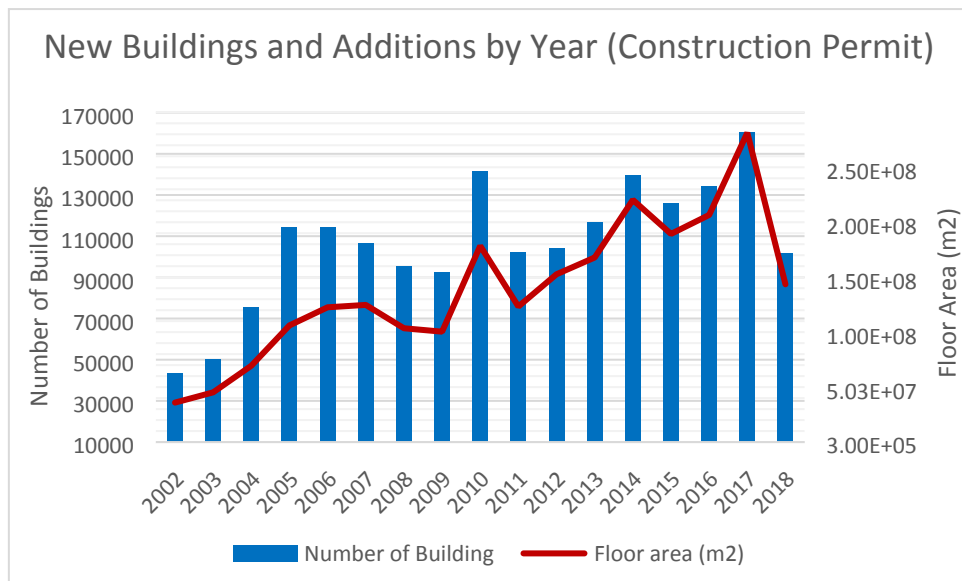


Figure 4. Annual number and floor area of new buildings and additions according to construction permits in Turkey. Sources: (TSI, 2019a).

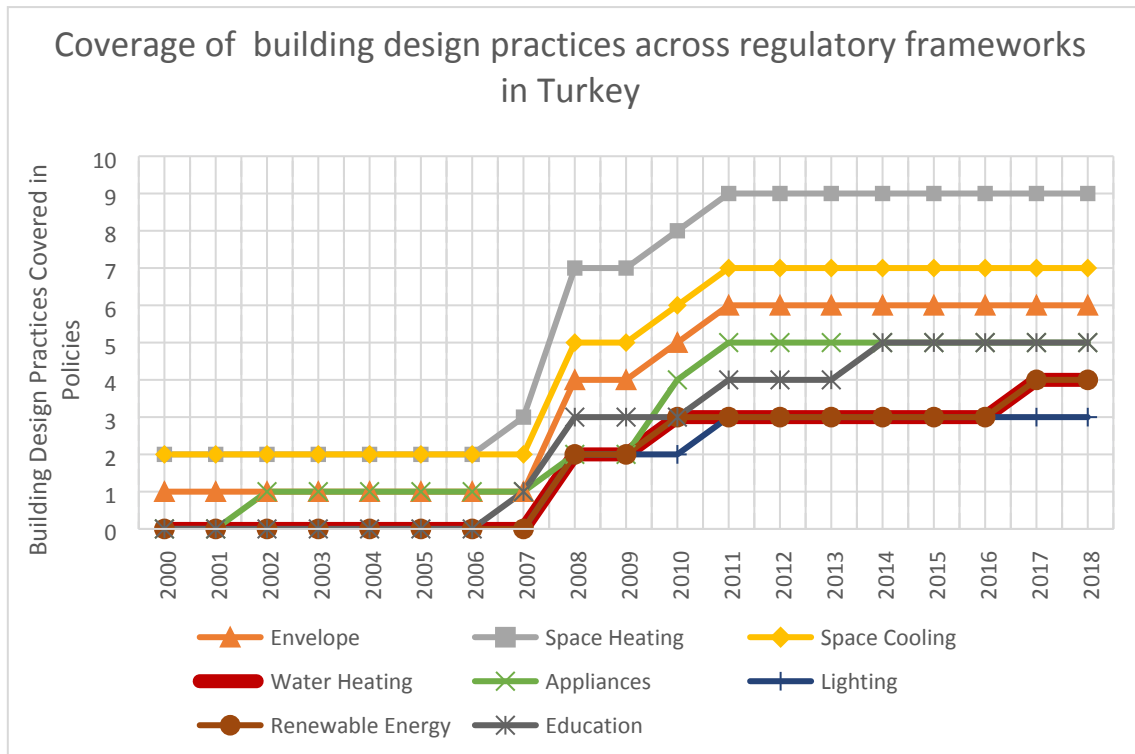


Figure 5. Coverage of Building Design Practices in Policies Related with Sustainability in Buildings of Turkey Between 2000 and 2018.

Table 1. Specific sustainability target samples for buildings from the world.

Country/ Union	Targets			
	Energy Saving	Emissions Reduction	Renewable Energy Sources	Nearly Zero Energy Target
EU	<p>*Mandatory of annual renovation on minimum energy performance for at least 3% of the central government buildings' total floor area (EPBD, 2018).</p> <p>*Obligation energy efficiency in the renovation of existing buildings and energy investments of public authorities for building stock by establishing long-term strategies (EED, 2018).</p> <p>*20% energy efficiency improvement by 2020 in the building and public transport sector (EC, 2019b).</p>	<p>*Implementation a roadmap for low and zero carbon building stock by reducing %80-95 GHG emissions compared to 1990 in the EU by 2050, prior to this 2030 and 2040 are also within the targets (EPBD, 2018).</p> <p>*Reducing emissions by improving the energy performance of buildings, encouraging for energy certification and environmentally friendly energy products, new technologies (EC, 2019a).</p>	<p>*Promoting installation of renewable energy by %30 energy generation; obligation period from 2014 to 2021 (EED, 2018).</p> <p>* Renewable energy is necessary for low energy in nearly zero buildings. Therefore, considering renewable energy sources is mandatory (EPBD, 2018).</p>	<p>* All public buildings built after 2018 and all buildings built after 2020 need to be nearly zero (EPBD, 2018).</p> <p>*Transformation of building stock into nearly zero-energy buildings with long-term plans in investment, cost and energy efficiency (EPBD, 2018).</p>
Denmark	<p>*Approximately 8% reduction (to be around 175 PJ) of total energy consumption of households by 2030 below 2015 level.</p> <p>75% reduction of energy consumption in buildings by 2020 below 2006 level (DEA, 2017).</p> <p>*Renovation of all existing buildings by 2050 (EA, 2008).</p>		<p>* Increasing local use of renewable energy (EA, 2008).</p>	<p>All new buildings built after 2015 will be zero energy (%50 reduced energy consumption compared with 2006) and mandatory of fuel-efficient buildings by 2050 (EA, 2008).</p>
US	<p>*%30 decrease in average thermal load for existing buildings, every new building must be 30% more energy-efficient than IECC and ASHRAE codes' requirements after 2007 and it must be 70% by 2020 (Doris, Cochran, & Vorum, 2009).</p> <p>*30% energy saving for non-residential buildings in California (IEA, 2018).</p>	<p>*70% reduction in carbon emissions with current policies via reduction of energy from new buildings by 2020 (Knowles, 2008)</p> <p>*Promoting intelligent efficiency technologies (Leung, 2018).</p>	<p>* Minimum 25% reduction of the total amount of building electric energy and thermal energy by renewable electric energy and alternatives by the fiscal year 2025 (FR, 2015).</p> <p>* After 2018, solar PV systems are necessary for new homes according to the California 2019 Building Energy Efficiency Standards (IEA, 2018).</p>	<p>*Net-zero energy for all new residential construction by 2020 and for all new commercial construction by 2030. Net zero for all commercial buildings by 2050 (Crawley, Pless, & Torcellini, 2009).</p> <p>* Ensuring net-zero all new Federal buildings over 5000 gross square feet area by 2020 and intended net-zero existing buildings over 5000 gross square feet area by 2025 (FR, 2015).</p>
Canada	<p>*%10 energy saving compared to 2011, promoting energy retrofitting in existing buildings and increasing the energy performance of appliances (IEA, 2018).</p>	<p>*Funding investments of projects to reduce greenhouse gas emissions (IEA, 2018).</p>		<p>*Introduced Zero Carbon Standards by Canada Green Council, with 16 sample pilot projects (IEA, 2017b).</p> <p>*Achieving net-zero energy ready buildings by 2030 (IEA, 2018).</p>
Japan	<p>*Promoting energy efficiency measures (METI, 2017).</p>	<p>*Reducing carbon emissions with the enforcement of the "Low Carbon City Act" (MLIT, 2019).</p>		<p>* Zero energy level of new public buildings by 2020, and new public and private buildings by 2030 (METI, 2015a).</p> <p>* Zero emission level in standard new built houses by 2020 and average zero-emission level in newly built</p>

				houses by 2030 (METI, 2015b).
		*37% reduction (18.1% in the building sector) of greenhouse gas emissions by 2030 (Jeong, Hong, & Kim, 2018).		* Zero energy constructed of all buildings by 2025 (IEA, 2017a).
South Korea	*38 Mtoe overall energy saving by 2030 and 32% (12 Mtoe) in the residential and commercial sector.	* Regarding the reduction of emissions from buildings, 50%, 25% and 25% for existing buildings, new buildings and improvement of occupant behaviour, respectively (Koo et al., 2014).	*Expanding markets for renewable and new energy by promoting these energies and providing discounts on installation costs (KEA, 2015a).	* One million new green home by 2020 and in total 2 million energy-efficient/environmentally friendly house by 2020 (KEA, 2015b).
China	*50% energy decrease in new buildings (Nejat et al. 2015). Increasing the application of energy efficiency higher standards and 75% energy saving compared to 1980s building standards (IEA, 2015).			At least 50% of new buildings will be green in 2020 (IEA, 2015).

Table 2. Policies on the sustainability of buildings in Turkey.

Policy and Legislation Item	Outline	Building Design Practices Covered							
		Envelope	Space Heating	Space Cooling	Water Heating	Appliances	Lighting	Renewable Energy	Education
The Thermal Insulation Regulations of the Buildings (No. 24043/2000 and renewed No.27019/2008)	Regulates the principles of application for energy saving and reducing the heat losses in buildings (RTOG, 2000b).	•	•	•					
Regulation on Performance of Heat Generators Used for Hot Water Production and Space Heating in New or Existing Non-Industrial Buildings, and Implementing of Internal Hot Water Distribution and Thermal Insulation in Non-Industrial Buildings (No.24260/ 2000)	Defines the principles for the economic use of energy, energy-saving to protect the environment and economic heat insulation for heating systems when installing new heating systems (RTOG, 2000a).		•		•				
Energy Labels for Households Appliances Law (No. 4703/2002, No. 26376/2006, No. 27478/2010)	Defines the energy labelling of the appliances regarding energy consumption and eco-design requirements (RTOG, 2002).					•			
Energy Efficiency Law (No. 5627/2007)	Conducts the implementation of measures to improve energy efficiency for all sectors, reducing the energy cost on the economy, protecting the environment via efficiency in energy resources and regulates the related policy (RTOG, 2007).		•						•
Renewed The Thermal Insulation Regulations of the Buildings (No.27019/2008)	Regulates the procedures and principles regarding the reduction of heat losses in buildings, energy-saving and implementation (RTOG, 2008a).	•	•	•					
Regulation on Improving Efficiency in the Use of Resources and Energy (No.27035/2008)	Regulates the procedures and principles for increasing the efficiency of energy use (RTOG, 2008c)	•	•	•		•	•	•	•
Regulation on the Distribution of Heating and Sanitary Hot Water Expenses in Central Heating	Determines the principles regarding the distribution of heating and sanitary hot water expenses in the existing and new buildings with central or district heating and sanitary hot water systems (RTOG, 2008d).		•		•				

and Sanitary Hot Water (No.26847/2008)									
Energy Performance of Buildings Regulation (EPBR) (No. 27075/2008)	Determines minimum energy performance requirements for buildings by considering outdoor climate conditions, indoor requirements, local conditions and cost-effectiveness. Regulates the application of renewable energy systems, limitation of greenhouse gas emissions and control of heating and cooling systems (RTOG, 2008b).	•	•	•	•	•	•	•	•
(Revised) Energy Performance of Buildings Regulation (EPBR) (No. 27359/2010)		•	•	•	•	•		•	
Implementing Regulation on Environmentally Friendly Design of Energy-Related Products (No. 27722/2010)	Determines the framework of the conditions that must be complied within the design of energy-related products by increasing energy efficiency, environmental protection level (RTOG, 2010c).						•		
(Renewed) Regulation on Improving Efficiency in the Use of Resources and Energy (No.28097/2011)	Regulates the principles and procedures regarding the efficient use of energy, prevention of energy waste and increasing the efficiency in the use of energy resources and energy for the protection of the environment, and covers energy efficiency training and certification activities (RTOG, 2011).	•	•	•			•	•	•
Regulation on Certification of Sustainable Green Buildings and Sustainable Settlements (No. 29199/ 2014)	Regulates the principles and procedures for establishing assessment and certification systems for sustainable green buildings and sustainable settlements (RTOG, 2014).								•
(Revised) Energy Performance of Buildings Regulation (EPBR) (No.30051/2017)							•		•
Green Certificate Regulation for Buildings and Settlements (No.30279/2017)	Regulates the procedures and principles related to the establishment of assessment and certification systems, assessment and certification process in order to mitigate the negative effects of buildings and settlements on the environment by using natural resources and energy efficiently (RTOG, 2017b).								

Table 3. Turkey's specific sustainable buildings objectives.

Strategy	Targets			
	Energy Saving	Emissions Reduction	Renewable Energy Sources	Nearly Zero Energy Target
National Climate Change Action Plan 2011-2023 (NCCAP) (NCCAP, 2011)	<ul style="list-style-type: none"> * Heat insulated and energy-efficient at least 1 million residential building, and public and commercial buildings with more than 10,000 m² by 2023 * Increasing energy saving in public buildings by 20% until 2023 * Promoting in situ energy generation in housing estates 	<ul style="list-style-type: none"> * Emissions reduction in new settlements by at least 10% compared to existing settlements by 2023 	<ul style="list-style-type: none"> * Increase the use of renewable energies and local energy * Necessary renewable energy systems with appropriate pre-investment cost, with 10 years pay-back period new buildings with less than 20,000 m² floor area and 15 years for new buildings with 20,000 m² or more * Necessary solar power systems for central space heating and hot water for non-residential buildings with more than 1,000 m² * Encouraging the usage of renewable energy via meeting at least 20% of the annual energy demand of new buildings as from 2017 	<ul style="list-style-type: none"> * Increase zero energy, passive energy and green building design * Encouraging usage of low-zero carbon technologies and clean coal technologies * Upgrading EIC certificate classification levels and providing coordination between revised EPBR and TS 825 by 2023
Energy Efficiency Strategy Paper 2012-2023 (EESP) (EESP, 2012)	<ul style="list-style-type: none"> *10% reduction in energy consumption of public buildings by 20% by 2023 *At least 20% reduction below 2011 values in the amount of energy intensity consumed per Gross Domestic Product by 2023 * Meeting with the current standards for heat insulation and energy-efficient heating system in commercial and service buildings with a useful area over 10000m² *Increasing Energy Efficient products 	<ul style="list-style-type: none"> * Administrative sanction for exceeding minimum CO₂ value from 2017 onwards * Promotion of sustainable and environmentally friendly buildings 	<ul style="list-style-type: none"> * Promotion of renewable energy resources in mass housing projects 	

		* To be sustainable of at least one-quarter of the building stock in 2010 until 2023 *20% reduction below 2013 values in energy consumption for buildings related to the ministry		
National Renewable Energy Action Plan 2013-2023 (NREAP) (NREAP, 2014)			*Promoting of renewable energy use in buildings	
Strategic Plan 2015-2019 (SP, 2015)	*20% increase in energy efficiency in the buildings of Ministry of Energy and Natural Resources compared to 2013 energy consumption levels * Implication of smart devices for monitoring energy consumptions in pilot buildings	* Rehabilitation of ministry buildings to decrease CO ₂ emissions		* Obligation of Energy Identification Certificate at C level in new buy and rented ministry buildings
National Energy Efficiency Action Plan 2017-2023 (NEEAP) (NEEAP, 2018)	*Establishing a database including energy consumption data of buildings until 2020 * Rehabilitation on existing buildings: replacement of building insulation, heaters, HVAC devices, lighting, hot water, daylighting systems, home automation * Promoting central and district heating systems in housing estates and large dwelling units with starting application after 2020 and promoting it in existing housing estates until 2023 * Financial support for energy efficiency measures in buildings * Establishing pilot projects in selected cities to implement the energy efficiency projects * Increasing implementation of energy efficiency	* Administrative sanctions for buildings causing higher CO ₂ emissions than standards	* Promoting integration of renewable energy and cogeneration technologies to buildings * Promoting district heating system using geothermal potential and waste heat from industrial and power generation facilities until 2023 * Facilitating the use of PVC solar panels	* Increasing the number of Energy Identification Certificate in existing buildings and sanctions on inefficient buildings will be evaluated after 2021 * Promoting of Green Building Certification Implementation * Planning target for an obligation of nearly zero energy building for new public and private buildings after 2020

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

investments in public
buildings after 2019

For Peer Review Only