Climate Action Tracker

Scaling up climate action

Key opportunities for transitioning to a zero emissions society

FULL REPORT

CAT Scaling Up Climate Action series

TURKEY

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NEW CLIMATE INSTITUTE

CLIMATE ANALYTICS

CAT Scaling Up Climate Action series

The Climate Action Tracker (CAT) strives to support enhancing climate action in the context of the Paris Agreement implementation. This analysis contributes to future revisions of mitigation targets, and aims at spurring an increase in climate mitigation actions, to close the gap between current emissions projections and required Paris-compatible pathways.

As part of this, we have been researching the potential for countries to scale up climate action in different focus areas. The analysis in this report is relevant to Parties considering revisions to their Nationally Determined Contributions (NDCs) to be submitted under the Paris Agreement by 2020 or thereafter, and also to their submission of long-term low greenhouse gas development plans, also due by 2020.

The result is our **Scaling Up Climate Action** country series, which identifies options for increased sectoral action that would move a country towards a pathway compatible with the Paris Agreement's long-term temperature limit and estimates the impact of those actions on emissions and other benefits.

The first round of our analysis covers **South Africa**, the **European Union**, **Argentina**, **Indonesia**, **Turkey**, and **Australia**.

The consistent method and similar structure for all six reports allows for country-specific insights, while enabling a cross-country comparison to draw general research findings and lessons learnt on global potentials.

Executive summary

Introduction and objectives

Under the Paris Agreement, governments have committed to limiting temperature increase to well below 2°C above pre-industrial levels and pursuing efforts to limit it to 1.5°C. Current efforts are insufficient: aggregate mitigation targets for 2030, according to Climate Action Tracker (CAT) estimates, result in global warming of about 3.0°C by 2100. Implementation of the targets is falling short, with greenhouse gas (GHG) emissions under implemented policies leading to an estimated warming of around 3.3°C.

To stay below the globally agreed limit, the IPCC Special Report on 1.5°C finds that an increase in efforts is required to peak global GHG emissions as soon as possible, reduce them by 45% compared to 2010 by 2030, and reduce CO_2 emissions to net-zero around 2050 and total GHG emissions by around 2070.

We no longer live in a world where climate change mitigation is a burden per se, but where it increasingly becomes the most feasible option when considering all socio-economic aspects. For cost-efficient global mitigation, it will be essential to make those mitigation actions accessible to, and overcome remaining barriers in, all countries.

In recent years, measures to reduce GHG emissions have, in many cases, become more attractive globally to policy makers and private investors, both because of falling technology costs, as well as increased awareness of the negative impacts to be avoided and other positive benefits of mitigation measures such as air quality improvement and job creation from zero-carbon technology and infrastructure development.

This report, the fifth country assessment in the Climate Action Tracker's Scaling Up Climate Action Series, analyses three key areas where Turkey could accelerate its climate action: electricity supply, road and rail passenger transport and the residential buildings sector. The report illustrates GHG emissions reductions from such actions, along with other benefits for sustainable development.

Our analysis begins with an in-depth review of Turkey's current policy framework and sectoral developments, comparing them with the policy packages and the sector indicators required under 1.5°C-compatible pathways.

We then focus on three areas we have identified that have a large potential to increase mitigation efforts: electricity supply, passenger road and train transport, and residential buildings. They were selected based on their share of GHG emissions while considering national and local circumstances, and the potential for scaling up climate action in these areas. The CAT emphasises that other sectors must also take similarly ambitious actions to decrease economy-wide emissions in line with the Paris Agreement.

Finally, we identify different scenarios of accelerated climate action in each sector:

	Scenario categories	Definitions
1	NATIONAL SCENARIOS	Scenarios based on national research and country-specific studies
2	BEST IN CLASS SCENARIOS	Scenarios based on practices implemented by regional or international frontrunners
3	1.5°C PARIS AGREEMENT COMPATIBLE SCENARIOS	Scenarios based on sectoral developments in line with the Paris Agreement's temperature limit.
4	CURRENT DEVELOPMENT SCENARIO	Baseline scenario used for comparison purposes. The scenario is based on the continuation of current trends and policies until 2050.

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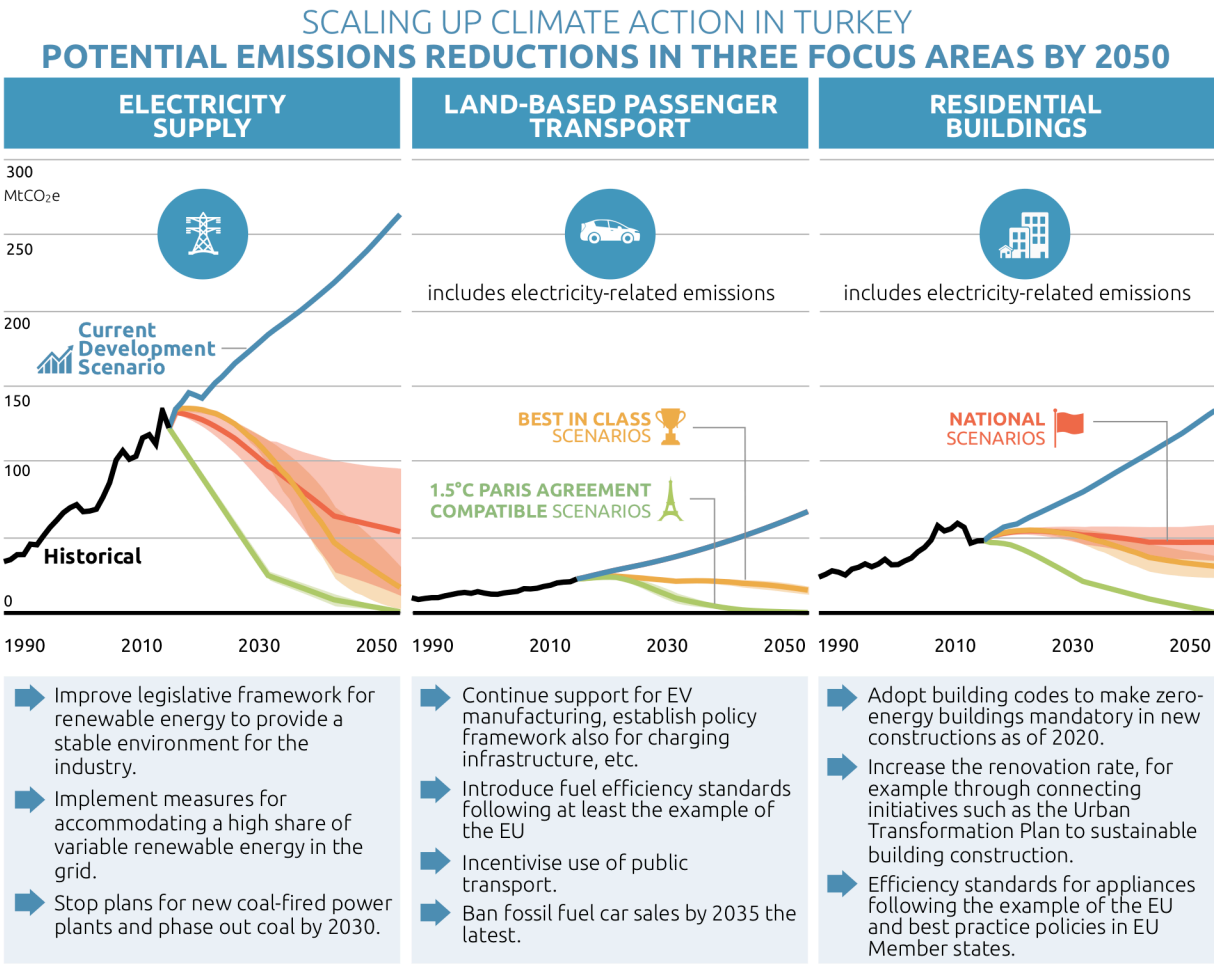


Figure 1: Overview of actions to manage the transition to a Paris-compatible pathway in three key sectors in Turkey

KEY FINDINGS

- Scaling up climate action in Turkey's electricity supply, passenger road and rail transport, and residential buildings sectors alone can reduce economy-wide emissions by 14% below 2017 levels by 2030, reversing the current upward trend. Together, these sectors account for about 50% of Turkey's national GHG emissions (excluding land use and forestry), which were at 526 $MtCO_2e$ in 2017.

- Turkey is already overachieving its mitigation target set in its Paris Agreement pledge ("Intended Nationally Determined Contribution" or INDC) and should improve this target by 2020.

- Ambitious decarbonisation efforts for these three selected sectors in Turkey would significantly reduce GHG emissions and foster co-benefits such as business opportunities for the construction and manufacturing industry, employment generation in the area of renewable energy, supporting sustainable development goals by reducing pollution from conventional modes of transport and electricity generation, and promoting modern housing facilities.

- To support energy security, Turkey aims at increasing both the share of renewables as well as domestic coal in **electricity generation**. The prices for renewables from Turkey's renewable auction rounds are very low, which brings into question the economic attractiveness of further embarking on fossil energy. In fact, the plans for new coal fired power plants, while still among the world's largest, has decreased in recent years. For a Paris-compatible electricity sector, Turkey needs to phase out coal by 2030, significantly increase the role of renewables in its planning, and establish a sound legislative framework that should include allowing for a high share of variable renewables. Turkey's electricity generation needs to be fully decarbonised by mid-century. This is also key for decarbonising end-use sectors through electrification.

- In parallel to decarbonising electricity, strong electrification of the passenger vehicle fleet is required to bring the Turkish **passenger transport sector** onto a pathway in line with the Paris Agreement. Other influencing factors, besides electrification, include a shift towards a higher share of public transport. In our Paris Agreement compatible scenarios, such actions reduce emissions in this sector by around a third in 2030 from today, and reduce them to zero by 2050.

- Turkey is one of the largest automotive manufacturers for exportation. It is also aiming at producing electric vehicles domestically, which will be an important step in enabling such a transition in Turkey and improving global competitiveness.

- A Paris-compatible **residential buildings sector** requires strengthened standards for new buildings towards near-zero energy, and a deep renovation of existing residential buildings. Heating and cooking need electrification and energy efficiency improvements, also required for lighting and other appliances. In our Paris-compatible scenarios, such actions can reduce emissions in this sector by 40% to 50% by 2030 from today, and to zero by 2050. This includes electricity-related emissions, under the assumption that the electricity sector decarbonises.

Sector transitions towards zero-carbon

In Turkey, there is tremendous potential to scale up climate action, including in the focus areas of this study, that is: electricity supply, road and rail passenger transport, and residential buildings. Increasing climate action now would initiate technically-feasible sectoral transitions towards a zero-emissions society while directly benefiting Turkey's sustainable development agenda.

Our findings confirm that ambitious decarbonisation efforts for the selected sectors in Turkey are feasible. They would significantly reduce greenhouse gas (GHG) emissions and foster co-benefits such as low-carbon-oriented employment generation, supporting sustainable development goals by reducing the adverse pollution effects of conventional modes of transport and electricity generation, and promoting modern housing facilities.

Electricity supply

To bring the electricity generation sector onto an emissions pathway in line with the Paris Agreement, an immediate and drastic reduction of today's emissions is required, as well as the full decarbonisation of the power sector by mid-century.

In our most ambitious Paris Agreement compatible scenario, Turkey needs to quickly ramp-up renewable electricity generation (up to 80% by 2030), exceeding the current renewable energy target. It also needs to decrease coal power by decommissioning current coal power plants and stop constructing new coal power plants, with the aim of phasing out coal-fired power generation by 2030.

Today, Turkey aims at increasing both the share of renewables as well as domestic coal to support energy security. The prices for renewables from Turkish renewable auction rounds are very low, which brings into question the economic attractiveness of further embarking on fossil energy. Turkey's coal pipeline, while still among the world's largest, has decreased in recent years.

For a Paris-compatible electricity sector, Turkey needs to significantly increase the role of renewables in its planning and establish a sound legislative framework to allow a high share of variable renewables. This way it can avoid risking stranded assets in the fossil energy industry.

Ambitious climate policy action in the electricity generation sector will bring other benefits beyond climate change mitigation, such as local employment. Between 2017 and 2018, employment in the renewable industry decreased because of uncertainties in the policy framework (Ferroukhi, Renner, García-Banos, & Khalid, 2019). A clear direction from the government towards renewables can provide investment security and lead to long-term sustainable employment. Turkey is a resource-rich country in terms of renewable energy resources. Most recent targets from the 11th Development Plan aim to reach a renewable energy share of 38.8% in 2023; however, there is no plan for renewables for the years beyond 2023 (SHURA, 2019). This is not enough to reach the required levels of 60% to 80% by 2030 as defined in our 1.5°C-compatible scenarios, and will underutilise Turkey's renewable energy potential. The realistic deployment potential of renewables is estimated at more than 1000 TWh per year, about double the demand forecast for 2030.

The Turkish government foresees that the country's energy demand will increase between 3.7% and 5.1% in the coming years, with the growth rate slowing down to between 2.7% to 3.8% in 2030 (*Türkiye Elektrik Enerjisi Talep Projeksiyonu Raporu*, n.d.). In spite of the projected growth, overcapacity in the power sector has caused restrictions for new power plants in recent years

(Saygın, Cebeci, Tör, & Godron, 2019). Turkey can cover up to 50% of electricity demand in 2026 through renewables (Godron, Cebeci, Tör, & Saygin, 2018), making investments in other technologies redundant.

Decarbonising electricity generation is essential in decarbonising other sectors. Electricity demand in Turkey will increase not only because of growing demand for traditional use of electricity but also because the electrification of demand is a key strategy in decarbonising the whole economy.

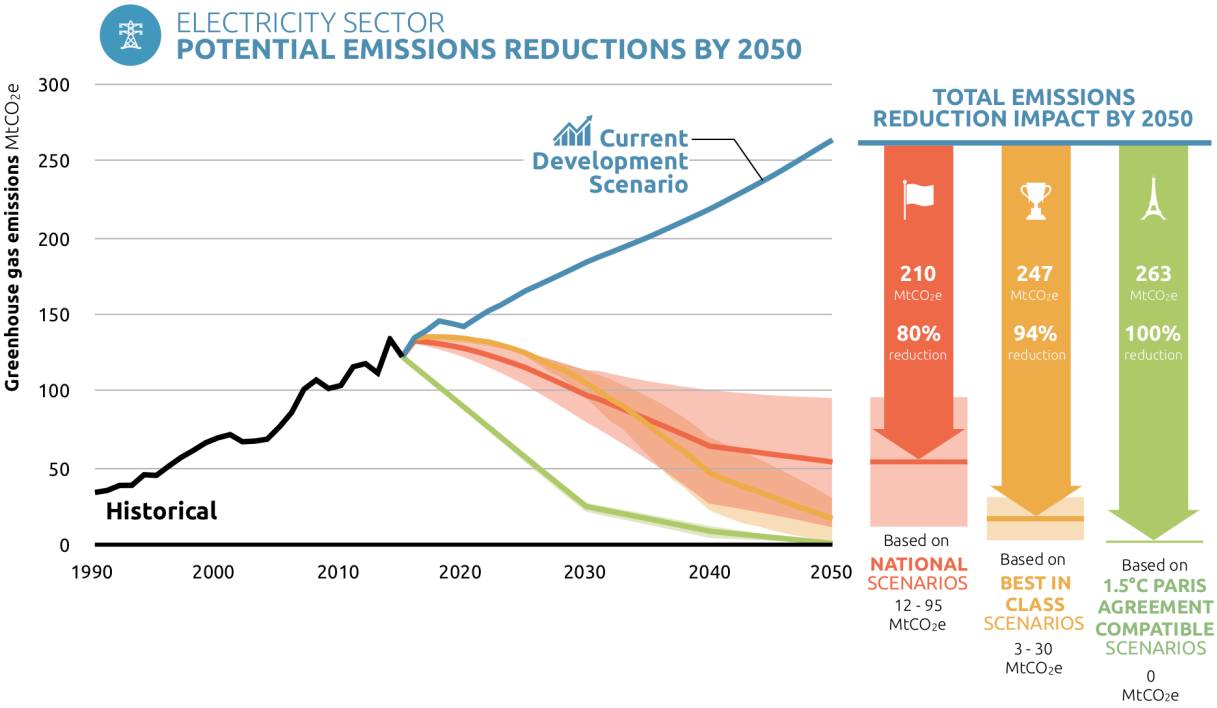


Figure 2: Overview of sectoral emissions pathways in the electricity sector under current policies and different levels of accelerated climate action. The projected electricity demand also considers accelerated climate action in the passenger transport and residential buildings sectors. All sectoral historical emissions and projections towards 2050 are analysed in the CAT PROSPECTS Turkey scenario evaluation tool. For more details on the scenario definition, see chapter 4 of the full report.

Land-based passenger transport

In a country with a rapidly growing, increasingly urban population, there is a huge potential for national and sub-national actors to accelerate climate action by decarbonising road and rail passenger transport.

Road and rail passenger transport can be decarbonised through a combination of the electrification of the passenger vehicle fleet, a shift towards public transport and fuel intensity improvements of the remaining non-electric personal vehicles. Electrification of the passenger transport sector depends on the full decarbonisation of the electricity generation sector. In our Paris compatible scenario, such actions can reduce GHG emissions in these sectors by up to 40% in 2030 and 100% in 2050 compared to 2015.

Given current developments and plans, Turkey has begun taking its first steps towards decarbonising both the road and rail passenger transport. Turkish climate policy includes the objective of developing and promoting alternative fuels and clean vehicle technologies. Turkey aims at manufacturing its own electric vehicle (EV) by 2022, which will be an important opportunity to boost EV sales in the country, but also to help make the automotive industry competitive internationally.

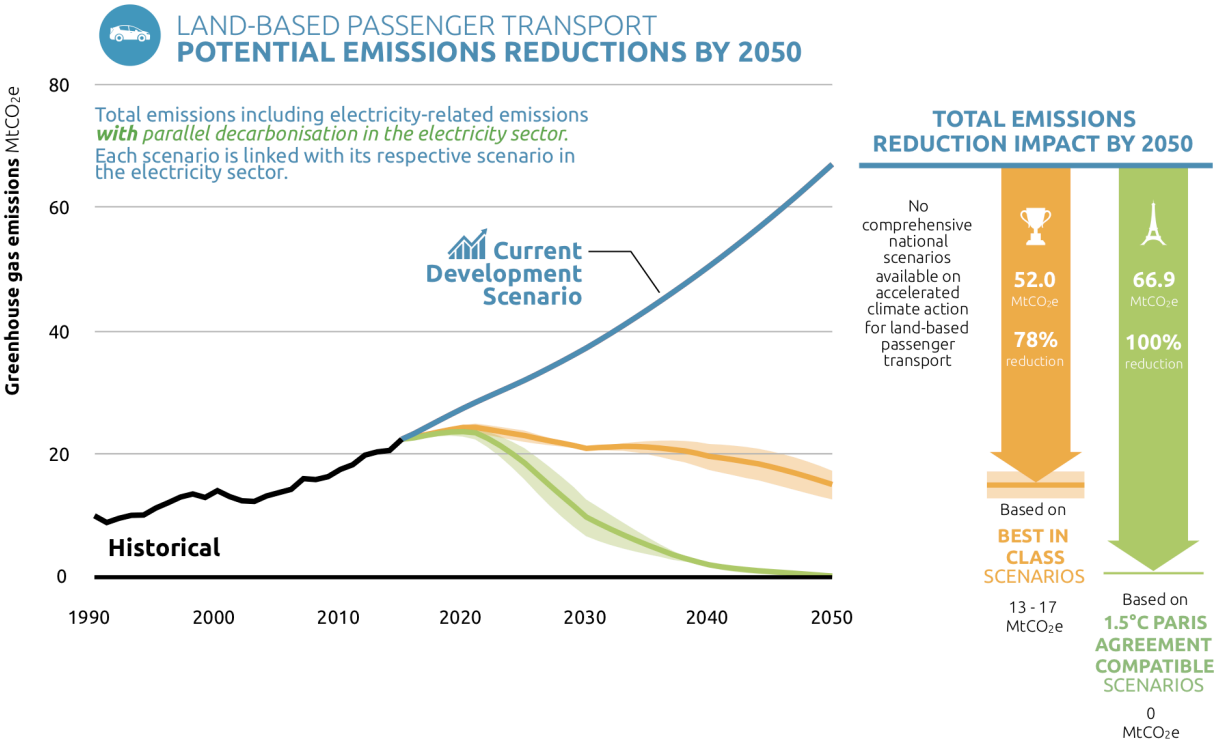


Figure 3: Overview of sectoral emission pathways under current policies and different levels of accelerated climate action in the road and rail passenger transport. All historical data and sectoral projections towards 2050 from the CAT PROSPECTS Turkey scenario evaluation tool. Data includes electricity related emissions. For more details on the scenario definition, see chapter 4 of the full report.

Residential buildings

Decreasing the energy demand is at the core of Turkey's objective to reduce the dependency on energy imports from abroad, and the buildings sector is the country's largest final-energy consumer. The construction sector is an essential pillar of the Turkish economy, with a contribution of 6.6% of GDP (GIZ, 2018). There is large potential in improvements of the building envelope and the electrification of appliances for cooking and heating, in combination with the decarbonisation of the electricity sector.

Decarbonisation of residential buildings can be achieved by strengthening standards for new buildings to near zero energy buildings (NZEBs) and a deep renovation of the existing buildings stock. Turkey already undertakes measures in this direction in its National Energy Efficiency Action Plan (NEEAP) and could build on those to bring the policy framework towards a Paris-compatible pathway. In our Paris-compatible scenario, such actions can reduce GHG emissions in this sector by up to 41% in 2030 and 93% by 2050 compared to 2015.

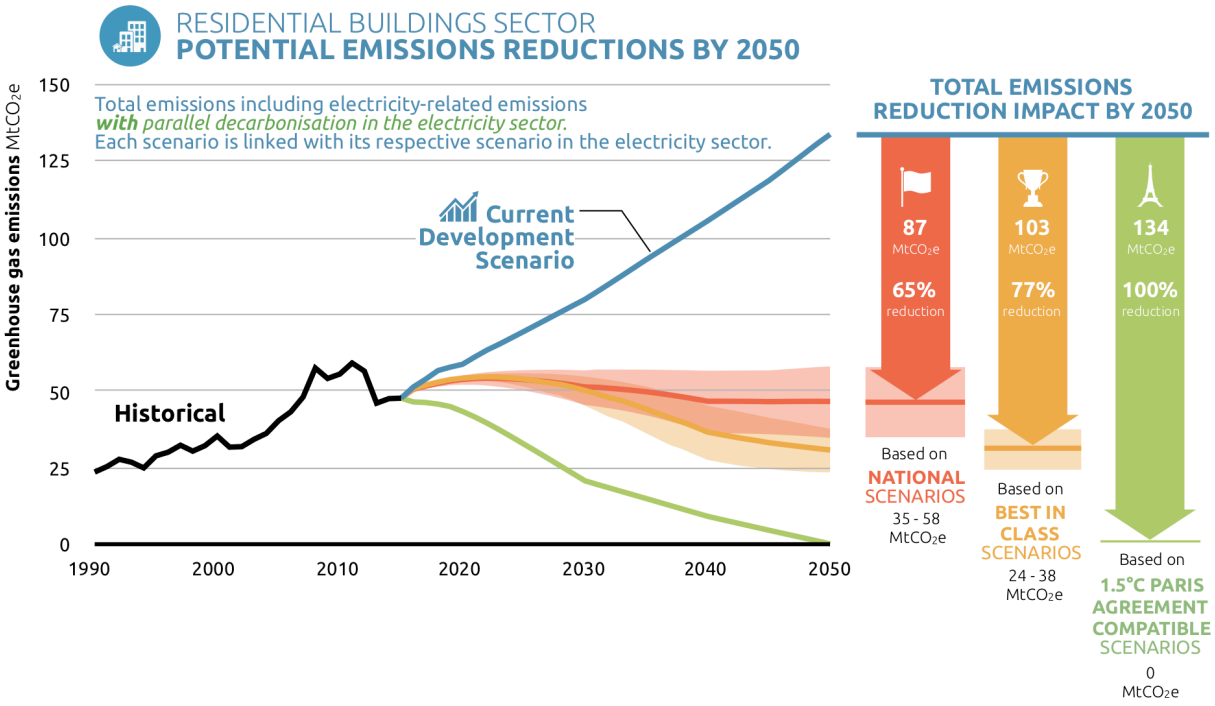


Figure 4: Overview of sectoral emission pathways under current policies and different levels of accelerated climate action in the residential buildings sector. All historical data and sectoral projections towards 2050 from the CAT PROSPECTS Turkey scenario evaluation tool. Data includes electricity related emissions. For more details on the scenario definition, see chapter 4 of the full report.

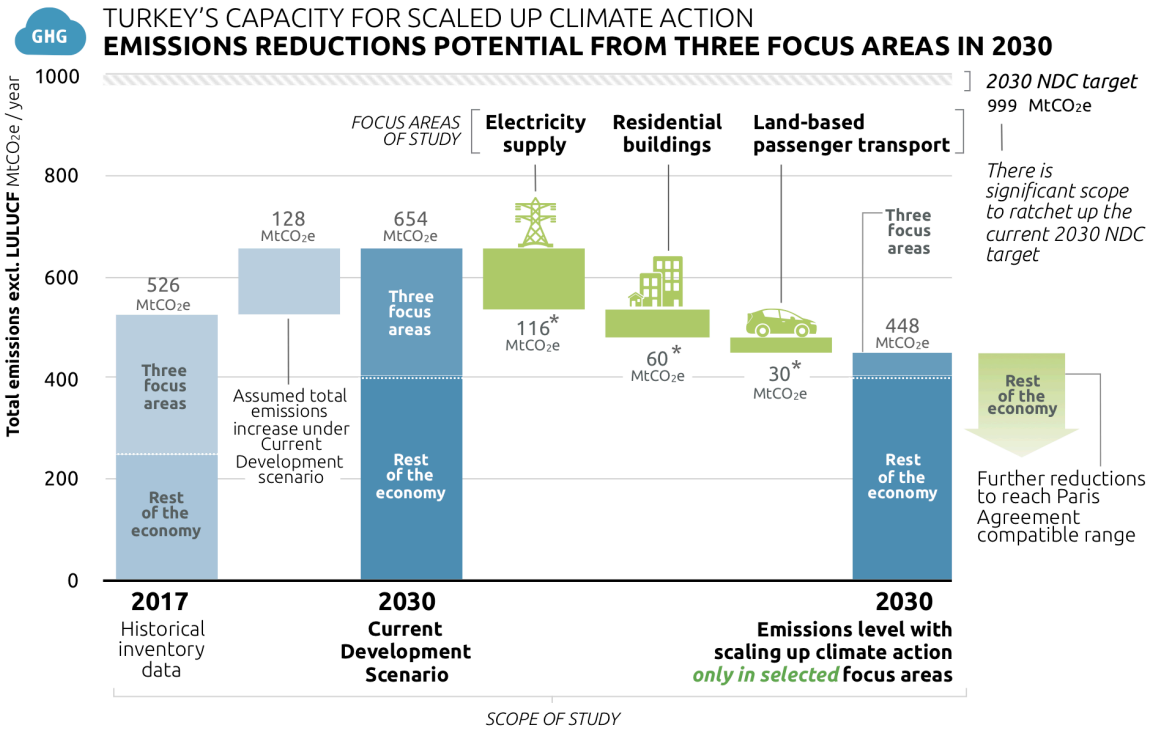
Accelerated climate action and Turkey's emission reduction targets

Scaling up climate action in Turkey's electricity supply, ground passenger transport, and residential buildings sector alone can reduce Turkey's total greenhouse gas emissions by up to 14% below 2017 levels by 2030, reversing the current upward trend.

This is 30% below where current developments are heading, and far below the emissions levels resulting from Turkey's (non-ratified) Paris Agreement target (INDC), which would result in an increase of emissions of 90% from 2017 levels. The CAT rates this target "Critically insufficient".

Turkey easily overachieves its INDC with its currently implemented policies, so there is huge potential for increasing its level of ambition. If Turkey were to increase its target to the level resulting from scaled-up climate action in the three target sectors we have identified, the CAT would increase Turkey's rating by two grades–to "Insufficient."

While our analysis focuses on three sectors covering about 50% of emissions today, Figure 5 also shows the remaining emissions in others sectors not addressed here. For Paris-compatibility it will be essential to implement climate action to effectively address emissions in all sectors.



* Emissions reductions from electricity use are allocated to end use sectors, for example emissions from electricity use in buildings are allocated to the buildings sector and removed from the electricity supply sector total.

Figure 5: Overview of total emission levels (excl. LULUCF) under historical inventory data in 2017 (left bar), under a current development scenario in 2030 (middle bar), and most ambitious levels of accelerated climate action by 2030 in the electricity supply, the residential buildings sector, and the passenger transport (right bar). All electricity-related emission reductions from the residential buildings and passenger transport sectors are allocated as emissions reductions under these two end-use sectors.

The status of sectoral transitions: opportunities for accelerating climate action

The transitions towards zero-emissions in the Turkish electricity supply, rail and road passenger transport, and residential buildings sectors have all shown slow progress or have barely begun. Given the status of the policy activities in the three focus sectors, more accelerated and stringent climate action is required to initiate meaningful sectoral transitions.

Table 1 is an overview of this study's evaluation of the current state of policy action for the three sectors compared with sector-specific benchmarks. These benchmarks represent the most important short-term steps for limiting global warming to 1.5°C identified by the Climate Action Tracker. The full results of this analysis for all sectors are detailed in Chapter 2 of the report.

Table 1: Summary table for sectoral policy activity and gap analysis in Turkey for the electricity supply, rail and road passenger transport, and residential buildings sectors. 1.5°C-consistent benchmarks relate to most important short-term steps for limiting global warming to 1.5°C (Kuramochi et al., 2017).

Sector	1.5 °C-consistent benchmark	Overall evaluation based on policy activity and gap analysis	Policy rating
Electricity supply	*Sustain the global average growth of renewables and other zero and low-carbon power until 2025 to reach 100% by 2050*	• Targeted share of renewable electricity generation of 38.8% by 2023, however there are no targets beyond. • Significant untapped potential for renewable power, especially solar power.	Getting Started
	No new coal plants, reduce emissions from coal power by at least 30% by 2025	• 0.3 GW of coal plants under construction and 33.8 GW in the pipeline either being permitted, pre-permit or announced. While the pipeline is shrinking, Turkey still pursues new plants and is not considering phasing out coal. • For a Paris Agreement compatible pathway, coal would need to be phased out by 2030. Therefore, early retirement of current capacity and cancellation of planned capacity is required.	No Action
Land-based Passenger transport	*Last fossil fuel car sold before 2035*	• Turkey's national action plans on climate change and energy efficiency address the switch to alternative fuels and clean vehicle technologies. However, the objectives stay qualitative (e.g. development of legal arrangements, capacity building and promotion activities). • Unclear whether the intended development and promotion of alternative fuels and clean vehicle technologies can be realised in the near to medium term.	Getting Started
Residential buildings	*All new buildings fossil free and near zero energy by 2020*	• Limited short-term target set by the government: 20% of energy demand of new buildings must be met by renewable energy sources as of 2017 and GHG emissions of new settlements must be reduced by at least 10% compared to existing settlements until 2023. • These targets do not appear to be supported by concrete policies and are unlikely to be achieved. • No long-term target or strategy in place.	Getting Started
	Increase building renovation rates from <1% to 5% by 2020	• The government has stated the objective of raising awareness of, supporting directly or indirectly, and imposing obligations on end-users to improving energy efficiency in the existing buildings stock. • Unclear whether this objective will be supported by concrete policies, and unlikely that a renovation rate of 5% by 2020 will be achieved.	Getting Started

Abbreviations

B2DS	Beyond 2°C Scenario
BRT	Bus rapid transit
CAT	Climate Action Tracker
CCS	Carbon Capture and Storage
CDS	Current development scenario
ETP	Energy Technology Perspectives
GDP	Gross Domestic Product
GHG	Greenhouse Gases
ICE	Internal Combustion Engine
IEA	International Energy Agency
INDC	Intended Nationally Determined Contribution
IPCC	Intergovernmental Panel on Climate Change
IPP	Independent Power Producer
LCEV	Low Carbon Emission Vehicle
LULUCF	Land-Use, Land-use Change and Forestry
NCCAP	National Climate Change Action Plan
NCCS	National Climate Change Strategy
NEEAP	National Energy Efficiency Action Plan
NEESP	National Energy Efficiency Strategy Paper
NEP	National Energy Plan
NREAP	National Renewable Energy Action Plan
PA	Paris Agreement
RES	Renewable Energy Share
Solar PV	Solar Photovoltaic
TPES	Total Primary Energy Supply
UNFCCC	United Nations Framework Convention on Climate Change
VRE	Variable Renewables

Contents

1 Context for scaling up climate action in Turkey

While the scientific community is continuously highlighting severe risks related to manmade climate change, the translation into actionable policies in Turkey and other countries remains inadequate. The IPCC Special Report on 1.5°C has found that, compared to 2°C warming, limiting warming to 1.5°C will reduce the impacts on vulnerable populations and ecosystems in the Mediterranean Basin (e.g. by limiting the risk of increased episode of droughts or fluvial flooding) (IPCC, 2018b). The report also finds that the energy transition required to limit warming to this level will have significant benefits for access to clean and affordable energy, and poverty eradication—both sustainable development goals.

At present, Turkey's GHG emissions account for 0.7% of global emissions (excl. LULUCF) (Climate Action Tracker, 2018a). Turkey has become an increasingly important emitter due to large energy demand increase (6–7% per year in the past, however a slow-down has been noticed in recent years) mainly due to rapid increases in industrialisation and urbanisation, and a booming population (30% increase since 1990) (Johnson et al., 2017). Overall GHG emissions have more than doubled since 1990 (UNFCCC, 2019a). Turkey's Intended Nationally Determined Contribution (INDC), submitted to the UNFCCC ahead of the Paris Conference of the Parties (COP) in 2015, commits Turkey to up to 21% reduction in GHG emissions from the Business as Usual (BAU) level by 2030 (Republic of Turkey, 2015).

CAT rates Turkey's INDC target "Critically Insufficient": "Turkey's commitment is not in line with interpretations of a "fair" approach in line with holding warming below 2°C, let alone with the Paris Agreement's stronger 1.5°C limit. This means that if most other countries followed Turkey's approach, global warming would exceed 3–4°C" (Climate Action Tracker, 2018a). Moreover, Turkey is one of the few countries that still have not ratified the Paris Agreement.

Turkey has some overarching policies in place that address challenges related to climate changes:

The **National Climate Change Strategy Document 2010–2020 (NCCS)** is one of the main governmental strategy documents which guides national climate change policies. The **National Climate Change Action Plan 2011-2023 (NCCAP)** was prepared within the framework of the NCCS and other national policies and strategy documents. The action plan sets out a road map with short-, medium- and long-term plans for the fight against climate change encompassing all sectors of the economy (Republic of Turkey Ministry of Environment and Urbanisation, 2011). The **Tenth Development Plan**, also the basis for Turkey's National Communication to the UNFCCC, contains policies and objectives regarding environment and sustainability. Turkey released the 11th Development Plan in July 2019. The more recent plan focuses on energy security rather than decarbonisation of energy, and for example stresses the importance of using domestic lignite reserves. The plan also mentions the increase of renewable energy, improvements to the grid and efficiency measures in the buildings sector, besides other measures. A lack of comprehensive quantitative targets in the plan causes uncertainty with regards to their impact on emissions. Continuing to rely on coal for power generation is not consistent with the Paris Agreement.

The **National Energy Efficiency Action Plan 2017–2023** (**NEEAP**) recognises and addresses the potential for energy efficiency improvement. The Action Plan was prepared in conformity with target policy documents such as the 2023 targets in the NCCAP and the National Energy Efficiency Strategy Paper 2012–2023. The **National Energy Efficiency Strategy Paper (NEESP)** issued in 2012 sets a long-term goal target of 20% reduction in energy intensity by 2023 compared to 2008 figures (Union, 2011).

Due to its strategic location and the forecasted increasing demand on Liquified Natural Gas worldwide, Turkey is aiming to become a gas trading hub by developing its storage and regasification capacities: two new floating storage and regasification (FSRU) units planned by 2023 (DAILY SABAH, 2019; World Bank, 2018). The CAT, however, cautioned in June 2017 that

natural gas has a limited role to play as a bridging fuel in the power sector and risks overshooting the Paris Agreement temperature limit if fully operational or creating stranded assets (Climate Action Tracker, 2017).

Table 2 provides an overview of all overarching climate change policies in Turkey.

Table 2: Overview of implemented overarching climate change policies in Turkey

GHG OVERARCHING CLIMATE CHANGE POLICIES OF TURKEY				
Changing activity	**Energy efficiency**	**Renewables**	**Nuclear or CCS or fuel switch**	**Non-energy**
Climate Strategy ▪ National Climate Change Strategy 2010–2020 (2001) ▪ Climate Change Action Plan 2011–2023 (2011) ▪ Tenth Development Plan (2013), Eleventh Development Plan (2019)				
GHG reduction target ▪ Intended Nationally Determined Contribution (INDC) (2015)				
Coordinating body for climate change ▪ Climate Change and Air Management Coordination Board ▪ Energy Efficiency Coordination Board ▪ Ministry of Energy and Natural Resources ▪ Ministry of Environment and Urbanisation ▪ Renewable Energy General Directorate				
Support for low-emission R&D				
	National energy efficiency target ▪ National Climate Change Strategy 2010 – 2020 (2001) ▪ Climate Change Action Plan 2011 – 2023 (2011) ▪ National Energy Efficiency Strategy Paper 2012 – 2023 (2012) ▪ National Energy Efficiency Action Plan Turkey 2017 – 2023 (2018)	**National renewable energy target** National Renewable Energy Action Plan (2014)		

No policies currently exist and a similar policy gap exists in all other countries

No policies currently exist however Turkey could adopt policies from other countries

Existing and planned policies for Turkey

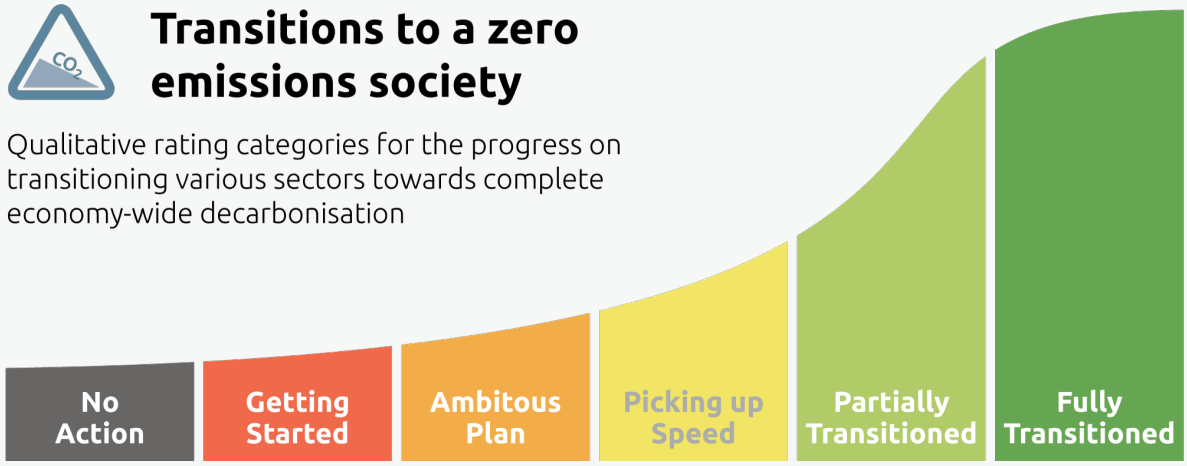
2 Overview of national climate policy actions and gaps

This chapter provides a comprehensive overview of existing and planned climate policies at the national level in Turkey. The first part overviews all existing climate change mitigation policies in Turkey and their implementation status, analysing climate policy activity on a sector-level. The second part identifies gaps of existing policies compared to required policy action for a Paris Agreement compatible pathway. The policy ambition analysis assesses how Turkey's implemented policies compare to the most important short-term steps for limited global warming to 1.5°C compared to pre-industrial levels that the Climate Action Tracker has identified (Kuramochi et al., 2018). We compare policy progress to actionable benchmarks in each sector and rate it according to a qualitative policy rating (see Box 1 below).

The policy ambition analysis compares historical and projected development under current policies to the global indicators without any further adjustments of the indicators to country-specific circumstances, such as for example the respective capabilities of countries. The policy ambition analysis mainly provides an indication to which degree current trends in each sector align with required steps on a global level and presents a standardised approach for all countries analysed in the CAT Scaling Up Climate Action series. The in-depth analysis addresses country specific circumstances and considerations for Turkey and specific sectors.

Box 1 Qualitative policy rating for sectoral transition to zero-emissions society

The qualitative analysis of policy activity and ambition of this analysis for Turkey results in a rating of each sector. The rating aims to reflect the sector's current transition state towards 1.5°C Paris Agreement compatibility. For this purpose, the rating accounts for existing sectoral long-term strategies and/or policies, their status of implementation, as well as the general state of transition of the sector under analysis.



Key findings of policy activity and policy ambition analysis

Table 3 summarises the policy activity and gap analysis for each of the sectors and respective benchmarks. The qualitative rating evaluates the current progress status in each respective sector and evaluates the sector's transition into 1.5°C Paris Agreement compatibility.

Table 3: Summary table for sectoral policy activity and gap analysis in Turkey.

Sector	1.5 °C-consistent benchmark	Overall evaluation based on policy activity and gap analysis	Policy rating
Electricity and heat sector	Sustain the global average growth of renewables and other zero and low carbon power until 2025 to reach 100% by 2050	• Targeted share of renewable electricity generation of 38.8% by 2023, however there are no targets beyond 2023. • Significant untapped potential for renewable power, especially solar power.	
	No new coal plants, reduce emissions from coal power by at least 30% by 2025	• 0.3 GW of coal plants under construction and 33.8 GW in the pipeline either being permitted, pre-permit or announced. Although the pipeline is shrinking, Turkey still pursues new plants and does not consider a phase out of coal. • For a Paris Agreement compatible pathway coal would need to be phased-out by 2030. Therefore, early retirement of current capacity and cancellation of planned capacity is required.	
Transport sector	Last fossil fuel car sold before 2035–2050	• Turkey's national action plans on climate change and energy efficiency address the switch to alternative fuels and clean vehicle technologies. However, the objectives stay qualitative (e.g. development of legal arrangements, capacity building and promotion activities). • Unclear whether the intended development and promotion of alternative fuels and clean vehicle technologies can be realised in the near to medium term. Turkey is developing an electric vehicle for domestic production, to be available as of 2022.	
	Aviation and shipping: Develop and agree on a 1.5°C compatible vision	• Unclear whether intended legislative arrangement around emission trading and modal shift in freight transport will result in significant GHG emissions reduction.	
Buildings sector	All new buildings fossil free and near zero energy by 2020	• Limited short-term target set by the government: 20% of energy demand of new buildings must be met by renewable energy sources as of 2017, GHG emissions of new settlements must be reduced by at least 10% compared to existing settlements until 2023 and energy consumption of public institutions will be decreased by 20% until 2020. • These targets do not appear to be supported by concrete policies and thus are unlikely to be achieved. • No long-term target or strategy in place.	
	Increase building renovation rates from <1% to 5% by 2020	• Unclear whether the objective to raise awareness of, support directly or indirectly, and impose obligations on end-users to improve energy efficiency in the existing building stock will be sufficient to realise a renovation rate of 5% by 2020.	

Industry sector	All new installations in emissions-intensive sectors are low-carbon after 2020, maximise material efficiency	• Government has a stated objective to raise awareness of, support directly or indirectly, and impose obligations on end-users to improve energy efficiency in the existing buildings stock. • Unclear whether this objective will be supported by concrete policies, and thus unlikely that a renovation rate of 5% by 2020 will be achieved.	
LULUCF	Reduce emissions from forestry and other land use to 95% below 2010 by 2030, stop net deforestation by 2025	• The LULUCF sector constitutes a (growing) emission sink. • In addition, the Turkish government aims to further increase the amount of carbon sequestered in forests and further reduce deforestation.	
Commercial Agriculture	Keep emissions in 2020 at or below current levels, establish and disseminate regional best practice, ramp up research	• Based on an expected shrinking of the Turkish agricultural sector and the objectives to limit GHG emissions and increase the sink capacity, agricultural emissions are likely to remain flat or decrease over time.	

2.1 Electricity and heat sector

In 2017, the electricity and heat sector accounted for approximately 28% of the total national GHG emissions (excl. LULUCF) (UNFCCC, 2019).

Between 2010 and 2017 Turkey's electricity consumption increased by 41% to 297 TWh in 2017. It is expected that the electricity demand will double between 2019 and 2030, as the electricity consumption will reach 453 TWh in the low-demand scenario or 515 TWh in the high-demand scenario in 2030 (*Türkiye Elektrik Enerjisi Talep Projeksiyonu Raporu*, n.d.). Between 2002 and 2018, there were gross investments in "electricity, gas, steam and air conditioning production and distribution" of nearly 110 billion USD in Turkey. In addition, 10 billion USD was invested for improving energy efficiency (Taranto & Dinçel, 2019). For the period from 2019 to 2030, Taranto and Dinçel expect that an average annual investment of 5.3-7.0 billion USD is required.

In 2018, 37% of electricity generation was from coal, followed by natural gas (30%) and hydro (20%). Liquid fuel, waste, wind and geothermal contribute the remaining 13%. Turkey's electricity sector heavily relies on natural gas, mostly imported from Russia. To reduce dependency and meet the increasing power demand, the Turkish Government aims to increase the share of electricity generation based on domestic lignite and renewables (Republic of Turkey Ministry of Environment and Urbanization, 2016). Compared to 2017 data on electricity generation, 2018 shows a decline of natural gas by 7%points, an increase of coal by 5%points and an increase of others by 2%points (2017 data from (IEA, 2019)).

Table 4 summarises Turkey's progress on the most important steps to decarbonise the electricity and heat sector.

Table 4: Turkey's progress on the most important indicators in the power sector to limit temperature increase to 1.5°C

Sector	1.5 °C-consistent benchmark	Projection(s) under current policies	Gap assessment (qualitative)	Policy rating
Electricity and heat sector	Sustain the global average growth of renewables and other zero and low carbon power until 2025 to reach 100% by 2050	• Targeted share of renewable electricity generation of 38.8% by 2023 and no targets beyond 2023 • In 2018, 31.5% of electricity generation in Turkey was met by renewables (i.e. 19,6% hydro, 6.6% wind, 2.6% solar, 2.5% geothermal)	+ The renewable energy share grew significantly in recent years - Current target will not be sufficient to meet the 1.5°C-compatible benchmark of 59%-81% by 2030 (world average) - Significant untapped potential for renewable power, especially solar power	
	No new coal plants, reduce emissions from coal power by at least 30% by 2025	• 1.1 GW of coal plants under construction and 37.5 GW in the pipeline either being permitted, pre-permit or announced contrary to the need to phase out coal by 2030	- The use of "clean coal technologies" and measures to increase energy efficiency is mentioned in the National Climate Change Action Plan - Significant new coal capacity in the pipeline	

2.1.1 Actionable benchmarks in electricity and heat sector

The Climate Action Tracker identified two short-term actionable benchmarks for the electricity sector to limit warming to 1.5°C at a global level (Kuramochi et al., 2018):

- The growth rates of renewables and other zero and low-carbon power ought to be sustained until 2025 to reach a 100% share of electricity generation by 2050.
- No new coal capacity ought to come online as of 2017 and emissions from coal combustion need to be reduced by at least 30% by 2025.

A recent analysis shows that coal needs to be phased out in all OECD countries by 2030 and globally by 2040 to achieve the Paris Agreement temperature goal (Yanguas Parra et al., 2019). The following gap analysis compares historical and projected developments in Turkey's electricity and heat sector to these global benchmarks. The analysis does not include any further adjustment to allow for comparison between countries under analysis within the scope of this project. Country specific circumstances will be addressed in the in-depth analysis on raising the level of ambition in climate policy in the following chapters. Please refer to the publication for more detailed explanation on each indicator.

2.1.2 Recent policy developments

A comprehensive overview of the currently implemented and planned sectoral climate policies is provided in Table 5.

Today, Turkish energy policies focus on the development of domestic energy sources and the promotion of energy efficiency measures to decrease the dependency on gas imports from Russia. Domestic energy sources cover both renewables as well as lignite reserves. According to CoalSwarm, Turkey has the third biggest pipeline of coal power plants in the world (CoalSwarm, n.d.); however the pipeline has decreased in size recently (EndCoal, 2019).

Table 5: Overview of implemented climate change policies in the electricity and heat sector in Turkey

OVERVIEW OF EXISTING, PLANNED AND POTENTIAL CLIMATE CHANGE POLICIES FOR THE ELECTRICITY AND HEAT SECTOR IN TURKEY				
Changing Activity	**Energy efficiency**	**Renewables**	**Nuclear or CCS or fuel switch**	**Non-energy**
	Support for highly efficient power plants ▪ Electricity Market Law (2001) ▪ Climate Change Action Plan 2011–2023 (2011) ▪ Act No. 5627 on Energy Efficiency (2007) ▪ National Energy Efficiency Action Plan 2017–2023 (2017)	**Renewable energy target for electricity sector** ▪ National Climate Change Strategy 2010–2020 (2001) ▪ Act No. 5346 on Utilization of Renewable Energy Sources for the Purposes of Generating Electrical Energy (2005) ▪ Climate Change Action Plan 2011 – 2023 Turkey (2011) ▪ National Renewable Energy Action Plan (2014) ▪ Intended Nationally Determined Contribution (NDC) (2015) ▪ Renewable Energy Law (2010) ▪ 11th Development Plan (2019)	**CCS support scheme** (none)	
	Reduction obligation schemes (none)	**Support scheme for renewables** ▪ Electricity Market Law (2001) ▪ Electricity Market Licensing Regulation (2001) ▪ Act No. 5346 on Utilization of Renewable Energy Sources for the Purposes of Generating Electrical Energy (2005)		
		Grid infrastructure development ▪ Electricity Market Licensing Regulation (2001) ▪ Act No. 5346 on Utilization of Renewable Energy Sources for the Purposes of Generating Electrical Energy (2005)		
		Sustainability standards for biomass use (none)		
Overarching carbon pricing scheme or emissions limit (none)				
Energy and other taxes (none)				
Fossil fuel subsidies ▪ Provision of subsidies to coal through state-owned enterprises				

No policies currently exist and a similar policy gap exists in all other countries

No policies currently exist however Turkey could adopt policies from other countries

Existing and planned policies in Turkey

Below, we describe Turkey's key legislation in the power and heat sector, taken from Table 5 and structured according to the policy categories. Only the most impactful policies are discussed. In the descriptions, the main aims of the policies are introduced as well as their envisioned effects.

The **INDC** includes the following intended plans and policies for the electricity and heat sector (Republic of Turkey, 2015):

- Increasing capacity of production of electricity from solar power to 10 GW until 2030.
- Increasing capacity of production of electricity from wind power to 16 GW until 2030.
- Tapping the full hydroelectric potential.
- Commissioning of a nuclear power plant until 2030.
- Reducing electricity transmission and distribution losses to 15 percent at 2030.
- Rehabilitation of public electricity generation power plants.
- Establishment of micro-generation, co-generation systems and production on site at electricity production.

The **National Renewable Energy Action Plan (NREAP)** was introduced in 2014 and presents the government's ambition to increase the share of renewables in the electricity generation mix to 30% by 2023 (Republic of Turkey Ministry of Energy and Natural Resources, 2014). The **11th Development Plan from 2019** names a targeted share of RE of 38.8% (Government of Turkey, 2019). This plan also describes measures to enhance energy efficiency and improvements to electricity grids.

To meet the 30% renewable energy target by 2023, Turkey implemented a **Renewable Energy Law**. The Renewable Energy Law introduces incentives for domestic energy projects, providing feed-in tariffs for electricity from renewable energy sources (International Energy Agency, 2015). According to the law, prices for the sale of electricity are adjusted based on the generation method, until the year 2020. Renewable energy plants will be subject to prices between 7.3 USD cent per kW (i.e. hydro and wind) and 13.3 USD cent per kW (i.e. biomass and solar) (Gedik & Eraksoy, 2017). In 2017, Turkey started to auction renewable energy capacities, guaranteeing the winner of the auction connection capacity utilisation rights and a 15-year power purchase agreement (Sarı, Saygın, & Lucas, 2019). The Turkish Minister of Energy and Natural Resources announced that through the auctioning scheme, 10 GW of solar and wind respectively would be installed over the next ten years (Republic of Turkey Ministry of Energy and Natural Resources, 2018).

The **National Energy Efficiency Action Plan 2017 – 2023 (NEEAP)** defines 10 actions to improve the sustainability of the energy sector. The actions involve, amongst others, identifying the potential of cogeneration and district heating and cooling systems, scaling up smart meters, implementing minimum performance standards for transformers, improving energy efficiency in electricity transmission and distribution, improving efficiency in existing power plants, building market infrastructure for demand-side response (Republic of Turkey Ministry of Energy and Natural Resources, 2017).

Turkey taxes oil, gas and electricity consumption in end-use sectors, no taxes apply to the electricity generating sector. Through state-owned enterprises, Turkey's government subsidises new capacities in coal power plants (OECD, 2018). In the period between 2015 and 2017, annually 0.6 billion USD went to thermal power generators mainly for electricity generation from domestic coal (Taranto & Saygın, 2019).

2.1.3 Comparison of recent developments and projections to benchmarks

In the following section, the actionable indicators relevant to the electricity and heat sector will be assessed against the policies and projections in place in Turkey.

2.1.3.1 ***Actionable indicator No.1:*** *Growth of renewables and other zero and low carbon power*

Given recent developments and projections under currently implemented policies, Turkey fails to meet the benchmark to sustain growth rates of renewables and other zero and low-carbon power until 2025 to reach a 100% share of electricity generation by 2050.

Growth in renewable electricity generation

Based on the objectives and plans announced, it is predicted that annual electricity demand will increase by 5.25% annually in the next 15 years. For the year 2023, Turkey aims at a share of renewable sources of 38.8%, and a share of natural gas of 21% (Government of Turkey, 2019).

The 1.5°C-compatible global benchmark requires a share of renewable electricity generation of 59% to 81% by 2030 (at global level), which is unlikely to be met given the projected renewable electricity share up to 2023. In the longer term, Turkey does not have plans to deploy further renewables in the electricity generation mix.

Turkey is a resource-rich country in renewable energy resources:

- The Bloomberg New Energy Finance analysis (BNEF & WWF-Turkey, 2014) indicated that Turkey can meet almost 50% from its power demand by renewable energy sources by 2030. This would allow GHG emissions from the power sector to be stabilised at an annual GHG emissions of approximately 120 $MtCO_2e$ in the next five years. National literature suggests that it would be feasible for Turkey to reach 50% already in 2026 (Godron et al., 2018).
- The renewable energy potential is estimated at over 5 EJ/yr (>1,000 TWh/yr), mostly from solar energy, compared to an electricity demand of 245.5 TWh in 2013, (Deng et al., 2015; Republic of Turkey Ministry of Energy and Natural Resources, 2017).
- Turkey has already overachieved its target of 5 GW of solar energy by 2023 in 2018 (IRENA, 2019b).

Growth of other zero and low-carbon technologies

Besides increasing the share of coal and renewable energy sources, the Turkey's government is at the same time commissioning two nuclear power plants (i.e. the Akkuyu nuclear power plant in 2019 and the Sinop nuclear power plant in 2023) (Republic of Turkey Ministry of Environment and Urbanization, 2016). While these plants will not cause GHG emissions, it is important to remember other environmental risks caused by operations, nuclear waste and potential disasters. While Akkuyu has received the confirmation for financing from a Russian bank (Daily Sabah, 2019a), a Japanese-French consortium and the Turkish government ended their cooperation on Sinop in June 2019, because of strong cost increases due to stricter safety regulations (Ahval, 2019a).

Carbon capture and storage is not prioritised as an option to be used to meet Turkey's emissions targets.

2.1.3.2 ***Actionable indicator No.2*** *- Reduce emissions from coal power plants*

With current policies, Turkey will not succeed in meeting the 1.5°C-compatible benchmark of not constructing new coal plants and reducing GHG emissions from coal power by at least 30% by 2025.

Turkey has significant lignite reserves (BNEF & WWF-Turkey, 2014) and as of July 2019, 0.3 GW of coal plants were under construction, with a further 33.8 GW in the pipeline being permitted, in the pre-permit development phase or announced (EndCoal, 2019). Turkish coal capacity in

operation is 19.9 GW, of which 10.1 GW is fuelled with domestic lignite, 8.9 GW with imported coal, and 0.8 GW with domestic hard coal (Turkish Electricity Transition, 2019). The need to phase out coal by 2030 implies not only no new coal but also decommissioning or reducing use of current capacity.

The NCCAP does include the aim to limit GHG emissions originating from use of electricity production, by using clean coal technologies and taking efficiency-increasing measures (Republic of Turkey Ministry of Environment and Urbanisation, 2011).

2.1.4 Conclusion

Turkey is a resource-rich country in terms of renewable energy resources. It has in place various support programmes for RE technologies, and aims to reach a renewable energy share of 38.8% in 2023. The target falls behind the required levels of 60% to 75% by 2030 within a 1.5°C-compatible global benchmark and underutilises Turkey's renewable energy potential. However, on the positive side, Turkey has already achieved its target for solar meant to be reached in 2023, and prices from recent auctions show a very competitive renewable energy sector.

Besides renewable energy sources, coal is considered the most important source of substitution to reduce the dependency on imported natural gas. The Global Coal Plant Tracker shows that around 34 GW of coal capacity is either being permitted, in the pre-permit development phase or announced. This represents a more than three-fold increase in installed capacity, from approximately 19 GW in operation to approximately 56 GW if all coal plants in the pipeline as of April 2019 were to be constructed. With these plans, Turkey will not succeed in meeting the 1.5°C-compatible benchmark of not constructing new coal plants and reducing emissions from coal power by at least 30% by 2025. The need to phase out coal by 2030 implies not only no new coal plants but also decommissioning or reducing use of current capacity.

2.2 Transport sector

In 2017, the road and rail transport sector accounted for 15% of the total national GHG emissions (excl. LULUCF) (UNFCCC, 2018).The largest share of emissions comes from road transportation. Turkish inventory data shows that between 1990 and 2017, road transport-related emissions more than tripled (UNFCCC, 2018).

Table 6 summarises Turkey's progress on the most important steps to decarbonise the transport sector to limit temperature increase to 1.5°C.

Table 6: Turkey's progress on the most important steps in the transport sector to limit temperature increase to 1.5°C

Sector	1.5 °C-consistent benchmark	Projection(s) under current policies	Gap assessment (qualitative)	Policy rating
Transport sector	Last fossil fuel car sold before 2035 –2050	• Unclear whether intended development and promotion of alternative fuels and clean vehicle technologies can be realised in the near to medium term.	+ Policies in place focused on the development of legal arrangements, capacity building and promotion of alternative fuels and clean vehicles. - No overarching 1.5°C/2°C compatible vision for transport sector in Turkey	
	Aviation and shipping: Develop and agree on a 1.5°C compatible vision	• Unclear whether intended legislative arrangement around emission trading and model shift in freight transport will result in the required GHG reduction in line with a 1.5°C scenario.	+ NCCAP's aims to shift towards railway freight transport and away from more emission-intensive road freight transport. + Turkish Government focuses on making legislative arrangements on their international airways and seaways regarding emission trading. - No overarching 1.5°C/2°C-compatible vision for the transport sector in Turkey.	

2.2.1 Actionable benchmarks in transport sector

The Climate Action Tracker identified two short-term actionable benchmarks for the transport sector to limit warming to 1.5°C at a global level (Kuramochi et al., 2018):

- The last fossil car needs to be sold before 2035–2050 to achieve car fleets consisting of 100% zero-emission cars by 2050–2065.
- A 1.5°C-compatible vision for the aviation and shipping needs to be developed and agreed upon.

Additionally, the freight transport needs to decarbonise: Freight trucks need to be almost fully decarbonised by approximately 2050 (Climate Action Tracker, 2018b). The following gap analysis compares historical and projected developments in the Turkish transport sector to these global benchmarks without any further adjustment to allow for comparison between countries under analysis. Country specific circumstances will be addressed in the in-depth analysis on raising ambition in the following chapters. For a more detailed explanation on each indicator, please refer to Kuramochi et al., 2017.

2.2.2 Recent policy developments

Table 7 provides a comprehensive overview of the currently implemented and planned sectoral climate policies.

Table 7: Overview of implemented climate change policies in the transport sector in Turkey

OVERVIEW OF EXISTING AND PLANNED CLIMATE CHANGE POLICIES FOR THE TRANSPORT SECTOR IN TURKEY				
Changing Activity	**Energy efficiency**	**Renewables**	**Modal switch**	**Non-energy**
Urban planning and infrastructure investment to minimize transport needs ▪ Climate Change Action Plan 2011–2023 (2011)	**Minimum energy/emissions performance standards or support for energy efficient for light duty vehicles** ▪ Act No. 5627 on Energy Efficiency (2007) ▪ National Energy Efficiency Action Plan 2017–2023 (2012) ▪ Transport and Communication Strategy Document 2011–2023 (2011)	**Biofuel target** (none)	**Support for modal share switch** ▪ Climate Change Action Plan 2011–2023 (2011) ▪ Transport and Communication Strategy Document 2011–2023 (2011)	
	Minimum energy/emissions performance standards or support for energy efficient for heavy duty vehicles ▪ Act No. 5627 on Energy Efficiency (2007) ▪ National Energy Efficiency Action Plan 2017–2023 (2007) ▪ Transport and Communication Strategy Document 2011–2023 (2011)	**Support schemes for biofuels** (none)	**E-mobility programme** (none)	
		Sustainability standards for biomass use (none)		
Tax on fuel and/or emissions ▪ Taxation of gasoline and vehicle registration tax				
Fossil fuel subsidies (none)				

No policies currently exist and a similar policy gap exists in all other countries

No policies currently exist however Argentina could adopt policies from other countries

Existing and planned policies in Argentina

Below, we describe Turkey's key legislation in the transport sector, taken from Table 7 and structured according to the policy categories. Only the most impactful policies are discussed. In the descriptions, the main aims of the policies are introduced as well as their envisioned effects.

The **INDC** includes the following intended plans and policies for the transport sector (Republic of Turkey, 2015):

- *"Ensuring balanced utilisation of transport modes in freight and passenger transport by reducing the share of road transport and increasing the share of maritime and rail transport*
- *Enhancing combined transport*
- *Implementing sustainable transport approaches in urban areas*
- *Promoting alternative fuels and clean vehicles*
- *Reducing fuel consumption and emissions of road transport with National Intelligent Transport Systems Strategy Document (2014–2023) and its Action Plan (2014–2016)*
- *Realising high speed railway projects*
- *Increasing urban railway systems*
- *Achieving fuel savings through tunnel projects*
- *De-licensing of old vehicles*
- *Implementing green port and green airport projects to ensure energy efficiency*
- *Implementing special consumption tax exemptions for maritime transport"*

The **Transport and Communication Strategy Document 2011–2023** provides the basis for a transformation towards a low carbon transportation system focused on railways, cycling, etc. It provides indicative targets for each of the subsectors related to a modal shift rather than emissions reductions of energy efficiency. It does not define specific incentives or implementing policies.

Under the **National Climate Change Action Plan 2017–2023 (NCCAP)** various objectives were defined to 1) switch model share, 2) minimise transport needs and 3) promote alternative fuels and increase energy efficiency to reduce GHG emissions.

In terms of modal share switch, the NCCAP's 2023 target of share distribution between transport modes is to increase the share of railway freight transport above 15% (5% in 2009) and the passenger freight transport above 10% (2% in 2009). It hereby targets a reduction of the road freight transport share in 2009 from 81% to below 60% in 2023 and the road passenger transport share from 90% in 2009 to below 72% in 2023 (Republic of Turkey Ministry of Environment and Urbanisation, 2011; Republic of Turkey Ministry of Environment and Urbanization, 2016). The type of infrastructure investment projects that will be carried out over the next 30 years and their related costs and technical details will be determined by the National Transport Masterplan which is under development (Atkins, n.d.).

The 11th Development Plan from 2019 provides a lower value of 10% of freight to be transported by rail by 2023 (Government of Turkey, 2019). The plan also wants to increase the modal share of rail in passenger transport to 3.8%.

In terms of transport needs, the NCCAP aims to restructure urban transportation in line with sustainable transport principles. To be more specific, the objectives are to 1) limit the emission increase rate of individual vehicles in intracity transport and 2) develop the necessary legislation, institutional structure and guidance documents until the end of 2023 for the implementation of sustainable urban transport planning (Republic of Turkey Ministry of Environment and Urbanisation, 2011).

In terms of alternative fuels and energy efficiency, the NCCAP aims to disseminate the use of alternative fuels and clean vehicle technologies in the transport sector. To be more specific, the objectives are to 1) provide the legal basis and building up capacity to increase the use of alternative fuels and clean vehicles until 2023 and 2) take local measures to encourage the use of these fuels and vehicles in urban transport until 2023 (Republic of Turkey Ministry of Environment and Urbanisation, 2011). Additionally, the NCCAP aims to decrease energy consumption in transport until 2023. Turkey is developing an electric vehicle for domestic production, to be available as of 2022 (Daily Sabah, 2019b).

The **Act No. 5627 on Energy Efficiency** contains a separate regulation on transport which sets out requirements on unit fuel consumption of vehicles manufactured in Turkey, raising efficiency standards in vehicles, rolling out mass transportation and installing advanced traffic systems for increasing energy efficiency in transportation (LSE, 2007).

The **National Energy Efficiency Action Plan 2017–2023 (NEEAP)** defines 9 actions for the transport sector to ensure sustainability and promote energy efficiency. The actions involve, amongst others, promoting energy-efficient vehicles, developing comparative studies on alternative fuels and new technologies, reducing the use of passenger cars to reduce traffic density in cities and strengthening maritime and rail transport (Republic of Turkey Ministry of Energy and Natural Resources, 2017).

Turkey taxes consumption of oil, gas and electricity. According to OECD, the effective tax rate is highest in the transport sector (OECD, 2018). Also, the vehicle registration tax is high compared for example to European countries, and increases with the engine size, thus incentivising purchase of small engines. At the same time, the advantage in size does not directly reflect in lower emissions, and the annual ownership tax is significantly lower for old cars, incentivising the further use of those vehicles (Şenzeybek & Mock, 2019). Taxes are lower for battery electric vehicles; however their market share is still low–at less than 1% (ibid).

2.2.3 Comparison of recent developments and projections to benchmarks

In the following section, the actionable indicators relevant to the transport sectors will be assessed against the policies and projections in place in Turkey.

*2.2.3.1 **Actionable indicator No.3:** Last fossil fuel car sold before 2035–2050*

A rapid introduction of zero-emissions vehicles is key to achieve the decarbonisation of the transport sector with the last fossil fuel car being sold between 2035 and 2050, assuming an average life time of 15 years. In the Turkish context, no coherent policy framework exists that addresses these challenges. The NCCAP and the NEEAP address the switch to alternative fuels and clean vehicle technologies. However, the NCCAP and NEEAP objectives stay qualitative (i.e. development of legal arrangements, capacity building and promotion of alternative fuels and clean vehicles) and it is unclear whether the intended development and promotion of alternative fuels and clean vehicle technologies can be realised in the near to medium-term. Tax incentives for smaller and low-carbon fuelled cars are insufficient to cause a clear shift of the market to low-carbon vehicles.

*2.2.3.2 **Actionable indicator No.4**: Develop a 1.5°C-compatible vision in aviation and shipping*

Aviation

Freight and passenger transportation by air has increased steadily since 1990. Emissions from domestic aviation increased by four between 1990 and 2017 (UNFCCC, 2019a).

In terms of climate action, Turkey is focusing on making legislative arrangements for its international airways and seaways regarding emissions trading. The Turkish Government defined two specific actions in this field, namely 1) to make legal arrangements for monitoring GHG emissions from international air and sea transportation and the creation of a registry system, and 2) to inform and increase the calculation capabilities of maritime and airline companies engaged in international transportation about the developments regarding emissions trading (Republic of Turkey Ministry of Environment and Urbanisation, 2011). These are first steps; however the actions above are not sufficient to result in a shift in travel demand from aviation

to other transport modes (e.g. high-speed rail) and substantially increase the energy efficiency of airplane and the use of low-carbon fuels.

Maritime shipping

Besides the objective and actions stated above on emission trading, no strategy or policies on greener maritime shipping exist in Turkey. This being said, maritime shipping only contributes marginally to the total transport-related GHG emissions, mainly due to the international nature of maritime emissions. Turkey is a member of the International Maritime Organization (International Maritime Organization, 2018b), which engages in emissions reduction through the following measures (International Maritime Organization, 2018a):

i. Adoption of regulations to address the emissions of air pollutants from ships.
ii. Adoption of mandatory energy-efficiency measures to reduce emissions of greenhouse gases from international shipping.
iii. Global capacity-building projects to support the implementation of those regulations and encourage innovation and technology transfer.

No information or analysis exists to which degree Turkey engages in these different work streams and whether these initiatives might reduce emissions from Turkish maritime shipping.

Freight transport

Turkey's NCCAP sets out aims for the freight transport sector, in which they outline a shift towards railway freight transport and away from more emission-intensive road freight transport. The 2023 target is to increase the share of railway transport above 15% (5% in 2009), thereby reducing the road transport share to below 60% in 2023 (81% in 2009) (Republic of Turkey Ministry of Environment and Urbanisation, 2011). It is unclear whether this intended modal shift in freight transport will result in the required GHG reductions to achieve decarbonisation by 2050 in line with a 1.5°C scenario. The realised GHG reduction will heavily depend on the realised decarbonisation (i.e. shift to low or zero-carbon fuels) in the road and rail transport sector.

2.2.4 Conclusion

Based on the analysis of recent developments and projects, the Turkish transport sector is not expected to meet either of the two actionable benchmarks in the transport sector. The objectives and actions stated in the NCCAP will contribute to the decarbonisation of the Turkish transport sector; however the NCCAP does not provide a comprehensive 1.5°C/2°C-compatible vision of the transport sector in Turkey.

2.3 Buildings sector

The buildings sector (i.e. commercial and residential buildings) accounted for 34% of Turkish final energy consumption in 2017 (IEA, 2019). In 2017, the buildings sector consumed mainly natural gas (39%) and electricity (30%). Coal (16%) and renewables (12%) play a significant role as well (see Figure 6). However, Turkey's buildings sector still heavily depends on fossil resources.

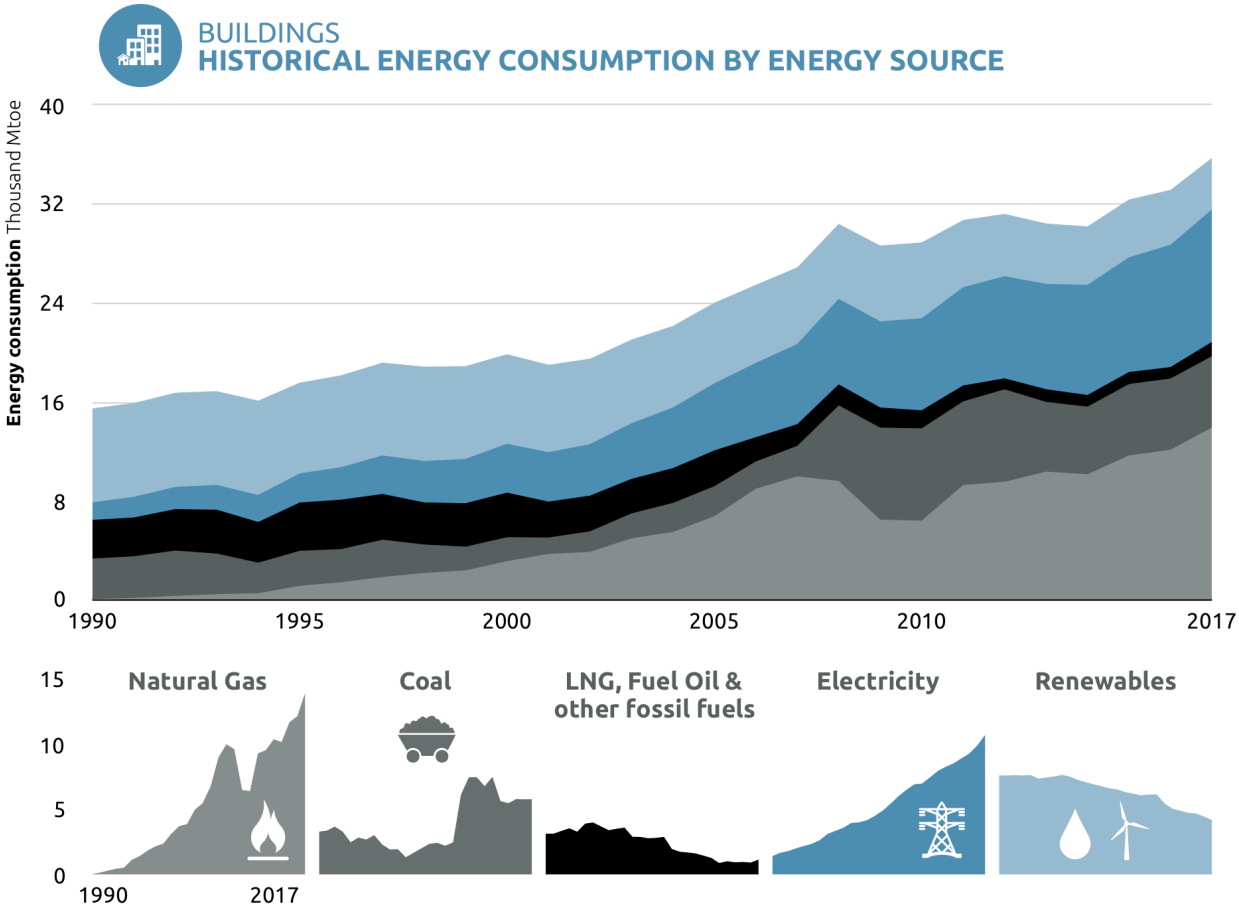


Figure 6: Historical breakdown of total final energy consumption by energy sources in the residential and commercial sector (IEA, 2019).

Direct GHG emissions from the residential buildings sector amounted to about 42 $MtCO_2e$/year in 2017, which is about 8% of the total national GHG emissions (excl. LULUCF). Between 1990 and 2017, the direct residential buildings-related GHG emissions increased by roughly 1.5. This rapid increase in the energy consumption of the buildings sector can be explained by fast-growing cities, population figures, income levels and living standards (Republic of Turkey Ministry of Environment and Urbanization, 2016).

Table 8 summarises Turkey's progress on the most important steps to decarbonise the buildings sector to limit temperature to 1.5°C.

Table 8: Turkey's progress on the most important steps in the buildings sector to limit temperature increase to 1.5°C

Sector	1.5 °C-consistent benchmark	Projection(s) under current policies	Gap assessment (qualitative)	Policy rating
Buildings sector	All new buildings fossil free and near zero energy by 2020	• 20% of energy demand of new buildings must be met by renewable energy sources as of 2017, which is lower compared to a 1.5°C compatible benchmark.	+ Objective to increase the use of renewable energy sources. - Objective is not sufficient to meet the 1.5°C-compatible benchmark of 100% renewable energy by 2020 in new buildings (world average).	
	Increase building renovation rates from <1% to 5% by 2020	• Unclear whether intended legislative arrangement around the rehabilitation of existing buildings will result in a required renovation rate of 5% by 2020.	+ Several objectives in place to rehabilitate existing buildings stock and improve energy efficiency. - No overarching 1.5°C-compatible vision for the buildings sector in Turkey.	

2.3.1 Actionable benchmarks in buildings sector

The Climate Action Tracker identified two short-term actionable benchmarks for the buildings sector to limit warming to 1.5°C at a global level (Kuramochi et al., 2018):

- All new buildings ought to be fossil-free and near-zero energy by 2020.
- The annual retrofit rates of existing buildings stock need to increase from less than 1% in 2015 to 5% by 2020.

The following gap analysis compares historical and projected developments in the Turkish buildings sector to these global benchmarks without any further adjustment to allow for comparison between countries under analysis. Country-specific circumstances will be addressed in the in-depth analysis on raising ambition in the following chapters. Please refer to the publication for more detailed explanation on each indicator.

2.3.2 Recent policy developments

Table 9 provides a comprehensive overview of the currently implemented and planned sectoral climate policies.

Table 9: Overview of implemented climate change policies in the buildings sector in Turkey

OVERVIEW OF EXISTING, PLANNED AND POTENTIAL CLIMATE CHANGE POLICIES FOR THE BUILDINGS SECTOR IN TURKEY				
Changing Activity	**Energy efficiency**	**Renewables**	**Nuclear or CCS or fuel switch**	**Non-energy**
Urban planning strategies (none)	**Building codes and standards and fiscal/financial incentives for low-emissions choices** ▪ Climate Change Action Plan 2011 – 2023 (2011) ▪ National Energy Efficiency Strategy Paper 2012–2023 (2012) ▪ National Energy Efficiency Action Plan 2017–2023 (2017) ▪ Act No. 5627 on Energy Efficiency (2007) ▪ Bep–TR Regulations and Rating of Energy Performance in Buildings (2010) ▪ Boilers and Stoves Certificates (2005) ▪ Improving Energy Efficiency in the Buildings Sector (2009) ▪ Buildings Energy Performance Regulation (2017) ▪ Regulation on Heat Insulation in Buildings, TS 825 (2000) ▪ Green Buildings Regulation (2017)	**Support scheme for heating and cooling** (none)		
	Minimum energy performance and equipment standards for appliances ▪ Climate Change Action Plan 2011–2023 (2011) ▪ Act No. 5627 on Energy Efficiency (2007)	**Support scheme for hot water and cooking** (none)		
		Sustainability standards for biomass use (none)		
Energy and other taxes ▪ Special Consumption Tax Law, ÖTV. N°4760 (2002)				
Fossil fuel subsidies • Special Consumption Tax (for natural gas) ÖTV. N°4760 (2002)				

No policies currently exist and a similar policy gap exists in all other countries

No policies currently exist however Turkey could adopt policies from other countries

Existing and planned policies in Turkey

Below, we describe Turkey's key legislation in the buildings sector, taken from Table 9 and structured according to the policy categories. Only the most impactful policies are discussed. In the descriptions, the main aims of the policies are introduced as well as their envisioned effects.

The **INDC** includes the following intended plans and policies for the buildings sector (Republic of Turkey, 2015):

- Constructing new residential buildings and service buildings as energy efficient buildings in accordance with the Energy Performance of Buildings Regulations.
- Creating Energy Performance Certificates for new and existing buildings to provide the information needed to control energy consumption and greenhouse gas emissions and to reduce energy consumption per square meter.
- Reducing the consumption of primary energy sources of new and existing buildings by means of design, technological equipment, building materials, development of channels that promote the use of renewable energy sources (loans, tax reduction, etc.).
- Dissemination of Green Building, passive energy, zero-energy house design to minimise energy demand and ensure local production of energy.

Under the **National Climate Change Action Plan (NCCAP)** various objectives are defined to increase energy efficiency and the share of renewable energy sources within the buildings sector. The NCCAP aims to (Republic of Turkey Ministry of Environment and Urbanisation, 2011):

i. Increase energy efficiency in buildings. The objectives are (1) to establish energy efficiency standards in commercial and public buildings with usable areas larger than 10,000 m^2 and in at least 1 million residential buildings by 2023 and (2) to decrease annual energy consumption in the buildings and premises of public institutions by 10% until 2015 and by 20% until 2023.
ii. Increase the use of renewable energy sources. At least 20% of the annual energy demand of new buildings must be met by renewable energy sources as of 2017.
iii. Limit GHG emissions from new settlements by reducing GHG emissions by at least 10% per new settlement in comparison to existing settlements until 2023.

The above-mentioned objectives contribute to the strategic goal defined in the **National Energy Efficiency Strategy Paper 2012–2023** to build (or renovate) at least one fourth of the buildings stock from 2010 to sustainable buildings[1] by 2023 (Republic of Turkey Ministry of Energy and Natural Resources, 2012). Note that the strategic goal has not been further specified.

The **Regulation on Energy Performance for Buildings** requires that buildings meet minimum performance standards for heat insulation, heating and cooling systems and electrification by demonstrating the buildings performance in Energy Performance Certificates. New buildings should have at least a C-class Energy Performance Certificate (Republic of Turkey Ministry of Energy and Natural Resources, 2017).

Within the **National Energy Efficiency Action Plan (NEEAP)** 12 actions are defined to improve energy efficiency in the buildings sector in line with the goals described above. The actions involve, amongst others, improving the energy efficiency classes of new and existing buildings and scaling up on-site generation and use of renewable energy in buildings. One of the objectives focussed on the renovation of existing buildings stock is to "raise awareness of, support directly or indirectly, and impose obligations on end-users to improve energy efficiency in heat insulation, high-efficiency windows, lighting, appliances, heat pumps, boilers and elevator engines, etc. areas in the buildings sector". The appropriate mechanism (e.g. incentives, support, taxation and/or sanctions) are currently under development. The mechanism will be implemented and

[1] Sustainable building: buildings that provide a safe and energy efficient indoor environment with the least impact on environment by using energy, water, and other natural resources efficiently.

results will be monitored from 2019 onwards (Republic of Turkey Ministry of Energy and Natural Resources, 2017).

The framework that regulates the implementation of energy efficiency measures is set in the **Energy Efficiency Law (Act No. 5627)**. The energy efficiency law aims to reduce energy intensity and overall energy costs for the economy. Yet, it does not prescribe a binding energy target.

The 11th Development Plan further supports efficiency measures in the buildings sector through a number of measures, such as for example implementation of energy efficiency in public buildings, promoting renovation of existing buildings, and a certification system for green buildings (Government of Turkey, 2019).

In September 2019, the government announced the **Urban Transformation Plan**, which aims at replacing old buildings in cities with sustainable living spaces (Daily Sabah, 2019c). During the UN SG Climate Summit, Turkey signed up to the initiative "Zero Carbon Buildings for All", which has the target to decarbonise new buildings by 2030 and existing buildings by 2050, and to mobilise investments in the sector in developing countries (Zero Energy Buildings for All, 2019).

2.3.3 Comparison of recent developments and projections to benchmarks

The population in Turkey increased from 56.5 million in 1990 to 80.7 million in 2017 (World Bank Group, 2018). During the same period urbanisation also increased. Increasing population figures and urbanisation are the key drivers for demand of (new) buildings. More than 100,000 new buildings are expected to be added to the building stock every year (NEEAP), resulting in a residential building stock that will grow from about 2,375 million m^2 in 2015 to almost 4,000 million m^2 in 2050. This is a total increase of approximately 68%, which corresponds to an annual average increase of about 1.5% (Schimschar, Boermans, Kretschmer, Offermann, & John, 2016). This growth presents a unique opportunity to save energy and reduce GHG emissions by making new buildings more energy efficient as well as improving the existing building stock (Republic of Turkey Ministry of Energy and Natural Resources, 2017).

In the following section, the actionable indicators relevant to the buildings sectors will be assessed against the policies and projections in place in Turkey.

*2.3.3.1 **Actionable indicator No.5:** All new buildings fossil free and near zero energy by 2020*

Turkey shows some initial progress on this actionable indicator, primarily through its objectives to increase the share of renewable energy sources and limit GHG emissions for new buildings under the NCCAP. However, these objectives are not sufficient to have solely fossil free or near-zero energy new buildings by 2020. The initiative "Zero Energy Buildings for All" that Turkey has committed to aims for fully decarbonised new buildings by 2030, ten years later than the CAT benchmark suggests.

*2.3.3.2 **Actionable indicator No.6:** Increase building renovation rates from <1 to 5% by 2020*

Turkey shows some initial progress on this actionable indicator, primarily through its objective to raise awareness of, support directly or indirectly, and impose obligations on end-users to improve energy efficiency in the existing buildings stock. However, it is unclear whether this intended legislative arrangement will result in the required renovation rate of 5% by 2020. The Urban Transformation Plan may accelerate renovations, through demolition of old buildings and reconstruction. Too little detail is available on the plan at this point to estimate its effect on the renovation rate.

2.3.4 Conclusion

Based on the analysis of recent developments and projects, the Turkish buildings sector got started and is making some first steps towards the 1.5°C-compatible benchmark. The current ambitions on both fossil free new buildings and the renovation of existing buildings will have to be increased and turned into legislative agreements to be compatible with a 1.5°C benchmark. Turkey is a large manufacturer of appliances, also for exportation, and high efficiency standards in Turkey could have a positive effect on other countries as well.

2.4 Industry sector

In 2015, the share of the Turkish industrial sector in GDP was approximately 26% and thereby a key driver of the economic growth as in many other countries (Republic of Turkey Ministry of Energy and Natural Resources, 2017).

GHG emissions from the industry sector amounted to approximately 115 $MtCO_2e$/year in 2017, which is approximately 22% of the total national GHG emissions (excl. LULUCF) (UNFCCC, 2019a). Most significant is the non-metallic minerals (cement) sub-sector, followed by the metal production (iron and steel) (see Figure 7)..

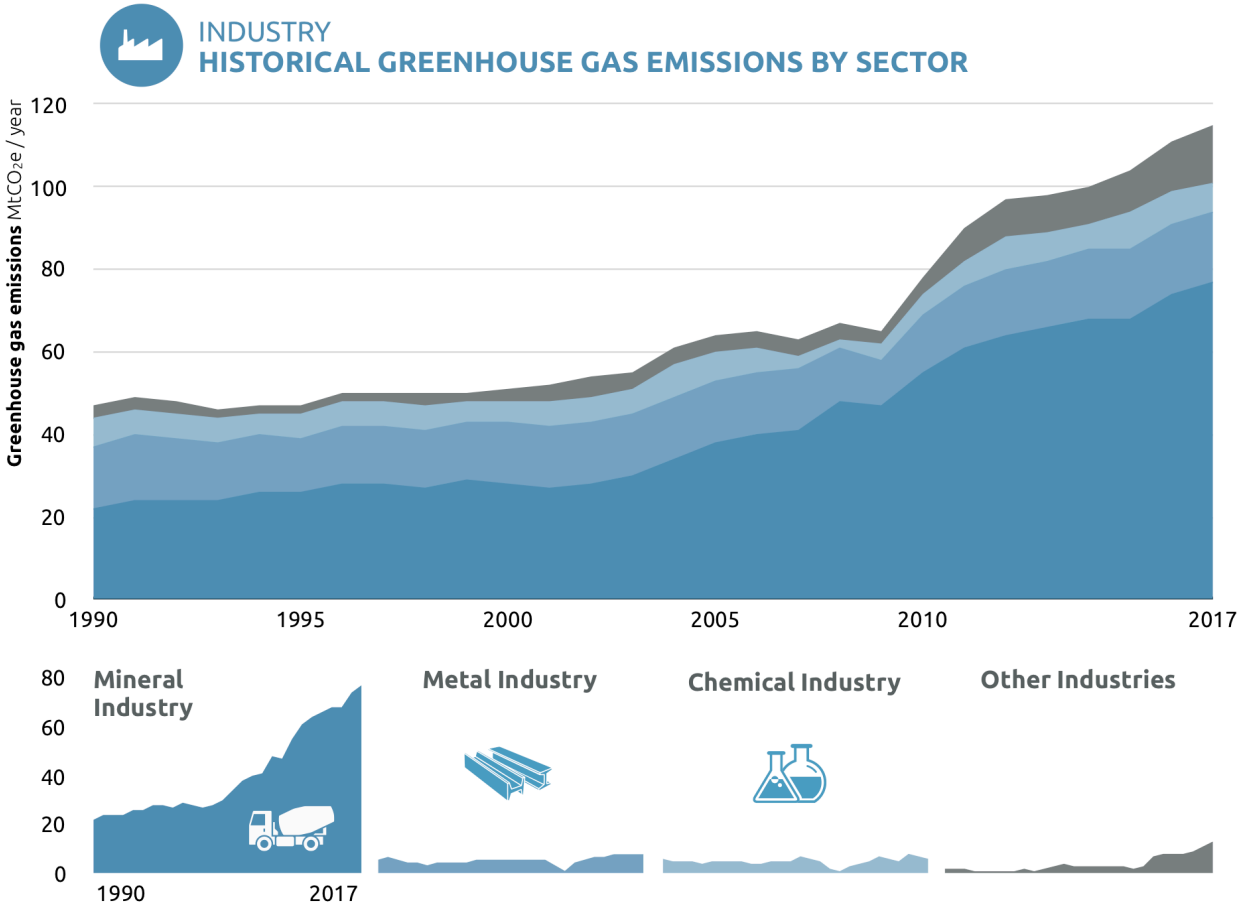


Figure 7 GHG emissions from the industry sector from 1990 until 2017. (UNFCCC, 2019a).

Of the total, energy related emissions are about 60.2 $MtCO_2e$ in 2017, of which about half come from the production of non-metallic minerals. Process-related GHG emissions from the industry sector amounted to approximately 66.5 $MtCO_2e$ in 2017, which is approximately 12.6% of the total national GHG emissions (excl. LULUCF). Most significantly is the mineral industry sub-sector which constitutes 66.7% of the process-related GHG emissions of the industry sector in 2017, followed by the metal industry (17.9%) (UNFCCC,2019).

Table 10 summarises Turkey's progress on the most important steps to decarbonise the industry sector to limit temperature to 1.5°C.

Table 10: Turkey's progress on the most important steps in the industry sector to limit temperature increase to 1.5°C

Sector	1.5 °C-consistent benchmark	Projection(s) under current policies	Gap assessment (qualitative)	Policy rating
Industry sector	All new installations in emissions-intensive sectors are low-carbon after 2020, maximise material efficiency	- Unclear whether the intended energy intensity reduction will result in the installation of solely low-carbon equipment after 2020.	+ The objective is to reduce the energy intensity by at least 10% by 2023 compared to 2011. - Did not find any specific details on the installation of low-carbon equipment in current energy efficiency policies (i.e. support scheme for energy efficiency in industry and act no. 5627).	

2.4.1 Actionable benchmarks in industry sector

The Climate Action Tracker identified one short-term actionable benchmark for the industry sector to limit warming to 1.5°C at a global level (Kuramochi et al., 2018):

- All new installations in emissions-intensive sectors need to be low-carbon after 2020, such as low-carbon steelmaking technologies, including carbon capture and storage (CCS), and material efficiency needs to be maximized.

The following gap analysis compares historical and projected developments in the Turkish industry sector to this global benchmark without any further adjustment to allow for comparison between countries under analysis. Country specific circumstances will be addressed in the in-depth analysis on raising ambition in the following chapters. Please refer to the publication for more detailed explanation on each indicator.

2.4.2 Recent policy developments

Table 11 provides an overview of implemented policies that foster the development towards a low-carbon industry in Turkey.

Table 11: Overview of implemented climate change policies in the industry sector in Turkey.

OVERVIEW OF EXISTING, PLANNED AND POTENTIAL CLIMATE CHANGE POLICIES FOR THE INDUSTRY SECTOR IN TURKEY				
Changing Activity	**Energy efficiency**	**Renewables**	**CCS or fuel switch**	**Non-energy**
Strategy for material efficiency (none)	**Support for energy efficiency in industrial production** ▪ Act No. 5627 on Energy Efficiency (2007) ▪ National Energy Efficiency Strategy Paper 2012–2023 (2012) ▪ National Energy Efficiency Action Plan 2017–2023 (2007) ▪ Support Scheme for Energy Efficiency in Industry (2008)	**Support schemes for renewables** (none)	**CCS support scheme** (none)	**Landfill methane reduction** (none)
	Energy reporting and audits ▪ Act No. 5627 on Energy Efficiency (2007) ▪ Regulation on Monitoring of Greenhouse Gas Emissions (2012)	**Sustainability standards for biomass use** (none)		**Incentives to reduce CH_4 from oil and gas production** Coal Bed Methane Mitigation Research (2005)
	Minimum energy performance and equipment standards ▪ Act No. 5627 on Energy Efficiency (2007)			**Incentives to reduce N_2O from industrial processes** (none)
	Incentives to reduce fluorinated gases (none)			
Overarching carbon pricing scheme or emissions limit (none)				
Energy and other taxes Special Consumption Tax Law, ÖTV. N°4760 (2002)				
Financial Support Schemes for Sustainable Development (none)				
No fossil fuel subsidies Subsidy for natural gas for industry				

No policies currently exist and a similar policy gap exists in all other countries

No policies currently exist however Turkey could adopt policies from other countries

Existing and planned policies in Turkey

Below, we describe Turkey's key legislation in the industry sector, taken from Table 11 and structured according to the policy categories. Only the most impactful policies are discussed. In the descriptions, the main aims of the policies are introduced as well as their envisioned effects.

The **INDC** includes the following intended plans and policies for the industry sector (Republic of Turkey, 2015):

- Reducing emission intensity with the implementation of National Strategy and Action Plan on Energy Efficiency.
- Increasing energy efficiency in industrial installations and providing financial support to energy efficiency projects.
- Making studies to increase use of waste as an alternative fuel in the appropriate sectors.

The Turkish economy is more energy-intensive compared to many developed countries. The industry sector accounts for approximately 32% of the end-use energy consumption and approximately 48% of the net electricity in 2015. Energy efficiency has become a key priority in Turkey (Republic of Turkey Ministry of Energy and Natural Resources, 2017).

The **Act No. 5627 on Energy Efficiency** enforced in 2007 introduced requirements for industrial enterprises to commission energy efficiency audits and establish an energy management structure. Additionally, the Energy Efficiency law introduced supporting mechanisms such as Efficiency Improvement Projects (EIP) and Voluntary Agreements (LSE, 2007; Republic of Turkey Ministry of Energy and Natural Resources, 2017). For instance, industrial facilities can receive financial support upon signing a voluntary agreement, which includes a commitment to reduce energy intensity by at least 10% within a three-year period. If the commitment is fulfilled, industrial facilities can receive subsidies amounting to 20% (max 100,000 TRY/~17,800 USD) of their energy expenditures in the year when the agreement was signed (European Environment Agency, 2011).

The **National Energy Efficiency Strategy Paper 2012–2023** aims to reduce Turkey's overall economy energy intensity (i.e. the amount of energy consumed per capita) by at least 20% by the year 2023 compared to 2011 figures. The strategy document provides a roadmap of energy-efficiency actions for all sectors of Turkey's economy. The energy intensity in each industry subsector has to be decreased by at least 10% (Republic of Turkey Ministry of Energy and Natural Resources, 2012).

The **National Energy Efficiency Action Plan 2017–2023 (NEEAP)** was formulated for effective implementation and monitoring of the 2023 energy efficiency goals set out in the National Energy Efficiency Strategy Paper. The NEEAP aims to improve energy efficiency through 55 actions in 6 sectors. The NEEAP defines 7 actions for the industry sector to ensure sustainability and promote energy efficiency. The actions involve, amongst others, mapping the energy saving potential in industry, defining new support mechanisms, scaling up cogeneration systems in large heat-using facilities, implementing environmental friendly design and labelling system for appliances (Republic of Turkey Ministry of Energy and Natural Resources, 2017).

2.4.3 Comparison of recent developments and projections to benchmark

In the following section, the actionable indicators relevant to the industry sector will be assessed against the policies and projections in place in Turkey.

*2.4.3.1 **Actionable indicator No.7:** All new installations in emissions-intensive sectors are low-carbon after 2020, maximise material efficiency*

The Turkish government aims to reduce the energy intensity in the industry sector by at least 10% by 2023 compared to 2011. Current policies, such as the Act No. 5627 on Energy Efficiency and the NEEAP, specify several measures to reach this target. Examples are the introduction of energy efficiency audits, energy management, new (financial) support mechanisms and several other actions. There is however no indication that newly installed manufacturing capacity coming online from 2020 onwards will be exclusively low-carbon.

2.4.4 Conclusion

Based on the analysis of recent developments and projects, the Turkish industry sector is starting to implement some measures towards energy efficiency. However, the current ambition to reduce the energy intensity by 10% by 2023 (compared to 2011) is low compared to the required level of climate action to meet the 1.5°C-compatible benchmark. Current policy context will not result in the installation of solely low-carbon equipment from 2020 onwards or equivalent emissions reductions in existing plants.

2.5 Agriculture and forestry

The share of the agriculture sector in GDP has declined from 30% at the end of 1970, to below 20% in the mid-1980s, to below 10% in the 2000s. In 2013, the GDP share dropped to 7.4% and is expected to drop further in the coming years. In 2013, the agriculture sector accounted for approximately 11% of the total national GHG emissions (excl. LULUCF). Most significant agricultural emissions are from livestock, i.e. enteric fermentation and manure management, which constitute respectively 48% and 12% of the GHG emissions of the agriculture sector, followed by the emissions from agricultural soils (37%). Rice cultivation and urea application constitute the remainder(UNFCCC, 2019a).

The Land Use, Land Use Change and Forestry (LULUCF) sector constitutes a sink, which reached a sink value of 58.7 $MtCO_2e$ in 2013. Between 1990 and 2013, the sink value increased by 94.5%, predominantly thanks to the increased amount of forests (Republic of Turkey Ministry of Environment and Urbanization, 2016).

Table 12 summarises Turkey's progress on the most important steps to decarbonise the agriculture and forestry sector to limit temperature to 1.5°C.

Table 12: Turkey's progress on the most important steps in the LULUCF and commercial agriculture sectors to limit temperature increase to 1.5°C

Sector	1.5 °C-consistent benchmark	Projection(s) under current policies	Gap assessment (qualitative)	Policy rating
LULUCF	Reduce emissions from forestry and other land use to 95% below 2010 by 2030, stop net deforestation by 2025	• The LULUCF sector constitutes a sink	+ The LULUCF sector constitute already a net positive sink of around 68 $MtCO_2e$ in 2016, up from approximately 45 $MtCO_2e$ in 2010 + The Turkish government aims to further increase the amount of carbon sequestered in forests and further reduce deforestation (target of 60 $MtCO_2e$ in 2030 is already overachieved)	Fully Transitioned
Commercial Agriculture	Keep emissions in 2020 at or below current levels, establish and disseminate regional best practice, ramp up research	• Unclear whether the objectives to limit GHG emissions and increase the sink capacity will be turned into practise • Given that the Turkish agricultural sector is expected to shrink, there is a likely change that emissions will stay flat or decrease over time	+ The Turkish government aims to limit the emissions from the agriculture sector and increase the sink capacity + The agriculture sector, and its GDP share, is likely to continue to decrease over time	Ambitious Plan

2.5.1 Actionable benchmarks in agriculture and forestry

The Climate Action Tracker identified two short-term actionable benchmarks for the transport sector to limit warming to 1.5°C at a global level (Kuramochi et al., 2018):

- Emissions from forestry and other land use need to be reduced to 95% below 2010 by 2030 and a stop of net deforestation has to be achieved by 2025.
- Emissions from commercial agriculture in 2020 need to be kept at or below current levels with the simultaneous establishment and dissemination of regional best practice and a ramp up of research.

The following gap analysis compares historical and projected developments in the Turkey LULUCF and commercial agriculture sectors to these global benchmarks without any further adjustment to allow for comparison between countries under analysis. Country specific circumstances will be addressed in the in-depth analysis on raising ambition in the following chapters. Please refer to the publication for more detailed explanation on each indicator.

2.5.2 Recent policy developments

Table 13 provides a comprehensive overview of the currently implemented and planned sectoral climate policies with the potential to affect GHG emissions directly.

Table 13: Overview of implemented climate change policies in the agriculture and forestry sector in Turkey

OVERVIEW OF EXISTING and PLANNED CLIMATE CHANGE POLICIES FOR THE AGRICULTURE AND FORESTRY SECTORS IN TURKEY				
Changing Activity	**Energy efficiency**	**Renewables**	**Nuclear or CCS or fuel switch**	**Non-energy**
Standards and support for sustainable agricultural practices and use of agricultural products ▪ Agricultural Law (2006) ▪ Strategic Plan of the Ministry of Food, Agriculture and Livestock (2013) ▪ 11th Development Plan (2019)				
Incentives to reduce CO_2 emissions from agriculture ▪ National Climate Change Action Plan 2011–2023 (2011)				
Incentives to reduce CH_4 emissions from agriculture ▪ National Climate Change Action Plan 2011–2023 (2011)				
Incentives to reduce N_2O emissions from agriculture ▪ National Climate Change Action Plan 2011–2023 (2011) ▪ Organic Agriculture Law (2001)				
Incentives to reduce deforestation or support for afforestation/reforestation ▪ Climate Change Action Plan 2011–2023 (2011) ▪ Forest Law No. 6831 (1956) ▪ National Forestry Program (2004) ▪ Regulation on afforestation (2012)				

No policies currently exist and a similar policy gap exists in all other countries

No policies currently exist however Turkey could adopt policies from other countries

Existing and planned policies in Turkey

Below, we describe Turkey's key legislation in the forestry and agricultural sector, taken from Table 13 and structured according to the policy categories. Only the most impactful policies are discussed. In the descriptions, the main aims of the policies are introduced as well as their envisioned effects.

The **INDC** includes the following intended plans and policies for the agriculture and forestry sector (Republic of Turkey, 2015):

Agriculture:

- Fuel savings by land consolidation in agricultural areas
- Rehabilitation of grazing lands
- Controlling the use of fertilisers and implementing modern agricultural practices
- Supporting the minimum tillage methods

Forestry:

- Increasing sink areas and preventing land degradation
- Implementing Action Plan on Forestry Rehabilitation and National Afforestation Campaign

Under the **National Climate Change Action Plan (NCCAP)** various objectives are defined to limit the GGH emissions from the agriculture sector. The NCCAP aims to (Republic of Turkey Ministry of Environment and Urbanisation, 2011):

i. Increase the sink capacity of the agriculture sector. The objectives are 1) to determine and increase the quantity of carbon stock captured in the soil and 2) to identify and increase topsoil and subsoil biomass.
ii. Limit GHG emissions from the agriculture sector. The objectives are 1) to identify the potential GHG emissions limitation in the agriculture sector and 2) to decrease the increase rate of GHG emissions originating from vegetal and animal production.
iii. Build the information infrastructure that will meet the needs of the agriculture sector in adapting to and combating climate change.

In addition to the NCCAP, the **Agricultural Law** includes more generic goals of agricultural policies to develop agricultural production in accordance with demand, protect natural resources, improve productivity, etc. Under the **National Energy Efficiency Action Plan,** 6 actions are defined to ensure sustainability and promote energy efficiency. The actions involve, amongst others, switching to energy efficient irrigation methods, encouraging the use of renewable energy resources and identifying agricultural by-products and waste potential to produce biomass (Republic of Turkey Ministry of Energy and Natural Resources, 2017).

Under the **National Climate Change Action Plan (NCCAP)** various objectives are defined to limit deforestation and increase the carbon sink of the LULUCF sector. The NCCAP aims to (Republic of Turkey Ministry of Environment and Urbanisation, 2011):

i. Increase the amount of carbon sequestered in forests by 15% of the 2007 value by 2020 (i.e. 14.5 MtC in 2007, 16.7 MtC in 2020).
ii. Reduce deforestation and forest damage by 20% of the 2007 values by 2020.
iii. Limit the negative impact of land uses and changes such as forests, pastures, agriculture and settlements on climate change. The objective is to:
    a. Increase the amount of sequestered carbon as a result of agricultural forestry activities by 10% of the 2007 values by 2020.
    b. Identify the amount of sequestered carbon in pastures and meadows in 2012 and increase carbon stock by 3% by 2020.
    c. Identify the existing carbon stock in wetlands in 2012 and maintain the level until 2020.
    d. Identify the quantity of carbon stored in settlement areas in 2012 and increase stored carbon 3% by 2020 through green planting.
iv. Strengthen legal and institutional structure for combating climate change with regard to land use and forestry.

Next to the NCCAP, the **Regulation on afforestation** aims at promoting afforestation for the rehabilitation of forests, erosion and flood control, prevention of avalanches and landslides, and for the improvement of pastures (NewClimate Institute, 2016).

The 11th Development Plan foresees a slight increase of the ratio of forest areas to country area from 29% in 2018 to 30% in 2023 (Government of Turkey, 2019).

2.5.3 Comparison of recent developments and projections to benchmarks

In the following section, the actionable indicators relevant to the agriculture and forestry sector will be assessed against the policies and projections in place in Turkey.

*2.5.3.1 **Actionable indicator No.8:** Reduce emissions from forestry and other land use to 95% below 2010 by 2030, stop net deforestation by the 2020s*

Given that the LULUCF sector in Turkey is a net sink, which is increasing, Turkey is well in line with the 1.5 °C-compatible benchmark. In addition, the NCCAP includes the objective to further increase the amount of carbon sequestered in forests and reduce deforestation and forest degradation levels.

*2.5.3.2 **Actionable indicator No.9:** Keep commercial agriculture related emissions in 2020 at or below current levels, establish and disseminate regional best practice, ramp up research*

Turkish agricultural GHG emissions will likely stay at or below current levels due to a combination of, on the one hand, the governmental aim to limit GHG emissions, and on the other hand, the projected shrinking of the Turkish agricultural sector.

2.5.4 Conclusion

Based on the analysis of recent developments and projects, Turkey is well in line with the 1.5 °C-compatible benchmark on forestry, since the LULUCF sector is a net sink. Turkey is expected to meet the 1.5 °C-compatible benchmark on agriculture as well, given the projected decrease in GHG emissions due to both policy measures and the expected decreasing role of the sector.

3 Selection of focus areas for analysis on scaling up climate action

Three areas have been identified as a priority for in-depth analysis on scaling up climate action in Turkey: the electricity sector, passenger transport sector and residential buildings sector.

This section explains the reasoning for looking further into three areas of action, considering the Turkish national context and country-specific circumstances. It should be noted that the selection of focus areas in no way indicates that less mitigation action needs to happen in all other remaining sectors. Relevant literature in the field and most recent emission scenarios clearly indicate that all sectors need to maximise their efforts for Paris Agreement-compatibility (Kuramochi et al., 2017). The selection of focus areas for scaling up climate action is based on following criteria combined with expert judgement by the authors:

- **GHG emissions:** The relevance of the (sub-)sector in terms of historical and projected future GHG emissions.
- **Overlaps with other sectors:** The (sub-)sector's overlap with other sectors relevant for long-term decarbonization (e.g. CO_2-neutral electricity sector in parallel to electrification trends in the transport or buildings sector).
- **Existing gap**: The existing gap between currently existing and planned policies and 1.5°C-compatible benchmark(s).
- **Potential for scaling up climate action:** The potential for enhancing climate action, given local and global sectoral development (e.g. decreasing prices for RE technologies, CCS capacities, pending investment in infrastructure).
- **Priority in the national discourse:** Priority of the respective (sub-)sector in the national discourse or window of opportunity to enhance climate action due to recent social, political, or economic developments.
- **Co-benefits potential:** Potential to realise co-benefits of scaling up climate action in a given country context (e.g. local job development through ambitious renewables deployment or reduction in urban air pollution due modal shifts away from combustion engines).

In the following sections provide detailed explanation for each sector selection, and specifies the technical feasibility of the research for the sectors (e.g. data availability might be a limiting factor).

3.1 Electricity sector

The focus on the electricity sector is justified by the significant share of emissions coming from the sector and the important challenge of increased demand in the years to come. Electrification of the other sectors will further increase the impact of the sector's decarbonisation on the country's emissions:

- **GHG emissions:** High relevance of electricity sector in terms of overall GHG emissions as electricity generation is to a large extent based on natural gas and coal (emission coverage: 28% of total national GHG emissions (excl. LULUCF) in 2017) (UNFCCC, 2019a) .
- **Existing gap:** Significant gap between currently implemented policies and 1.5°C-benchmarks as the Turkish Government is, next to renewables, also investing in new coal plants (i.e. 37.5 GW of coal plants are in the pipeline, either being permitted, in pre-permit or announced) (Endcoal, 2018).
- **Potential for scaling up climate action:** Turkey is resource-rich in renewable energy sources and there is a significant potential for the deployment of wind and solar power capacity. The sector has been a key focus in the national policy making process, with the

aim of improving its efficiency and enhancing (promoting?) its liberalisation and privatisation. At the moment, Turkey pursues both domestic coal, as well as renewable sources, to decrease dependence on imported fuels. With decreasing prices, there is a huge potential in moving towards renewables only.

- **Overlaps with other sectors**: Decarbonization of electricity supply sector as prerequisite for any low-carbon electrification of the transport and buildings sector.
- **Co-benefits potential:** Increasing the share of renewables in the power sector and transitioning away from coal-based electricity generation offers significant potential to generate co-benefits. The most significant ones include job creation in the renewables sector and other low-carbon-oriented sectors, sustainable local industrial development and innovation, a reduction of fossil fuel imports and a reduction of air pollution from coal combustion. Such co-benefits directly contribute to several sustainable development goals, such as promoting access to affordable, reliable, sustainable and modern energy for all (SDG 7) (Ministry of Development, 2016). Research also finds that pushing wind and solar energy development would provide important industrial development and trade opportunities: For the solar industry for example, capacity additions of 25 GW in the next ten years would increase the value of industrial production to 11.3 billion USD up from 0.88 billion USD today (Istanbul Policy Center, IASS, & IET, 2019).

3.2 Passenger transport

The focus on the transport sector is justified by the significant share of emissions coming from the sector, the existing gap but also the potential of significant co-benefits:

- **GHG emissions:** High relevance of passenger transport sector in terms of overall emissions (i.e. the transport sector in total makes up 20.83% of energy related emissions and 15.1% of total national GHG emissions, excl. LULUCF)(UNFCCC, 2019).
- **Existing gap:** Unclear whether intended development and promotion of alternative fuels and clean vehicle technologies can be realised in the near to medium term.
- **Potential for scaling up climate action:** Policies in place focused on the development of legal arrangements, capacity building and promotion of alternative fuels and clean vehicles. But no overarching 1.5°C/2°C-compatible vision for transport sector in Turkey.
- **Overlaps with other sectors:** Reducing emissions from the transport sector by replacing combustion engines by electric vehicles will require decarbonisation of the power sector.
- **Co-benefits potential:** Replacement of combustion cars by low/zero-carbon alternatives would also significantly reduce air pollution. Reduction in road traffic, especially trucks and motorbikes, would also reduce noise pollution and economic losses due to congestion. Such co-benefits might considerably contribute to sustainable development goals such as SDG 3's provision of healthy lives and well-being for all ages through, for example, the reduction of cardiovascular diseases, cancer, diabetes and chronic respiratory diseases developed because of particulate matter (PM) pollution.

3.3 Residential buildings sector

The focus on the residential buildings sector is justified by the significant potential for scaling up climate action given the rapid growing cities and population figures:

- **GHG emissions:** Medium relevance of buildings sector in terms of overall emissions (8.1% of total national GHG emissions, excl. LULUCF) in 2017 (UNFCCC, 2019b).

- **Existing gap:** Unclear whether the objectives to increase the use of renewable energy sources and the rehabilitation of the existing building stock will be sufficient to meet the 1.5°C-compatible benchmarks.
- **Potential for scaling up climate action:** Due to rapidly growing cities and population figures, more than 100,000 new buildings are expected to be added to the buildings stock every year. This gives the possibility to save energy and reduce GHG emissions by making new buildings more energy efficient.
- **Overlaps with other sectors**: An energy efficient and energy positive buildings sector will support the transition of the power and the transport sector by reducing the overall load required from electricity generation and provide oversupply to the electrified fleet of vehicles.
- **Co-benefits potential:** Potential for household savings and opportunities for job creation and local economic development linked to retrofitting and new construction of low-emission buildings. Increasing the efficiency of the buildings sector will also significantly reduce energy poverty, and elimination of fossil fuels will reduce the issue of air pollution, especially from the low stack sources.

4 Scenario analysis of scaling up climate action in Turkey

This section presents scenario analysis supporting scaling up climate action in Turkey for three focus sectors: electricity supply, passenger transport, and the residential buildings sector. We quantify the emissions reduction achieved through enhanced climate action and corresponding co-benefits based on the selection of three different scenario categories as elaborated below. This scenario analysis allows to identify the overlaps, or the gaps, between sectoral transformations under the reference scenario projections, sectoral transitions required to be compatible with the Paris Agreement's temperature target. Additionally, we investigate the sectoral transformations demonstrated by international frontrunners and existing national-specific scenarios.

	Scenario categories	Definitions
1	NATIONAL SCENARIOS	Scenarios based on national research and country-specific studies
2	BEST IN CLASS SCENARIOS	Scenarios based on practices implemented by regional or international frontrunners
3	1.5°C PARIS AGREEMENT COMPATIBLE SCENARIOS	Scenarios based on sectoral developments in line with the Paris Agreement's temperature limit.
4	CURRENT DEVELOPMENT SCENARIO	Baseline scenario used for comparison purposes. The scenario is based on the continuation of current trends and policies until 2050.

1.5°C Paris Agreement compatible scenarios

The category of '1.5°C Paris Agreement compatible scenarios' comprises sectoral indicator values, which are in line with a 1.5°C-compatible sectoral emissions trajectory. The analysis in this scenario category enhances the general understanding about required sectoral transformations in the Turkey context to be in line with the Paris Agreement's temperature goal.

Applying best-in-class level(s)

The scenario category 'applying sectoral best-in-class level(s)' identifies indicator values from international and regional frontrunner(s) on national climate action in the respective (sub-) sector. The absolute indicator level(s) or growth rate(s) are applied to the developments in the respective sector. The analysis in this scenario category reveals the sectoral implications if sectoral transitions achieved by international frontrunners are replicated at a country scale.

National scenarios

The scenario category 'national scenarios' comprises sectoral indicator levels obtained from analyses conducted particularly by national research institutions, NGOs and universities. Such analyses mainly include long-term, least-cost modelling studies for the whole energy sector or at sectoral level. The analysis in this scenario category aims to illustrate the sectoral decarbonisation pathways proposed by recent studies focusing specifically on the country.

4.1 Electricity sector

4.1.1 Context for scaling up climate action in the electricity sector in Turkey

Development of renewable and other low-carbon sources for electricity generation

- **Financial feasibility of increasing share in renewables generation:** recent tenders for large-scale PV and wind installations resulted in offers well below existing feed-in tariffs (e.g. USD 3.48 ct/kWh for wind and USD 6.99 ct/ kWh for solar PV). These developments point to even greater future declines in Turkey's generation costs (Godron et al., 2018). IRENA also finds that the cost of installing 1 kW of solar power was about 1200 USD in 2018, showing a significant decrease in costs compared to earlier years (IRENA, 2019a). Similarly for wind energy, IRENA shows that in Europe and Eurasia, the costs are down to below 2000 USD/kW.
- **Resource availability for renewables:** Turkey generated about 300 TWh electricity in 2018 (Republic of Turkey Ministry of Energy and Natural Resources, 2019). Estimates of Turkey's realistic deployment potential for renewables have been put at more than 5 EJ/yr (>1,000 TWh/yr), mostly from solar and geothermal sources (Deng et al., 2015), allowing for significant increases in demand from electrification even in a high renewable share power system.
- **Transmission and grid-connection feasibility of renewables generation:** Turkey can increase the currently installed capacity of wind and solar energy to 40 GW by 2026, doubling of planned capacities, without any requirement for additional transmission infrastructure investment than that currently planned. This means that roughly 20% of the total electricity can come from wind and solar without a significant impact on system planning and operation. The system could also cope with up to 50% renewables%, of which 30% wind and solar, if additional flexibility measures were implemented (Godron et al., 2018).
- **Development of nuclear energy:** Until 2018, Turkey had no nuclear energy in its electricity generation mix. However, Turkey has decided to introduce nuclear energy to meet the increasing energy demand and lower its dependence on imported energy sources. Turkey envisions to install two nuclear power plants by 2030 with a total capacity of 4.8 GW (IAEA, 2018). The construction for the first reactor in Akkuyu has been slow but shall be completed in 2023. The foundation of the reactor has been laid and financing has recently been secured for this project. For the other reactors and plant, the planning is less clear.
- **Development of coal:** Turkey is continuing to increase the role of domestic lignite in its energy supply. 2018 saw Turkey breaking its record in domestic coal production, which reached 101.5 million tonnes (Anadolu Agency, 2019). In May 2019, the Ministry of Energy and Natural Resources announced forthcoming tenders for coal mines acquisition (Ahval, 2019b). In 2018, two new power plants in Turkey (Yumus Emre and Çan-2) started operating and the Soma Kolin power plant, totalling 1.2 GW of additional capacity, is under construction, with completion expected by the end of 2019 (Climate Action Network Europe, 2019). The government is continuing to press for a large expansion in coal power with close to 33.8 GW of planned power plants (announced, pre-permitted and permitted) (EndCoal, 2019). However, the pipeline has decreased compared to previous estimates. Expanding coal capacities stands in strong contrast to the global need to reduce the use of coal in electricity by two-thirds over 2020-2030 and to zero by 2050 (IPCC, 2018a).

Apart from the impact on emissions, this would add severe stress to already drought-prone regions, increasing the threat to water demand, by adding competition with other water users. At least 7 GW of the proposed coal-fired power plants in Turkey are to be built in areas already experiencing water over-withdrawal and baseline water stress (Greenpeace, 2016).

Job benefits and local economic development

- In 2018, approximately 62,000 people worked within the energy sector(Ferroukhi et al., 2019).
- Greenpeace (2015) shows that if Turkey were to heavily invest in renewable energy, the number of jobs would be expected to rise significantly to approximately 130,000 in 2030 (Greenpeace, 2015a).

4.1.2 Scenario analysis for scaling up climate action in the electricity sector

4.1.2.1 Identification of indicator levels

Table 14 provides a complete overview of indicator levels identified for the three different scenario categories. The indicator levels have been directly inputted into the PROSPECTS Turkey scenario evaluation tool to conduct the emission pathway analysis for the Turkish electricity supply sector. Data on the fuel mix that is defined in the scenario is also considered in PROSPECTS.

Table 14: Identification of indicator levels for analysis on scaling up climate action in the electricity supply sector.

Indicator	Current Development Scenario (CDS)	National scenarios	Best-in-class scenarios	1.5°C Paris Agreement Compatible scenario
Share of renewables in total electricity generation (in %)	32% by 2015			
	35% by 2030	47%–66% by 2030	54%–60% by 2030	59%–75% by 2030
	35% by 2040	51%–87% by 2040	69%–89% by 2040	69%–94% by 2040
	35% by 2050	54%–93% by 2050	84%–98% by 2050	75%–100% by 2050
	Based on IEA balances 2017 and IEA WEO 2017 (Climate Action Tracker, 2019; IEA, 2016b)	*Based on electricity generation projects from Greenpeace and Bloomberg (Bloomberg, 2014; Greenpeace, 2015b)*	*Based on s-curve VRES approach by NewClimate and the average annual increase in RE share from Fekete et al. (Fekete et al., 2015)*	*Based on electricity generation mix projections from Greenpeace (Greenpeace, 2015c) and the "B2DS Scenario" for the European Union from IEA ETP* (IEA, 2017).

1.5°C Paris Agreement compatible benchmarks

The review of relevant literature identifies a range of 59% to 75% by 2030, 69% to 94% by 2040, and 75% to 100% by 2050 for the renewable energy share (RES) in total electricity generation of Turkey to be in line with the 1.5°C Paris Agreement's temperature target. The benchmark values have been derived from the following literature:

- **Upper bound of RES indicator range:**
    - The upper bound of RES indicator is based on the 'Advanced Energy Revolution (ADV E[R])' scenario by the Greenpeace International, Global Wind Energy Council and Solar Power Europe (Greenpeace, 2015a). This scenario has been developed using a primarily "bottom-up" approach (technology-driven), relying on the Mesap/PlaNet simulation model. This model does not use a cost optimization approach for the calculation of energy technology expansion; rather it requires a consistent exogenous definition of feasible developments to meet the targets. In line with the 1.5°C benchmark, the ADV E[R] scenario represents an ambitious pathway towards a fully decarbonised global energy system by mid-century. By 2050, 100% of the electricity produced worldwide, and therefore also in Turkey, should come from renewable energy sources. On global average, the scenario suggests 12% hydro, 47% wind and 30% solar, with the remaining 11% coming from other renewable sources. In our analysis, we sum up all renewables and do not work with a breakdown. A rather fast introduction of new efficient technologies and applying other mitigation measures, such as fundamental changes of consumption patterns leads to a complete, decarbonisation of the global energy system by mid-century.
    - Dynamic expansion of renewable energy in all sectors is the main strategy to meet the overall target of CO_2 emission reductions. CCS technologies are not implemented, and globally, nuclear and lignite power plants are phased out quickly, followed by hard coal power plants. The global quantities of biomass power generators and large hydro power remain limited in the Energy [R]evolution scenarios, for reasons of ecological sustainability.
    - Wind power and solar power (both photovoltaics and concentrating solar power (CSP)) are expected to be the main pillars of future power supply, complemented by smaller contributions from geothermal (hydrothermal and Enhanced Geothermal Systems (EGS)), ocean energy and the further expansion of small and medium-sized hydro power.
    - The modelling results indicate a RES share of 75% by 2030, 94% by 2040, and 100% by 2050 for OECD Europe (including Turkey)[2]. This is also in line with the higher ambition end of the share of electricity generated by renewables and other zero and low carbon sources as envisaged by the recent 1.5°C scenarios (IPCC, 2018b).
- **Lower bound of the RES indicator range:**
    - The lower bound of RES indicator value is based on the "Beyond 2°C scenario (B2DS)" by the IEA Energy Technology Perspectives (ETP) 2017 (IEA, 2017). The B2DS provides a close analogue to a 1.5°C compatible pathway for the Turkish power sector by 2050. The B2DS results indicate a RE share of 59% by 2030, 69% by 2040 and 75% by 2050 for the European Union. The renewable energy mix is dominated by wind (35% by 2050), hydro (13% by 2050) and biofuels (12% by 2050).. Although Turkey is not an EU member state, the ETP B2DS pathway for the European Union has been chosen over the ETP B2DS pathway for the OECD region. This has been decided given the currently high RE share in Turkey and the

[2] Countries included in OECD Europe are Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Israel, Luxembourg, the Netherlands, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

fact that the ETP B2DS pathway for the OECD region still has a 9% fossil share in 2050, which is not in line with a 1.5°C-compatible scenario.

- The share of other low-carbon energy sources, such as nuclear, reaches 25% by 2050 in the ETP B2DS. The share of renewables in power generation based on the ETP B2D scenario is comparable with the lower ambition end of the share of electricity generated by renewable sources from the recent 1.5°C scenarios. At the same time, an increase in nuclear energy to 25% is highly unlikely for the EU and also for Turkey, given the rising costs of nuclear energy (UCS, 2018), especially if compared with the rapidly decreasing costs of dispatchable renewables and storage (Lazard, 2018). While Turkey is trying to construct nuclear power capacity, progress has been slower than expected. Realistically, a higher share of dispatchable renewable energy would be expected instead and at a lower cost.
- More analysis on how the B2DS compares to 1.5°C pathways is available in our EU Scaling Up report, Box 2 "IEA B2DS and 1.5°C-compatibility" (Climate Action Tracker, 2018d).

Applying best-in-class levels

Applying best-in-class levels of international frontrunners in raising the renewable energy share (RES) in total electricity generation allows to understand how the Turkish electricity sector might transform under similar developments. The application resulted in a RES indicator ranges of **54%-60% by 2030, 69%-89% by 2040**, and **84%-98% by 2050**. The range of indicator values have been derived as follows:

- **Upper bound of the RES indicator range**:
  - The upper bound indicator values have been obtained by applying an s-curve shaped good practice trajectory for the uptake of variable renewable-based electricity generation (i.e. solar and wind). The s-curve has been fitted by applying Denmark's historical growth in share of variable renewables (VRES) between 2009 and 2015, which went from 19.2% to 39.2%. The saturation level has been defined by Denmark's long-term target of 100% renewable energy generation by 2050. The methodological approach of fitting an s-curve is explained in a summary report of Cornet (Cornet et al., 2018).
  - The results for Turkey with share of variable renewables of 4.5% in 2016 are 30% by 2030, 70% by 2040, and 92% by 2050. This share only includes variable renewables, the non-VRE share as well as the disaggregation of the total VRE into solar and wind is derived based on the upper bound of the national scenario. Consequently, the total share of renewables in this scenario is 60% by 2030, 89% by 2040 and 98% by 2050.
- **Lower bound of the RES indicator range**:
  - A linear increase of 1.5% points per year in the Turkish share of renewable-based electricity generation is assumed as the lower bound. The annual increase in %-points is informed by average growth rates of renewable energy in Germany after the implementation of ambitious renewable support policies (Fekete et al., 2015).
  - The results for Turkey with a share of renewable-based electricity of 32% in 2015 are 54% by 2030, 69% by 2040, and 84% by 2050. This linear approach faces the limitation that no dynamic uptake in the renewable energy can be incorporated, especially when reaching the natural threshold of 100% in total generation. Furthermore, the breakdown into renewable energy technologies as well as the share of non-renewable energy sources is derived based on the high bound of the national scenario until 2050.

National scenarios

Recently published modelling results by Turkish research institutions and intergovernmental bodies like IRENA inform the selection of RES indicator value ranges for national scenarios in the Turkish electricity sector. The RES indicator ranges are **47%-66% by 2030, 51%-87% by 2040, and 54%-93% by 2050**. The range of indicator values have been informed by following modelling results:

- **Upper bound of the RES indicator range**: The upper bound values are based on the 'energy [r]evolution' scenario from the sustainable energy outlook for Turkey, written by Greenpeace International, Greenpeace Turkey and the Bahcesehir University Center for Economic and Social Research in Turkey. The RES share within the 'energy [r]evolution' scenario is 66% by 2030, 87% by 2040 and 93% by 2050 (Greenpeace, 2015b). In 2050, the scenarios still include gas in the electricity mix, whereas the IPCC Special Report on 1.5°C indicates that gas without CCS has to be phased out by then. It is because of this that CAT does not include this scenario in the Paris-compatible pathways. Note that the energy [r]evolution considers national circumstances but is not in line with governmental policies and plans.
- **Lower bound of the RES indicator range**: The lower bound values are based on the electricity generation mix for 2030 defined in the 'renewable development pathway' scenario (Bloomberg, 2014). Note that a linear extrapolation has been applied from 2030 onwards based on the TWh production per fuel type (i.e. coal, natural gas, oil, hydro, etc.).

Other national studies exist that support the feasibility of such short-term increase of renewable capacities: They find that it would be possible to accommodate about 50% of renewable electricity in Turkey's power grid already by 2026, if additional flexibility measures are implemented in the system (Godron et al., 2018; Saygın et al., 2019).

4.1.2.2 *Quantification of emissions levels with PROSPECTS*

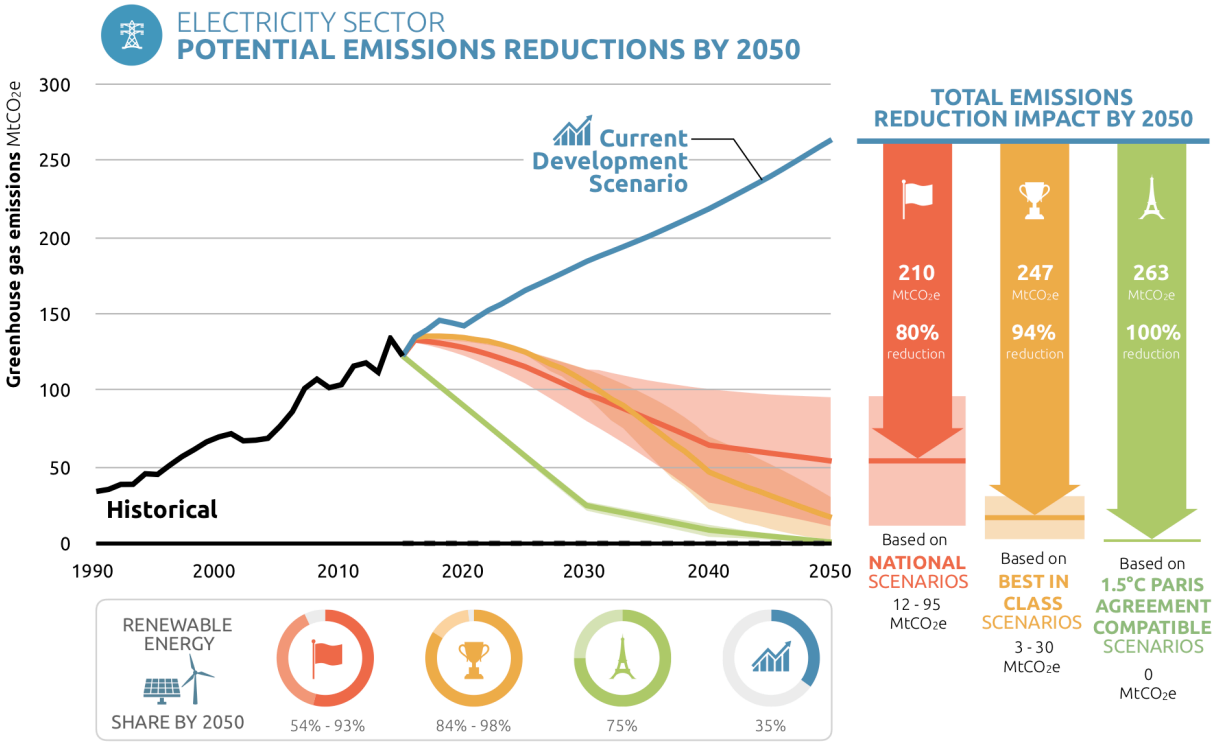


Figure 8: Overview of sectoral emission pathways under reference scenario and different levels of accelerated climate action in the Turkish electricity supply. All sectoral projections towards 2050 are done with the CAT PROSPECTS Turkey scenario evaluation tool. The electricity-related emissions from end-use sectors are included.

Figure 8 illustrates the emissions trajectories from the Turkish electricity generation sector until mid-century. Under the current development scenario, emissions from electricity generation continue to increase up to about 264 $MtCO_2e/yr$ in 2050. Enhancing climate action and strengthening mitigation measures in the electricity generation sector imply further emissions reductions far beyond the reference scenario projections:

- The '**1.5°C Paris Agreement compatible**' pathways imply an immediate and drastic reduction of today's emissions from electricity generation already before 2030, and lead to a full decarbonisation of the electricity generation sector by mid-century. This is mainly driven by a quick ramp-up of renewable electricity generation and a decrease in coal power. To support such a development, it is of importance to 1) introduce policies that would accelerate the development of renewables, 2) introduce measures that increase the flexibility of the electricity grid (i.e. demand management, storage, power to gas) and 3) introduce measures that phase out coal.
- The '**Applying best-in-class levels**' pathways imply an immediate and drastic reduction of emissions under the upper ambition trajectory, which leads to a near complete decarbonisation of the electricity sector by mid-century, reducing emissions by 90% from 1990 levels. The lower ambition trajectory leads to slightly higher emissions around 30 $MtCO_2e/yr$ by 2050, about the same levels as in 1990.
- The '**National scenario**' pathways reveal a broad range across the upper and lower ambition trajectory. The upper ambition end (i.e. 93% renewables in 2050) implies an immediate and quick reduction of emissions, while the lower ambition end (i.e. 54% renewables in 2050) shows a slight decrease in today's emissions towards 2030 and stabilizing emission levels in the period 2030–2050. The range of emissions in 2050 resulting from the two scenarios is 12–95 $MtCO_2e/yr$.

4.2 Passenger transport sector

4.2.1 Context for scaling up climate action in the passenger transport sector

Emissions reduction options in the Turkish passenger transport sector

- Given the strong dependence of the Turkish economy on the transport sector, it is of importance that the sector is ready to meet current and future challenges such as climate change and energy security. Among different options, this study considers the modal shift away from private vehicles, transport sector electrification and fuel intensity improvements of new cars for in-depth analysis (Climate Action Tracker, 2016b):
    - **Modal shift**: Shifting transport activity from modes with carbon-intensive emissions to modes with lower specific emissions can significantly reduce energy demand and average emissions per passenger-kilometre.
    - **Electrification**: Replacing vehicles with internal combustion engines with electric or plug-in hybrid vehicles reduces tailpipe emissions to zero. Unless electricity generation is decarbonised, absolute emissions from electricity generation increase due to higher power demand.
    - **Fuel economy**: Penetration of EVs will not alone guarantee a sustainable, emissions-free transport sector. Simultaneous decarbonisation of the power sector, along with fuel intensity improvements of new cars, are complementary measures to achieve a clean transport sector.

Significant co-benefits of decarbonising the transport sector

- **Health benefits:** In addition to GHG emissions, green and smart mobility solves various other challenges such as air pollution by reducing particulates matters and NO_X (ICCT, 2016a). Noise pollution will also be reduced. While transport electrification will not reduce aerodynamic or tire noise dominating at higher speeds, the slower, urban traffic noise coming mainly from engines will be reduced dramatically (Barnard, 2016). It will also make public spaces available for open, green areas, thus having a positive impact on the quality of life in the cities (Mulliner & Maliene, 2011).
- **Important role for the economy:** Turkey is one of the most important vehicle manufacturing countries in the world. About three-quarters of the total annual vehicle production is exported abroad. As a result, the transport sector in Turkey plays an important role in the national economy, with many production plants and a large number of people employed in the vehicle manufacturing sector. Smart mobility is expected to decrease the number of cars on the road and therefore ease congestion, which has major negative impact on economic productivity (ICCT, 2016a).

4.2.2 Scenario analysis for scaling up climate action in the passenger transport sector

4.2.2.1 Identification of indicator levels

Table 15 provides an overview of indicator levels identified for scenario modelling in the passenger transport sector. The upper part of the table presents the relevant benchmarks as specified in the literature. The lower part shows how those benchmark levels have been adapted into selected indicator levels for providing input to the PROSPECTS Turkey scenario evaluation tool.

Table 15: Overview of different benchmarks identified in the literature and translation into indicator levels for analysis of scaling up climate action in the passenger transport sector with PROSPECTS Turkey scenario evaluation tool.

Indicator	Current Development Scenario (CDS)	National scenarios	Best-in-class scenarios	1.5°C Paris Agreement Compatible scenario
Share of public transport (% of bus and train in total road and rail passenger transport activity)	32% in 2030 *Based on the ICCT, assumption that current split persists (ICCT, 2016b)*	Current share (i.e. 32%) is already within the best-in-class range of 27.4%–33.5% in 2050 *N/A*	Current share (i.e. 32%) is already within the best-in-class range of 27.4%–33.5% in 2050 *Based on the best-in-class performance of Austria (low-bound) and Czech Republic (high-bound)*	Same as Best-in-Class scenario, no 1.5°C-compatible benchmark set at this level *N/A*
Electric vehicle development (EVs share in total fleet for cars and buses)	**Cars** 0% in 2030 0% in 2050 **Buses** 0% in 2030 0% in 2050 *Based on the assumption taken in PROSPECTS that there is no change after 2015*	No national scenario available	**Cars** 17% in 2030 58% in 2050 **Buses** 20% in 2030 60% in 2050 *Based on the best-in-class performance of Norway (Kriegler et al., 2018)*	**Cars** 43%–57% in 2030 100% in 2050 **Buses** 51%–68% in 2030 100% in 2050 *Based on ten key short-term sectoral benchmarks to limit warming to 1.5°C (Kuramochi et al., 2017)*
Fuel economy (fuel intensity improvement for new non-electrified LDVs)	0% *Default*	No national scenario available	3.6% per year average fuel intensity improvement rate of non-electrified personal vehicle transport activity for 2016 - 2050 *Based on the assumption that Turkey will follow the same trend as the EU*	Same as Best-in-Class scenario, no 1.5°C compatible benchmark set at this level *N/A*

1.5°C Paris Agreement compatible benchmarks

To only have zero-emission cars on the road by 2050, the last fossil fuel powered car would have to be sold roughly before 2035, assuming a 15-year lifetime (Kuramochi et al., 2017). Of course, such a transition will be much easier with a reduction and modal shift of the demand for transport (Climate Action Tracker, 2016b). Therefore, modal shift and electrification of the transport sector must be seen as complementary measures and not as alternatives. Additionally, the extensive reduction of fuel intensity of new, non-electric cars is an important intermediate measure until the full electrification of the passenger transport sector is achieved by mid-century. Lacking a clear benchmark for a Paris-compatible modal share as well as fuel intensity levels of new cars, we apply the EU targets as identified in best-in-class scenario, also reflected in the 1.5°C-compatible scenario, combined with the electrification of the passenger transport sector according to the 1.5°C Paris Agreement compatible benchmark based on Kuramochi et al. (2017).

Paris Agreement compatible deployment of electric vehicles in passenger transport are combined with the modal shift and CO_2 standards for new non-electric cars from the high ambition case of the best-in-class scenario:

- **Modal shift:** There is no 1.5°C scenario available on the share of public transport. Note that the current share within Turkey (i.e. 32%) is already within the best-in-class range (27.4% - 33.5%).
- **Electrification:**
    - For all road transport modes (personal vehicles, MBT, Bus, BRT), the **share of EVs in new sales is modelled with an s-curve that reaches 100% in 2036**. With a lifetime of 15 years for personal vehicles and 12 years for buses, the new sales translate into share of the total fleet via a stock turnover model.
- **Fuel intensity of new cars**: Same as Best-in-Class scenario, no 1.5°C-compatible benchmark set at this level.

Applying best-in-class levels

The objective of the "best-in-class" scenarios is to assess the impact of sectoral transformations that have already occurred or that are expected to occur in comparable countries or regions. This would indicate that reaching a similar level of changes could be considered as technically feasible for Turkey, disregarding potentially different political or socio-economic circumstances. For the three indicators assessed in this study, there are illustrative examples of countries or regions that have achieved or have demonstrated a potential to achieve an important level of transformation.

On increased share of public transport, the analysis focused on the frontrunners within the EU, given Turkey's ambition to become an EU member state. Two clear frontrunners within the EU are Czech Republic and Austria. Czech Republic records a relatively low use of passenger cars. In 2015, passenger car trips represented 66.5% of the passenger-kilometres travelled on land. In other words, all other passenger transport (i.e. 33.5%) was by public transport, predominantly buses and coaches. Austria records a relatively low use of passenger cars as well. In 2015, passenger cars trips represented 72.6% of the passenger-kilometres travelled on land. In other words, all other passenger transport (i.e. 27.4%) was by public transport, predominantly rail.

On electric mobility development, Norway's support for electric cars serves as a good example. The global market share for electric vehicles (EVs) was only 0.8% in 2016 (IEA, 2018). However, in Norway, EVs (including plug-in hybrids) accounted for nearly 30% of new cars the same year (IEA, 2018).

On fuel intensity of new vehicles, the EU sets one of the strictest standards in the world. In December 2018, the representatives of the European Parliament and the Council agreed on a

regulation with the goal of reducing CO_2 emissions from new passenger cars by 37.5% in 2030 below 2021 levels. The emissions standards for new vans are to improve by 31%. For both types of vehicles there should also be an intermediary improvement of 15% by 2025 above 2021 level.

Based on the best-in-class benchmarks as specified above, the following indicators levels have been identified for the quantification of emissions trajectories with the PROSPECTS Turkey scenario evaluation tool:

- **Modal shift**: Not modelled, since the current public transport share within Turkey (i.e. 32%) is already within the best-in-class range (27%–34%). The value remains in this range in our current development scenario.
- **Electrification**: The current share of EVs in new vehicles sales in Norway is applied as 2030 target for middle- and high-income countries according to the 'good practice' policy scenario developed by Fekete et al. (Fekete et al., 2015). We further extrapolate this target and assume a linear increase to 70% share of electric cars in new sales by 2050. With a 15-year assumed lifetime for personal vehicles and 12-year assumed lifetime for buses, the new sales were translated into the share of the total fleet via a stock turnover model. Additionally, we assume a linear interpolation between today and the target years.
- **Fuel intensity of new cars**: For fuel economy of new vehicles, the EU sets one of the strictest standards in the world. Consequently, the EU trend has been applied to Turkey. The methodology for the most recent legislation and previous targets varies and limits the comparability of the target values for earlier years and future improvements. However, in our simplified approach, we do calculate the improvement of 15% and 37.5% over the 95 gCO_2e/vkm as a proxy. For the years after 2030, we assume a continued but modest improvement, at the minimal rate of intensity decrease between 2015 and 2030. This leads to an average improvement rate of 3.6% per year.

National scenarios

Given that the current public transport share within Turkey (i.e. 32%) is already within the best-in-class range (i.e. 28%–34%), the indicator modal shift has not been modelled.

Also, considering the lack of available ambitious and comprehensive national scenario, the indicators on electrification and fuel intensity of new cars has not been modelled.

4.2.2.2 *Quantification of emissions levels with PROSPECTS*

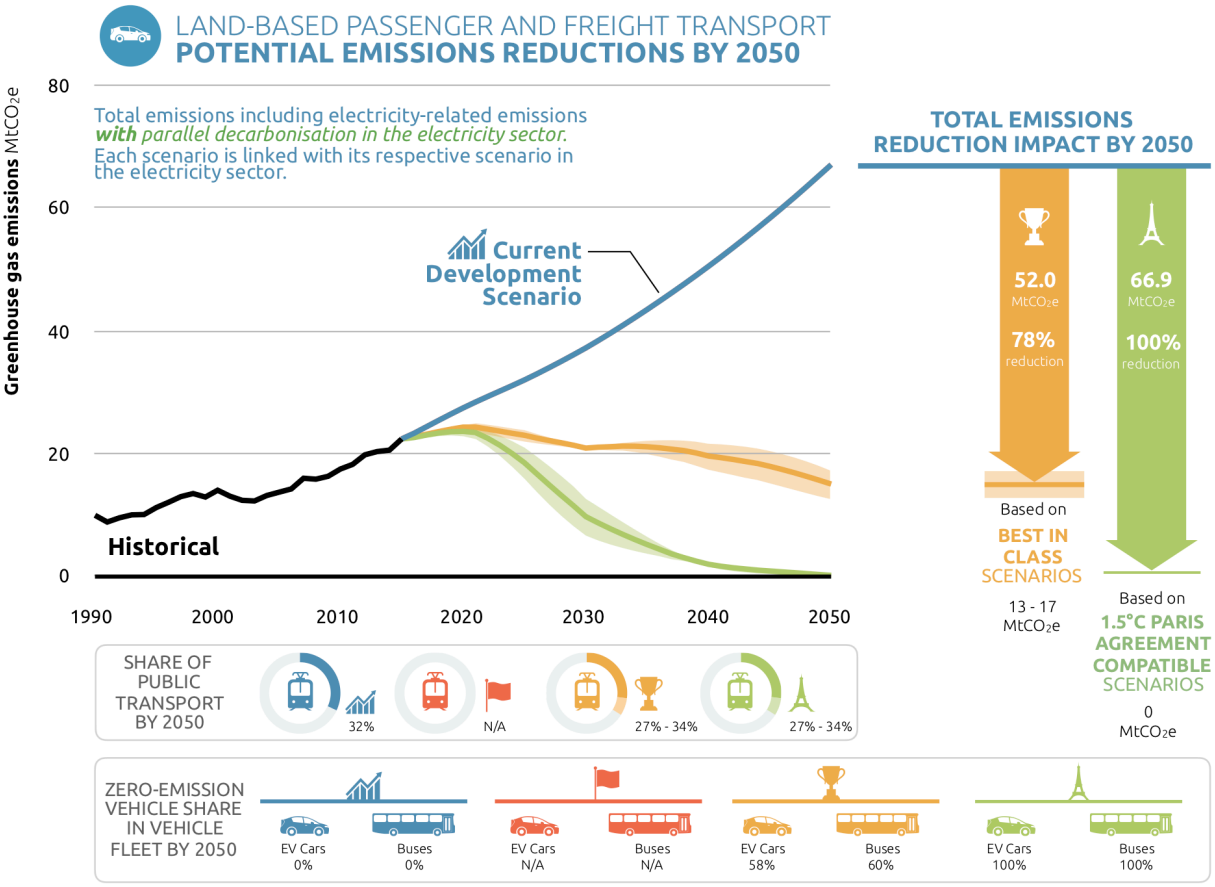


Figure 9: GHG emissions from Turkish rail and road passenger transport sector under different scenarios, incl. electricity-related emissions and parallel decarbonisation actions according to the respective scenario categories in the Turkish electricity supply sector.

Figure 9 illustrates the emissions trajectories from the Turkish passenger transport sector until mid-century. This graph includes both direct energy emissions and electricity-related emissions. Under the current development scenario, emissions from passenger transport continue to increase up to about 67 $MtCO_2e$/yr in 2050. Enhancing climate action and strengthening mitigation measures in the passenger transport sector imply further emissions reductions, far beyond the reference scenario projections:

- The '**1.5°C Paris Agreement compatible**' pathway substantially reduces emissions and leads to the near complete decarbonisation of the passenger transport sector by mid-century. This is mainly driven by the strong electrification of the passenger vehicle fleet. Further influencing factors include modal shift towards a higher share of public transport as well as fuel intensity improvement of the remaining non-electric personal vehicles. To support such a development, it is important to 1) increase the ambition level of fuel standards, 2) introduce a ban on sales of combustion cars by 2035 to send a clear signal to car manufacturers, 3) invest in electrified public transport and 4) facilitate the development of charging stations by a stable and predictable policy and, if needed, initial co-financing.

- The '**Applying best-in-class levels**' pathway shows a reduction to emissions levels of around 13–17 $MtCO_2e$/yr by 2050, under the low and high ambition case respectively. Given the lower EV share in the total fleet for cars and buses, the pathway is less ambitious that the '1.5°C Paris Agreement compatible' pathway.

- Due to lack of ambitious and comprehensive national scenarios, no '**National scenarios**' pathway could be included in this report.

To reduce emissions from the overall transport sector, additional policies would have to be introduced for land freight transport and for maritime and aviation transport. Freight transport should be decarbonised by 2050 (Climate Action Tracker, 2018e).

4.3 Residential buildings sector

4.3.1 Context for scaling up climate action in the residential buildings sector

Turkey faces a fast-growing building stock because of population increase and rapid urbanization

- Turkey is facing a fast-growing building stock: Experts expect that the residential buildings stock will almost double from 2,375 million m^2 in 2015 to almost 4,000 million m^2 in 2050 (Schimschar et al., 2016). This rapid increase presents a unique opportunity to decrease emissions by rapidly increasing standards to nearly-zero energy buildings (NZEBs) for new buildings.
- With 35% of the overall final energy consumption consumed in the residential sector (Republic of Turkey Ministry of Environment and Urbanization, 2016), and less than 15% of which is coming from renewables (IEA, 2016a), there is significant potential to reduce CO_2 emissions by on the one hand reducing energy consumption and on the other replacing fossil fuels by renewables.
- Because of the expected growth, the Turkish buildings sector is an important pillar for realising its mitigation targets (GIZ, 2018).

On top, significant benefits exist beyond climate change mitigation

- More than 60% of the final energy in the residential buildings sector in Turkey is consumed in the form of fossil fuels, especially natural gas imported from abroad. Reduced energy consumption and replacement of fossil fuels by low-carbon alternatives would significantly decrease Turkey's energy dependency.
- To be in line with the Paris Agreement, it is key that new buildings are equipped with the best energy efficiency technologies and that the existing buildings stock goes through a deep retrofit. Realising this would create great opportunities for Turkey's manufacturing sector in energy efficient technologies, building materials, etc. (GIZ, 2018).

4.3.2 Scenario analysis for scaling up climate action in the residential buildings sector

4.3.2.1 Identification of indicator levels

Table 16 provides an overview of indicator levels identified for scenario modelling in the residential buildings sector. The upper part of the table presents the relevant benchmarks as specified in the literature. The lower part shows how those benchmark levels have been adapted into selected indicator levels for providing input to the PROSPECTS Turkey scenario evaluation tool.

Table 16: Overview of different benchmarks specified in the literature and translation into indicator levels for analysis of scaling up climate action in the residential buildings sector with PROSPECTS Turkey scenario evaluation tool.

Indicator	Current Development Scenario (CDS)	National scenarios	Best-in-class scenarios	1.5°C Paris Agreement Compatible scenario
Renovation rate	**0.45%** per year renovation rate from 2016–2050 *Based on current policies scenario (Schimschar et al., 2016)*	**1.5%** per year renovation rate from **2020–2050** Rate under current policies from 2016–2020 *Based on current policies and NDC scenario (Schimschar et al., 2016)*	**1.5%–2.1%** per year renovation rate from 2020-2050 Rate under current policies from 2016–2020 *Based on current policies scenario (Schimschar et al., 2016) and best-in-class practice specified (Kriegler et al., 2018)*	**5%** per year renovation rate from 2020–2050 Rate under current policies from 2016–2020 *Based on current policies scenario (Schimschar et al., 2016) and 1.5°C-compatible benchmark for OECD (Kuramochi et al., 2018)*
Relative improvement of energy efficiency in renovated/new buildings	**0% annual** improvement of energy efficiency in renovated/new buildings Current energy performance level is 87 kWh/m^2/year *Based on information on energy demand (IEA, 2014) and m^2 (Schimschar et al., 2016)*	**New** buildings (used as high bound): **40%** improvement based on NDC level of 52 kWh/m^2/year from 2016 onwards **Renovated** buildings (used as low bound): **32%** improvement based on NDC level of 59 kWh/m^2/year from 2020 onwards *(Schimschar et al., 2016)*	**New** buildings: **77%** improvement based on best-in-class (i.e. Denmark) level of 20 kWh/m^2/year from 2016 onwards **Renovated** buildings: **45%** improvement based on the subsidies granted by the KfW bank from 2020 onwards *(Erhorn & Erhorn-Kluttig, 2015; Kriegler et al., 2018)*	**New** buildings: **100**% improvement as derived from benchmark for new buildings stock of 0 kWh/m^2/year from 2016 onwards **Renovated** buildings: **75%** improvement in final energy use per retrofit from 2020 onwards *Based on 1.5°C-compatible benchmarks for OECD (Kuramochi et al., 2018)*
Energy intensity improvement of cooking/lighting / appliances (electricity + direct energy)	Average efficiency improvement of **0.5%** per year in the period 2016-2050 *Based a combination of data (IEA, 2014; Navigant Research, 2017)*	Average efficiency improvement of **1.6%–1.8%** per year applied from 2016-2050 *Based on EU buildings sector energy efficiency improvements (Astroem, S., Lindbalk, M., Sarnholm, E., Soederblom, 2010) and efficiency improvement trend of the lighting and appliances in the European residential sector (Bosseboeuf, 2015)*	Average efficiency improvement of **1.5%–1.8%** per year applied from 2016-2050 *(Fekete et al., 2015; Kriegler et al., 2018)*	Average efficiency improvement of **2%** per year applied from 2016-2050 *(Kriegler et al., 2018)*
Decarbonisation of water heating/ space heating	**2.9**% electrification rate in water/space heating in **2015** *(IEA, 2014)*	Not specified benchmark Electrification rate under Reference Scenario is applied *n/a*	Not specified benchmark Electrification rate under Reference Scenario is applied *n/a*	**100%** electrification rate in water/space heating by **2050** *(Climate Action Tracker, 2016a)*
Decarbonisation of cooking, lighting and appliances	**50%** electrification of cooking/lighting/appliances by **2050** *(IEA, 2014)*	No specifically defined benchmark for national scenarios *n/a*	No specifically defined benchmark for best-in-class level(s)' scenarios *n/a*	**100%** electrification of cooking/lighting/appliances by **2050** *Based on the concept of "going gas free" (electrification, replacing gas appliances with high-efficiency electric alternatives)* (Zero Carbon Australia, 2013)

1.5°C Paris Agreement compatible benchmarks

A review of relevant literature and studies identifies the following Paris Agreement compatible benchmarks for the three selected indicators in residential buildings sector:

- All new buildings need to be fossil free and zero energy by 2020. This is an average value proposed for OECD regions based on 1.5°C-compatible benchmarks as identified in Kuramochi et al., 2018.
- For the retrofit of existing residential buildings stock, the renovation rate needs to increase to 5% by 2020 (average for OECD regions) with an achieved average reduction of 75% in final energy use per retrofit (Kuramochi et al., 2018).
- For the energy efficiency improvements of lighting and residential appliances, an average efficiency improvement of 2.0% p.a. is assumed as implied by the "net zero" policy package proposed by Kriegler et al. (2018), which adds policies pushing for zero-emissions technologies, particularly in energy end-use sectors in line with the Paris Agreement's goal to reach net-zero CO_2 emissions in the second half of the century.
- For decarbonisation of water/space heating, it is assumed that a 100% electrification rate will be achieved in Turkey's residential buildings by 2050. Replacing fossil fuel-based heating with renewable energy such as solar thermal heating would achieve equivalent results. This has been mainly inspired by the assessment conducted in the Climate Action Tracker (2016a), concluding that the buildings sector needs to completely phasing out emissions by mid-century, in line with a 1.5°C pathway.
- For the decarbonisation of cooking/lighting/appliances, it is assumed that Turkey will follow the same trend as in Europe and reach the current European electrification rate of 87% in 2050 (Climate Action Tracker, 2018c).

Based on the Paris Agreement compatible benchmarks as specified above, the following indicator levels have been identified for the quantification of emissions trajectories with the PROSPECTS Turkey scenario evaluation tool:

- **Renovation rate:** 5% per year renovation rate from 2020 onwards with a renovation rate under currently implemented policies of 0.45% used before 2020.
- **Relative improvement of energy efficiency in renovated/new buildings compared to the average existing buildings stock:**
    - Upper bound: 100% improvement of energy efficiency as a result of a new buildings stock consisting of near-zero emissions buildings (i.e. 0 kWh/m^2/year).
    - Lower bound: 75% improvement of energy efficiency as a result of a deep retrofit of the existing buildings stock.
- **Relative improvement of total energy intensity of cooking/lighting/appliances (electricity + direct energy):** Average efficiency improvement of 2% per year for all appliances from 2016 onwards until 2050.
- **Decarbonisation of space/water heating**: 100% electrification of space heating and water heating by 2050. We assumed a linear interpolation between today's level (3%) and the target value.
- **Decarbonisation cooking/lighting/appliances**: 87% electrification of cooking, lighting and appliances by 2050. We assumed a linear interpolation between today's level (30%) and the target value.

Applying best-in-class levels

Applying best-in-class levels are implemented according to international frontrunners in increasing energy efficiency of new buildings stock and renovation of existing buildings. This allows to identify the implications of a successful implementation of mitigation measures at the level of international frontrunners for the Turkish residential buildings sector. A review of relevant literature identifies the following best-in-class benchmarks in the residential buildings sector:

- **For the new buildings stock, the European Union's Energy Performance of Buildings Directive (EPBD) requires that all newly constructed buildings in EU member states will have to consume 'nearly net-zero' energy by the end of 2020 and the energy will have to be 'to a very large extent' from renewable sources (BPIE, 2011; Fekete et al., 2015). In general, the EPBD's requirements can be considered international best practice, although EU member states interpreted the directive's objective of 'near-zero energy' differently in terms of final energy consumption allowed (BPIE, 2011). Among the member states, Denmark has the most ambitious definition of 'near-zero energy' with a proposed (primary) energy consumption level of 20 kWh/m^2/year. We apply this as the best-in-class energy performance level of the new residential buildings stock to be achieved by 2020 for the Turkish residential buildings sector. This would translate into 77% energy efficiency improvement, compared to the average energy efficiency of 87 kWh/m^2/year in the existing buildings stock in Turkey (IEA, 2014; Schimschar et al., 2016).**

- For the retrofit of existing residential buildings stock, a renovation rate of 1.5%-2.1% with efficiency improvement of 45% from 2020 onwards is applied as best-in-class level, which is comprised of the following components:
    - Renovation rate: annual renovation rate of 1.5% (low end) to 2.1% (high end) according to the 'good practice' policy scenario developed by the recent study conducted in Kriegler et al. (2018).
    - Relative improvement of energy efficiency in renovated buildings: Subsidies and loans in Germany, offered by the state-owned *Kreditanstalt fuer Wiederaufbau* (KfW) bank, provide economic incentives for, amongst others, renovations of existing buildings. The maximum subsidy (i.e. corresponding to the highest standard) are granted to buildings which are at least 45% better than the reference house in the respective category (Kriegler et al., 2018).
    - Target year: The target year of the renovation rate specified above is 2020 for OECD countries, as informed by the European Union's Energy Performance of Buildings Directive (EPBD).
- For the energy efficiency improvements of lighting and residential appliances, an average annual efficiency improvement of 1.5% is considered across all appliances for the lower bound of best-in-class levels according to the 'good practice' policy scenario developed by Kriegler et al. (Kriegler et al., 2018). An upper bound of annual efficiency improvement of 1.8% across all appliances is considered as international best practice according to the study conducted in Fekete et al. (Fekete et al., 2015). This is based on average improvement of appliances' efficiencies between 2001 and 2012 for EU member states with successful efficiency policies implemented before 2005: UK, Sweden, Netherlands, France, Slovakia, Finland, Czech Republic and Latvia according to the MURE database.

Based on the best-in-class benchmarks as specified above, the following indicators levels have been identified for the quantification of emissions trajectories with the PROSPECTS Turkey scenario evaluation tool:

- **Renovation rate**:
    - Upper bound: 2.1% per year renovation rate from 2020 onwards with a renovation rate under reference scenario used before 2020.
    - Low bound: 1.5% per year renovation rate from 2020 onwards with a renovation rate under reference scenario used before 2020.
- **Relative improvement of energy efficiency in renovated/new buildings**:
    - Upper bound: 77% improvement of energy efficiency as a result of a new buildings stock with an energy efficiency level equal to the best-in-class (i.e. Denmark), compared to the average existing buildings stock.
    - Low bound: 45% improvement of energy efficiency as a result of a deep retrofit of the existing buildings stock, compared to the average existing building stock.
- **Relative improvement of total energy intensity of cooking/lighting/appliances (electricity + direct energy)**:
    - Upper bound: energy efficiency improvement of 1.8% for all appliances.
    - Lower bound: energy efficiency improvement of 1.5% for all appliances.

National scenarios

A review of relevant literature identifies the following Turkey-specific scenarios in the residential buildings sector:

- The energy performance of new buildings should be equal to or less than 52 kWh/m^2/year to reach the NDC (Schimschar et al., 2016). Given the current energy performance of 87 kWh/m2/year, this leads to a relative improvement of energy efficiency of 40%.
- For the retrofit of existing buildings stock, a renovation rate of 1.5% with efficiency improvement of 32% is applied as Turkey-specific scenario, which is comprised of the following components:
    - Renovation rate: An annual renovation rate of 1.5% is needed from 2020 onwards to reach the targeted 21% emissions reduction as defined in the NDC (Schimschar et al., 2016).
    - Relative improvement of energy efficiency in renovated buildings: An energy efficiency improvement of 32% is required to reach the NDC level of 59 kWh/m^2/year (Schimschar et al., 2016).
- For the energy efficiency improvements of lighting and residential appliances, we assumed that Turkey will follow the European Union, given its ambition to become a member state. An average annual efficiency improvement of 1.6% is considered across all appliances for the lower-bound of the national scenario according to the EU buildings sector energy efficiency improvements (Astroem, S., Lindbalk, M., Sarnholm, E., Soederblom, 2010). An upper bound of annual efficiency improvement of 1.8% across all appliances is considered according to the efficiency improvement trend of electrical appliances and lighting since 2000 in the European residential buildings sector (Bosseboeuf, 2015).

Based on the Turkey-specific scenarios, as specified above, the following indicator levels have been identified for the quantification of emissions trajectories with the PROSPECTS Turkey scenario evaluation tool:

- **Renovation rate**: A 1.5% per renovation rate from 2020 onwards with a renovation rate under reference scenario used before 2020.
- **Relative improvement of energy efficiency in renovated/new buildings**:
  - Upper bound: 40% improvement of energy efficiency as a result of a new buildings stock with an energy efficiency level equal to the NDC compared to the average existing buildings stock.
  - Low bound: 32% improvement of energy efficiency as a result of a deep retrofit of the existing buildings stock, compared to the average existing buildings stock.
- **Relative improvement of total energy intensity of cooking/lighting/appliances (electricity + direct energy)**:
  - Upper bound: energy efficiency improvement of 1.8% for all appliances.
  - Lower bound: energy efficiency improvement of 1.6% for all appliances.

4.3.2.2 Quantification of emissions levels with PROSPECTS

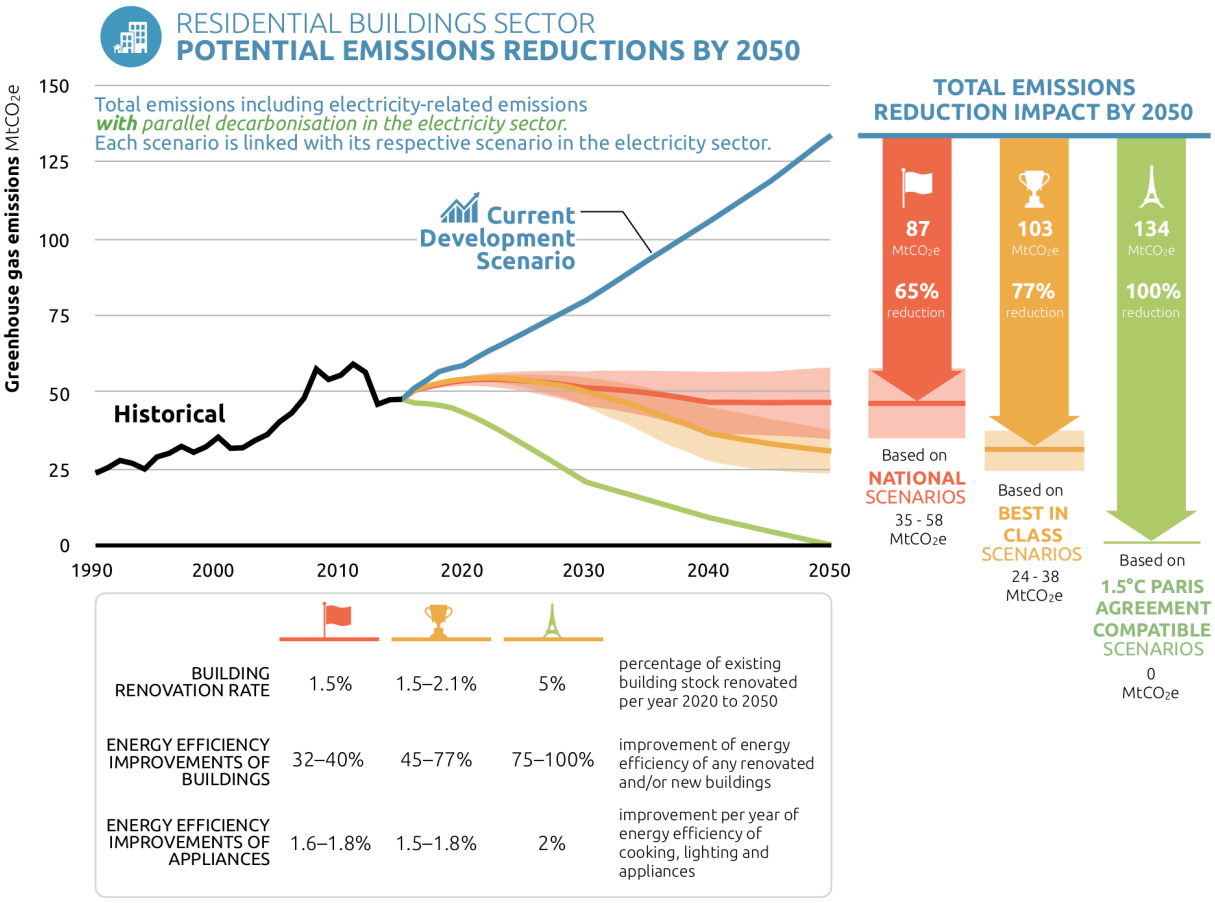


Figure 10: GHG emissions in the Turkish residential buildings sector under different scenarios, including electricity-related emissions and parallel decarbonisation actions according to the respective scenario categories in the Turkish electricity supply sector.

Figure 10 illustrates the emissions trajectories from the Turkish residential buildings sector until mid-century. This graph includes both direct energy emissions and electricity-related emissions. Under the current development scenario, emissions from residential buildings continue to increase up to about 134 $MtCO_2e$/yr in 2050. Enhancing climate action and strengthening mitigation measures in the residential buildings sector imply further emissions reductions far beyond the reference scenario projections:

- The '**1.5°C Paris Agreement compatible**' pathway substantially reduces emissions and leads to the near complete decarbonisation of the Turkish residential buildings sector by mid-century. This is mainly driven by the deep renovations, strong efficiency improvements in renovated and new buildings, energy intensity improvement of buildings' appliances as well as the electrification of heating and cooking/lighting/appliances in residential buildings. To support such a development, it is of importance to 1) increase awareness about the economic and non-economic benefits of increasing energy efficiency in the housing sector, 2) introduce measures reducing the scale of the upfront investment, 3) introduce NZEBs standards for new buildings to avoid carbon lock-in and 4) ensure decarbonisation of space heating, no fossil fuel-based heating should be installed from 2030 on.

- The '**Applying best-in-class levels**' pathway allows emissions to increase slightly and peak in the mid-2020s. The sector's emissions level then decreases to around 24–38 $MtCO_2e$/yr by 2050.

- The '**National scenario**' pathway shows an increase of emissions beyond today, peaking around 2020 in the most ambitious case, but continuously increase in the less ambitious scenario. In 2050, emissions levels under this scenario is between 35–69 $MtCO_2e$/yr in 2050.

5 Conclusions

Scaling up climate action in Turkey's electricity supply, passenger road and rail transport, and residential buildings sectors alone can reduce economy-wide emissions by 13% below 2017 levels by 2030. Together, these sectors account for about 50% of Turkey's national GHG emissions (excluding land use and forestry), which were at 526 $MtCO_2e$ in 2017.

This is 30% below where current developments would lead, and far below emissions levels resulting from Turkey's INDC, which would lead to an increase of emissions by 90% compared to 2017. Climate Action Tracker rates this target "Critically insufficient". Already with implemented policies, Turkey easily overachieves its INDC. This shows huge potential for increasing the level of ambition. If Turkey were to increase the level of ambition to the level resulting from scaled-up climate action in the three target sectors, the increased target would receive the Climate Action Tracker's "Insufficient" rating.

Ambitious decarbonisation efforts for the selected sectors in Turkey would significantly reduce greenhouse gas (GHG) emissions and foster co-benefits such as business opportunities for the construction and manufacturing industry, employment generation in the area of renewable energy, supporting sustainable development goals by reducing the adverse pollution effects of conventional modes of transport and electricity generation, and promoting modern housing facilities.

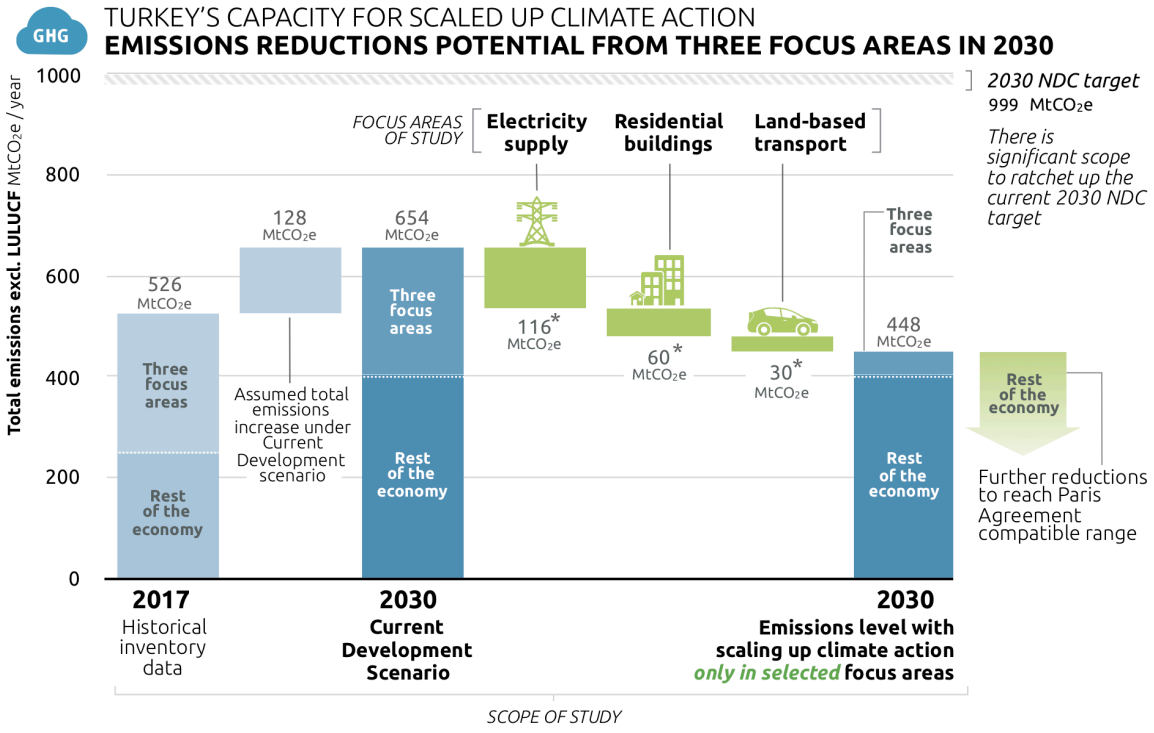


Figure 11: Overview of total emission levels (excl. LULUCF) under historical inventory data in 2017 (left bar), under a current development scenario in 2030 (middle bar), and most ambitious levels of accelerated climate action by 2030 in the electricity supply, the residential buildings sector, and the passenger transport (right bar). All electricity-related emission reductions from the residential buildings and passenger transport sectors are allocated as emissions reductions under these two end-use sectors.

To support energy security, Turkey aims at increasing both the share of renewables as well as domestic coal in electricity generation. The prices for renewables from Turkey renewable auction rounds are very low, questioning the economic attractivity of further embarking on fossil energy. In fact, the pipeline for coal, while still among the world's largest, has decreased in recent years.

For a Paris-compatible electricity sector, Turkey needs to phase out coal by 2030, significantly increase the role of renewables in its planning and establish a sound legislative framework, including measures allowing a high share of variable renewables.

Strong electrification of the passenger vehicle fleet, in parallel to decarbonising electricity, is required to bring the Turkish passenger transport sector on a pathway in line with the Paris Agreement. Other influencing factors, besides electrification, include a shift towards a higher share of public transport. In our Paris Agreement compatible scenarios, such actions would reduce emissions in the sector by around a third in 2030 compared to today and phase them out entirely by 2050. Turkey is one of the largest automotive manufacturers for exportation; it also aims at producing electric vehicles domestically. This would be an important step in enabling such a transition at the national level and improve competitiveness globally.

A Paris-compatible residential buildings sector requires strengthened standards for new buildings towards near-zero energy buildings, a deep renovation of existing residential buildings, and electrification of heating and cooking, as well as and energy efficiency improvements for lighting and other appliances. In our Paris-compatible scenarios, such actions can reduce emissions in the sector by 40% to 50% in 2030, compared to today, and to 0 by 2050 (incl. electricity-related emissions, under the assumption that the electricity sector decarbonises).

While our analysis focuses on three sectors, covering about 50% of emissions today, Figure 11 also shows the remaining emissions in sectors that are not addressed here. For Paris-compatibility, it will be essential to implement climate action in order to effectively address emissions in all sectors.

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The Climate Action Tracker (CAT) is an independent scientific analysis produced by three research organisations tracking climate action since 2009. We track progress towards the globally agreed aim of holding warming well below 2°C, and pursuing efforts to limit warming to 1.5°C.

The Consortium

NewClimate Institute is a non-profit institute established in 2014. NewClimate Institute supports research and implementation of action against climate change around the globe, covering the topics international climate negotiations, tracking climate action, climate and development, climate finance and carbon market mechanisms. NewClimate Institute aims at connecting up-to-date research with the real-world decision making processes.

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Climate Analytics is a non-profit climate science and policy institute based in Berlin, Germany with offices in New York, USA, Lomé, Togo and Perth, Australia, which brings together interdisciplinary expertise in the scientific and policy aspects of climate change. Climate Analytics aims to synthesise and advance scientific knowledge in the area of climate, and by linking scientific and policy analysis provide state-of-the-art solutions to global and national climate change policy challenges.

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Technical contributions

Ecofys, a Navigant company, a leading international energy and climate consultancy focussed on sustainable energy for everyone was founded in 1984. The company has been a trusted advisor to governments, corporations, NGOs, and energy providers worldwide. In 2016, Ecofys joined Navigant and is now integrated in this global consultancy.

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