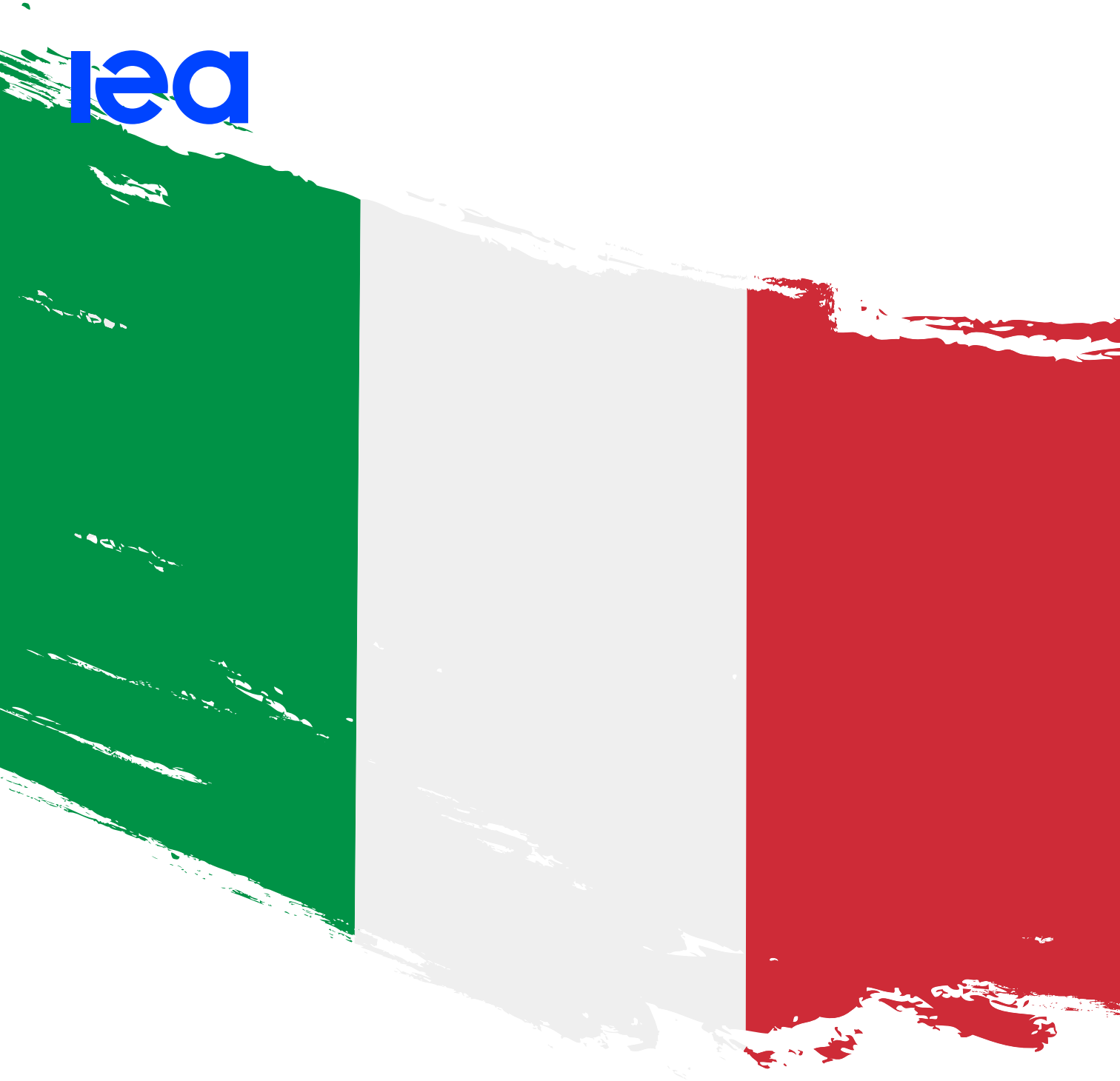

Italy 2023

Energy Policy Review

International Energy Agency

INTERNATIONAL ENERGY AGENCY

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Foreword

The International Energy Agency (IEA) has conducted in-depth peer reviews of its member countries' energy policies since 1976. This process supports energy policy development and encourages the exchange of and learning from international best practices. By seeing what has worked – or not – in the "real world", these reviews help to identify policies that deliver concrete results.

Italy has successfully reduced its reliance on Russian gas imports over the last year. It has diversified its natural gas sources and supply routes – signing new contracts with alternative suppliers, and making good use of the pipeline and LNG infrastructure that it has built up over the last decade. Over the longer term, an accelerated diversification to alternative energy sources, and a stronger focus on energy efficiency, will not only strengthen domestic energy security further, but also help Italy meet its emissions reduction targets.

Italy is implementing several measures to improve the energy efficiency of residential and commercial buildings, with energy consumption already declining in this area. By 2030, the building sector is expected to contribute 60% of annual energy savings and the government has already launched several policy instruments for retrofitting existing buildings, which is to be commended. Since the last IEA review of Italy in 2016, the country has increased its climate ambitions by endorsing the EU-wide goal of reaching climate neutrality by 2050, as set out in the European Green Deal. Moreover, the country is on track to reach its national targets for both emissions reductions and energy efficiency by the end of this decade, which is welcome news.

Despite strong interest from investors, Italy is – like several countries – seeing a gap between actual and desired renewable energy installations. There is a similar picture in relation to distribution and transmission infrastructure, which are essential elements of an efficient and integrated electricity system. Efforts to simplify and accelerate permitting procedures could help close these gaps. Encouraging legislative steps were taken in 2021 and there have been some clear signs since that the permitting for new projects is being expedited. The full adoption of the regulatory implementation framework would be a valuable and impactful next step.

Italy is a founding member of the IEA and has engaged actively on international energy security and clean energy transitions. I am grateful for its leadership on international efforts to ramp up progress on power system modernisation through the International Smart Grids Action Network (an IEA Technology Collaboration Programme) and the Mission Innovation Green Powered Future Mission, for example. Both are important platforms for engaging and aligning stakeholders across the energy industry to address the shared challenge of decarbonisation.

I sincerely hope that the recommendations set out in this report will help Italy accelerate its energy system transformation while ensuring energy supplies remain affordable and secure.

Dr. Fatih Birol

Executive Director

International Energy Agency

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1. Executive summary

Italy's energy system has changed notably since 2010 and today the country's energy mix includes more natural gas and renewable energies and less coal and oil. From a lower base than the IEA average, Italy's energy intensity, measured by the ratio of total final consumption (TFC) to gross domestic product (GDP), declined by 15% between 2005 and 2021, reflecting a shift in the economic structure from industrial to the service sector combined with energy efficiency improvements.

Italy is on track to reach the emissions reductions and energy efficiency targets set in its National Energy and Climate Plan (NECP) for 2030. However, it will need to make substantial additional efforts to meet the much more ambitious new targets for 2030 stemming from the European Union's (EU) Fit-for-55 (FF55) package (and that are still being defined in the EU legislative process) as well as to align with the even more ambitious objectives proposed by the REPowerEU plan aimed at rapidly reducing the European Union's dependence on Russian fossil fuels. Italy reduced total greenhouse gas (GHG) emissions by almost 30% between 2005 and 2019. There was an additional strong dip from 2019 to 2020 largely due to the Covid-19 pandemic, but preliminary data show a noticeable rebound of emissions in 2021, although they were still 4% lower than in 2019. Italy is committed to achieving carbon neutrality by 2050.

Energy poverty has been a key policy issue ever since the presentation of the Clean Energy for All European package in 2016 and has gained more importance in Italian energy policy in light of the recent massive price increases for natural gas and electricity. The government is implementing several policy measures to restore affordability across the board, but there is scope for more targeted interventions to combat energy poverty.

Strengthening energy security through the energy transition

The current energy crisis demonstrates that accelerating the clean energy transition can also improve energy security. Italy's energy sector is strongly reliant on fossil fuel imports from the Russian Federation (hereafter "Russia"), which in 2021 accounted for one third of total energy supply (TES) of fossil fuels. Natural gas was the single largest fuel in TES in Italy at 42% in 2021, 94% of which was imported and around 41% of natural gas imports originated from Russia. Natural gas is also the dominant fuel in the electricity sector, with a share of 50% of generation. Italy is committed to phasing out the dependence of Russian gas by 2025.

Over the last decade, Italy has diversified its gas supply routes and sources and increased the flows through the existing liquefied natural gas (LNG) and pipeline import infrastructure. This now helps ease the country's high dependence on Russian gas, which was reduced to around 3% of total gas imports by November 2022. Reducing overall demand for natural gas through an accelerated diversification to alternative energy sources and a stronger focus on energy efficiency will not only strengthen energy security further, but also help the country meet its emissions reduction targets.

Oil accounted for 33% of TES and 37% of TFC in 2021. A high share (92%) of crude oil is imported, 12% of which came from Russia in 2021. Italy's crude oil import dependency on Russia has steadily declined over the last ten years and is expected to cease by the end of 2022 when an EU ban on seaborne imports of Russian crude oil enters into force.

Oil demand fell significantly in 2020 due to the restrictions on mobility during the Covid-19 pandemic, but has rebounded strongly since mid-2021. The government expects oil consumption to decline notably over the medium and long terms as a result of policies to promote alternative fuels for passenger cars. The uptake of biofuels in the transport sector is particularly strongly promoted while there are plans to expand charging infrastructure for electric vehicles (EVs) and maintain the sale of new passenger cars with combustion engines beyond 2035 but running on climate friendly fuels. However, Italy does not have specific targets for reducing oil consumption. In 2022, the government introduced a discount on the excise duty of gasoline and diesel to mitigate the impact of rising fuel prices on consumers caused by Russia's invasion of Ukraine. While this seems justifiable from a social policy point of view as a countermeasure to mitigate the price hikes, the government will continue implementing other policy measures to reduce oil consumption, and has removed the discount as of 1st January 2023.

Coal plays only a minor, and continuously declining, role in Italy's energy mix. It accounted for just under 4% of TES and 5% of electricity generation in 2021 and represented 7% of energy-related carbon dioxide (CO_2) emissions in the same year. But all coal is imported and more than half of coal imports in 2021 came from Russia. As part of the country's energy transition, Italy committed to phase out coal use in electricity generation by 2025 and replace it primarily with gas-fired and renewable generation, supported by a reinforced transmission infrastructure. While Italy has opted to temporarily increase the use of coal in light of the current energy crisis, it remains committed to the phase-out target year.

Boosting low-carbon power generation

Given its geographical location, Italy has a strong resource base to replace some of its electricity from natural gas with renewable power generation capacity. In 2020, the share of renewables in gross electricity consumption was 38% (with hydro being the main source), a substantially higher share than the target for 2020 of 26.4%. However, this share slightly decreased in the following years, due to the rebound of total electricity consumption in 2021 and lower hydro availability in 2022.

Impressive renewables growth occurred between 2010 and 2013 when about 20 gigawatts (GW) were added to renewable electricity capacity, of which solar photovoltaics (PV) accounted for three-quarters, thanks to generous incentives. However, deployment has since stalled because the EU 2020 targets had been reached early and less generous incentives were sufficient for the sector. Long and complex permitting procedures on the other hand continue to plague new investments. As a result, between 2014 and 2022, Italy added only 8.6 GW of new renewable capacity, of which solar PV accounted for 5.6 GW.

While capacity additions have recently grown due to changes to the regulatory framework, Italy is far from installing 4 GW of new renewable capacity annually, which is needed to meet the targets set for 2030. In 2022, Italy added 1.6 GW of new solar PV capacity and 0.5 GW of new wind capacity. Italy has scope to increase the share of wind power, which accounted for 11 GW (9%) of installed capacity and 7% of electricity generation in 2021. The NECP sees wind power capacity reaching 19 GW in 2030, which would require an accelerated roll-out. The government estimates that to achieve the FF55 package's likely

more ambitious renewable electricity generation target, 5 GW of new renewable generation capacity must be added annually from 2020 to 2030. The annual additions will need to be even higher to make up for the low additions in the years to 2023 and to also account for the new targets under the REPowerEU plan.

The delivery gap for new renewable installations is due to the long permitting procedures, high administrative burden and increasing local opposition. Permitting procedures are also slowing down the strengthening of the distribution and transmission grids, which is required in a system with higher shares of distributed generation. Italy, therefore, needs to simplify the overall permission process all along the renewable electricity sector value chain. Encouraging legislative steps were taken in 2021; however, the regulatory implementation framework has not yet been fully adopted.

Another important aspect is to incentivise Regions, which are in the lead of granting permits, to deliver their contribution to accelerating the country's energy transition. The Regions have largely achieved the targets set for 2020, while new regional targets for 2030 are under negotiation between the Central government and the Regions. Moreover, these targets are not mandatory and the central government thus far has only limited leverage under Italy's constitution to enforce them.

Another challenge for Italy is the considerable regional disparity between renewable electricity generation and load centres. Dispatchable renewable sources (hydro and bioenergy) are far more present in northern regions than in southern ones, which have a dominant share of variable sources (solar and wind). These territorial disparities complicate the management of electricity flows along the national transmission and distribution grids, which need to be further extended and upgraded. Italy has already made substantial progress in the development and deployment of system flexibility and smart grid solutions, including the installation of smart meters, but a higher penetration of renewables will require greater transmission, distribution and storage capacity. Italy is also heading international efforts to ramp up progress in power system modernisation, including through Mission Innovation Green Powered Future Mission and the International Smart Grids Action Network.

Accelerating energy efficiency improvements

Improving energy efficiency, especially in the building sector, which accounted for almost 40% of TFC in 2021, would make an important contribution to the energy transition. As natural gas was the main source of energy in buildings (with 51% in the same year followed by electricity at 27%), reducing energy use will also contribute to increasing energy security.

Italy has put several measures in place to improve the energy efficiency of buildings and since 2017 building energy demand has started to decline. Looking towards 2030, the building sector is expected to contribute 60% of annual final energy savings. To achieve this, the government has launched several new policy instruments for retrofitting existing buildings, including tax rebates for private and subsidies for public buildings.

To stimulate economic recovery after the Covid-19 crisis, especially in the construction sector, and promote energy efficiency, the government launched the so-called "Super bonus 110%" in 2020. The scheme offers a declining rate of tax deductions, from 110% of incurred expenses for works performed by the end of 2023 to 65% in 2025 when the scheme ends; the same level as the earlier bonus scheme. While the Super bonus has

resulted in a notable uptake of energy efficiency investment, it is not cost-effective, as investors do not feel the need to find the cheapest offer and the high demand has seen overall costs for renovation works increasing.

The government should consider modifying the Super bonus to deliver stronger energy savings at lower costs and to also offer other climate-related benefits, for example via the chosen energy carrier of the new heating and cooling systems. When designing new instruments, a special focus should be given to energy efficiency measures that address the energy needs of the most vulnerable segments of the population. These groups often cannot benefit from the existing instruments to the same degree as other socio-economic groups. Italy should consider providing tailor-made policies and instruments that successfully overcome the identified access barriers.

Key recommendations

The government of Italy should:

- Revise the National Energy and Climate Plan, in line with the European Union timetable, to strengthen energy security, including by defining a plan that would enable Italy to end any reliance on Russian fossil fuels, while incorporating Italy's commitments under the European Union's Fit-for-55 package and its 2050 carbon-neutrality target and aligning to the more recent REPowerEU plan proposals.
- Implement policies to reduce oil consumption in transport and promote the use of alternative fuels and vehicles, including through preferential taxation, to reduce carbon emissions from the transport sector.
- Swiftly implement the reform of permitting procedures for renewable generation projects and grid development, proactively engage with affected communities, introduce an incentive scheme for timely compliance by Regions based on agreed targets at the State-Regions Conference level from 2023 onwards; and improve capacity to deliver at all government levels by providing adequate staff and technical assistance.
- Avoid untargeted measures, such as tax cuts, to address energy poverty; instead, focus on helping vulnerable consumers and consider combining light-handed demand restraint measures with awareness-raising campaigns to encourage reduced energy consumption in the short term to reduce consumers' bills.
- Revise the tax deduction schemes for energy efficiency investments in buildings to maximise energy savings per euro spent; ensure that the schemes can be sustained for longer periods, thereby giving stakeholders market certainty. Ensure that the support schemes target low-income households more specifically and address identified barriers to their participation, taking into account the experiences with ongoing support schemes in Italy.

2. General energy policy

Key data

(2021)

TES: 6 259 PJ in 2021, -11% since 2011

TES by source: natural gas 41.8%, oil 33.0%, bioenergy and waste 10.1%, other renewables 8.9%, coal 3.7%, electricity imports 2.5%

Energy intensity per GDP (TES/GDP)*: 2.7 MJ per 2015 USD PPP (IEA30 average 3.74 MJ per 2015 USD PPP); -10% since 2011

Energy intensity per capita (TES/capita): 105.9 GJ/capita (IEA30 average: 166.7 GJ/capita); -10% since 2011

TFC: 4 895 PJ; -8.5% since 2021

TFC by sector: buildings 40.1%, transport 30.2%, industry 29.7%

* Gross domestic product in 2015 prices and purchasing power parity (PPP).

Source: IEA (2022a).

Introduction

The Italian energy system has undergone major changes in the decade since 2010. Total energy demand has declined and the energy mix now counts more natural gas and renewables and less coal and oil.

The invasion of Ukraine by Russia has shown vividly that accelerating the clean energy transition is also a matter of energy security. Natural gas dominates Italy's energy mix and electricity output, with a high dependence on Russian imports. There is scope to save energy and fast-track renewable deployment in all sectors in line with the European Commission's (EC) proposed REPowerEU plan. The plan aims to reduce the European Union's dependency on Russian fossil fuels by increasing the share of renewables in the European Union's gross final energy consumption to at least 45% by 2030 (European Parliament, 2022).

Italy's 2019 NECP is the main strategic document guiding Italy's energy policy to 2030 (Italy, Ministry of Economic Development, Ministry of the Environment and Protection of Natural Resources and the Sea, and Ministry of Infrastructure and Transport, 2019). The plan will be updated in line with the European Green Deal goals and the 2021 FF55 package of legislative proposals to deliver on them. The European Green Deal revised upwards the European Union's energy and climate targets, including cutting the European Union's net GHG emissions by 55% by 2030 (from 1990 levels). To scale up

and accelerate efforts to expand renewables and improve energy efficiency, the government has been prioritising the implementation of the National Resilience and Recovery Plan (NRRP) 2021-2026, as foreseen by the EU package to help member countries recover from the Covid-19 socio-economic crisis and prepare for the green and digital transitions (EC, 2021). The government emphasises the need of addressing energy poverty as part of a just transition.

Box 2.1 Country profile of Italy

Italy is a peninsula situated at the centre of the Mediterranean Sea, crossed by two large mountain ranges, the Alps and the Apennines. Its surface covers 301 300 square kilometre, including 2 major islands, Sicily and Sardinia, and about 70 minor islands.

Italy is a parliamentary republic. Its territory is divided into 20 regions, 5 of which are autonomous and 1 is constituted of two autonomous provinces. Each region has an elected parliament and a government, headed by a governor. Regions have wide-ranging legislative and regulatory powers. There are 7 904 municipalities.

The country's population has been declining slightly since 2014, to about 60 million inhabitants in 2020. The population is concentrated in small- and medium-sized cities, more than on average in the Organisation for Economic Co-operation and Development (OECD). The share of the population in metropolitan areas (above 500 000 inhabitants) is 35%, compared to the OECD average of 60% (OECD, 2020).

Italy is among the ten largest economies in the world by nominal GDP, and the third in the European Union. It is a large manufacturer and exporter. Its products include machinery, vehicles, steel, pharmaceuticals, furniture, food and clothing. The manufacturing sector is largely based on small- and medium-sized enterprises. Services account for most of value added (56% in 2021), as in most EU countries. Agriculture, forestry and fishery were about 2% of value added in 2021, slightly above the EU average.

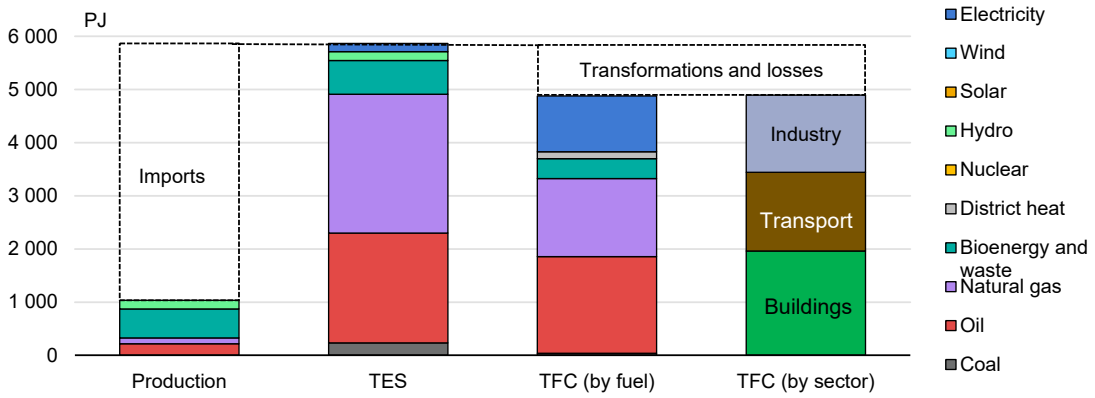
Italy's economy had one of the lowest growth rates among EU countries in the past 15 years. The country faced one double-dip recession following the global economic crisis (2009-14). GDP in 2019 was nearly at the same level as in 2005. In 2020, with the onset of the Covid-19 pandemic, the economy contracted by 9.1% but rebounded by 6.6% in 2021. Economic growth is projected to slow down to 2.5% in 2022 as a consequence of Russia's war in Ukraine (OECD, 2022a).

In 2021, Italy's GDP per capita was about USD 46 600 (in current prices and purchasing power parities), or 90% of that of the euro area. The unemployment rate was 9.5% in 2021, higher than the average of the euro area (7.7%). Income inequality is higher than in most advanced economies, with the poorest 20% of households earning 6.6% of total income. There are wide differences between Italian regions, with southern regions and the large islands being generally poorer, with lower quality infrastructure and services. Italy has the largest regional disparities among OECD countries in terms of unemployment rates and the second largest in terms of household income (OECD, 2020).

Energy supply and demand

Italy is a net energy importer. On average between 2016 and 2021, Italy imported 80% of its TES, mostly oil and gas (Figure 2.1). Domestic production consists mainly of renewable energy sources such as bioenergy, hydro, solar and wind. Production from renewable sources has increased in the last decade to reach 74% of domestic energy production in 2021. Italy produces a limited amount of oil and natural gas (Figure 2.1).

Figure 2.1 Overview of energy production, supply and demand in Italy, 2021



Italy imports more than three-quarters of its energy needs. Natural gas and oil dominate the energy mix. Buildings are the major end users.

Notes: *Other renewables* includes hydro, solar, wind and geothermal. 2021 data are not available for TFC so the chart refers to 2020. PJ = Petajoules.

Source: IEA (2022a).

Italy relies heavily on natural gas imports. In particular, it has a high dependence on gas imports from Russia, which accounted for 41% of its total gas imports in 2021. In 2021, about 23% of the country's electricity generation depended on fossil fuel imports from Russia, the second-highest dependency among International Energy Agency (IEA) member countries, just after Hungary (see Chapter 7). Energy imports from Russia account for a significant part of final energy consumption (FEC) in all sectors (IEA, 2022b).

Natural gas dominates Italy's electricity mix. In 2021, natural gas covered 50% of total electricity generation, the second-highest share among IEA countries after Mexico. Hydro was the second-largest source of electricity (16% of electricity output) in 2021, followed by solar (9%), bioenergy and waste (8%), and wind (7%). Coal accounts for a minor and decreasing share (5% in 2021), followed by oil (3%) and geothermal (2%) (see Chapter 7).

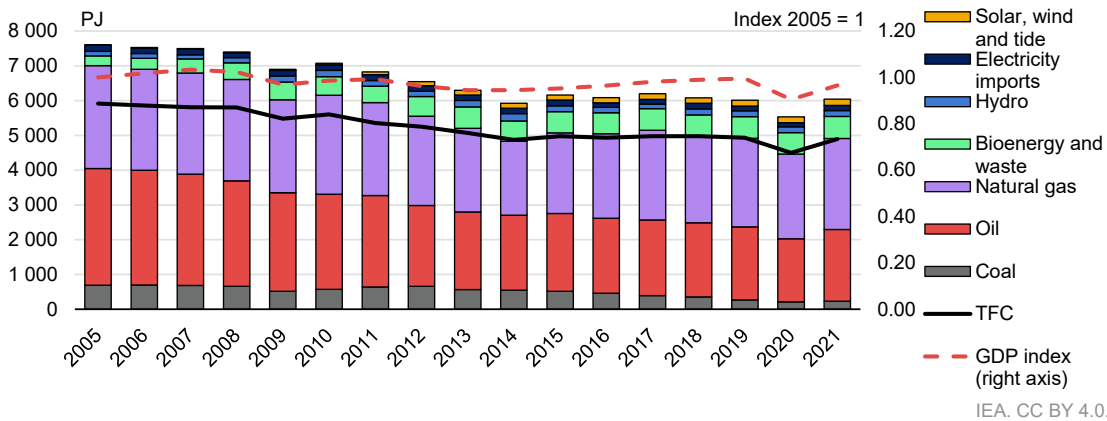
Fossil fuels are the main energy source: natural gas and oil accounted for 42% and 33% of TES in 2021, respectively, while coal represents a minor share (3.7%). Fossil fuel contribution to TES declined from 90% in 2005 to 78% in 2021, which remains in line with the IEA average. Energy supply from renewables grew to 19% of TES in 2021. Bioenergy and waste are the main renewable source, accounting for 38% of energy production and 10% of TES in 2020 (see Chapter 5).

Italy's 2020 renewables target, as set out in the 2009 EU Renewables Directive, was to cover 17% of gross final energy consumption with renewables.[1] This target was met six years in advance thanks to a boom in PV installations early in the decade. About 20 GW were added to renewable electricity capacity in just four years, between 2010 and 2013, although at high costs to the consumers. However, the contribution of renewables to the energy mix stabilised at around 17-18% in 2014-2019. Only 4 GW of renewable electricity capacity were installed in that period, due to less generous incentives, long and complex permitting procedures, and increasing local opposition (see Chapter 5). In 2020, the share of renewables increased to 20.4% of gross final energy consumption, due to lower energy demand as a result of the Covid pandemic, and was 19% in 2021.

TES declined by 20% between 2005 and 2019. Most of this decrease occurred between 2005 and 2014, due to a prolonged contraction of the economy, a move towards less energy-intensive economic activities, and increased efficiency in power and heat generation. However, TES stabilised after 2014, before dropping by nearly 7.7% in 2020 with the onset of the Covid-19 pandemic. It increased again by 8.7% in 2021. Between 2005 and 2021, TES declined more than GDP, resulting in a 17% decrease in the energy intensity of the economy (TES/GDP). Italy's overall energy intensity is relatively low compared to many IEA countries, but it has declined less than on average in IEA countries (-23% between 2005 and 2021) (Figure 2.2).

Fossil fuels also dominate final energy demand, covering two-thirds of TFC. In 2021, TFC was primarily covered by oil, mostly used in transport, and natural gas, mainly used in industry and buildings (Figure 2.3). Electricity covered some 21.5% of TFC, slightly below the IEA average of 23%. There is scope for electrification of end-uses, especially in buildings and transport. Bioenergy and waste, district heat, and solar accounted for the remaining TFC.

Figure 2.2 Total energy supply by source, total final consumption and GDP in Italy, 2005-2021



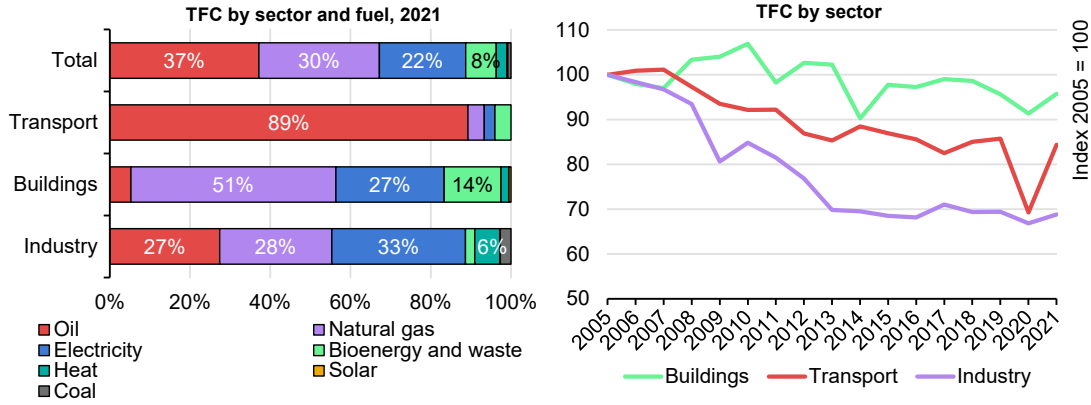
Total energy supply and total final consumption have declined faster than GDP over the last 15 years. They stabilised in the second half of the 2010s, before dropping due to the pandemic.

Source: IEA (2022a).

[1] These shares are based on Eurostat accounting. Eurostat applies formulas to normalise fluctuations of electricity generation from wind and hydro, and uses multiplication factors that give higher shares to advanced transport biofuels and to renewable electricity in transport.

Buildings have been the largest energy-consuming sector since 2008, accounting for some 40% of TFC. Transport and industry have hovered around 30% of TFC each in the last decade. Natural gas covered more than half of energy use in buildings in 2021. Nonetheless, buildings are the sector with the highest share of demand covered by renewables (25.3%), mainly bioenergy and renewable electricity. Oil is by far the dominant fuel used for transport (89% in 2021). Electricity, oil and natural gas contribute nearly equal shares to industrial energy use (Figure 2.3).

Figure 2.3 Energy demand by sector and fuel in Italy



Oil and gas cover two-thirds of TFC, with differences across end-use sectors. TFC has declined in all sectors, more rapidly in industry than in transport and buildings.

Source: IEA (2022a).

TFC followed a trend similar to TES, but declined at a slower pace. In 2021, TFC was 17% below its 2005 level. It dropped by 9% in 2020 as a result of the Covid-19 pandemic, but rebounded in 2021 by 9%, returning to a similar value as in 2019. Industry accounts for most of the decrease in TFC. Industrial energy use declined markedly between 2008 and 2013 but has stabilised since (Figure 2.3). Energy use in buildings hovered around the same level for most of the last decade and started to decline in 2018, in part as a result of energy efficiency measures (see Chapter 4). Transport energy demand declined by 14% between 2005 and 2019, although at a slower rate in the second half of the 2010s. It fell by 19% in 2020 due to the pandemic, but rebounded by 22% in 2021. Oil use decreased accordingly. In the medium term, some lifestyle changes induced by the pandemic may result in higher energy use (e.g., preference for private cars and higher consumption in homes when teleworking).

Italy largely achieved its 2020 energy consumption targets deriving from the EU Energy Efficiency Directive (EED). In 2020, primary energy consumption (PEC) and FEC were about 16% below their respective targets. However, Italy fell short of its target of cumulated energy savings to be achieved through dedicated policy measures, as required by Article 7 of the EU EED (see Chapter 4).

Key institutions and energy players

The central government and the regions and autonomous provinces share legislative competences on the production, transport and distribution of energy. Regional legislative power in this matter is limited by the fundamental principles established by national legislation. The State-Region Conference is the institutional body devoted to co-ordinating national and regional policies in all matters of shared responsibility, including energy.

The early 2020s saw a major institutional change. The top government competences concerning energy policy, formerly held by the Ministry of Economic Development, were attributed to the newly created Ministry of Ecological Transition (MiTE, Ministero della Transizione Ecologica) when the government led by Mario Draghi took office on 13 February 2021, while the Ministry for the Environment, Land and Sea was in charge of national climate and environmental policies. The Inter-ministerial Committee for Ecological Transition was then created in 2022. The name of the MiTe was changed to "Ministry of the Environment and of Energy Security" when the government lead by Ms Giorgia Meloni took office on 22 October 2022, following general elections on 25 September 2022.

The establishment of the MiTE aimed to increase the coherence of energy and climate policies and integrate the transition to a low-carbon and green economy into all of the ministry's activities. However, as of April 2022, the transfer of the energy competences from the Ministry of Economic Development to the MiTE, with effective integration of staff and functions, had not yet been completed.

Several other ministries have energy- or climate-related competences, such as the ministries responsible for transport and infrastructure, agriculture, and education and research. In addition, various other organisations are involved in developing, implementing and evaluating energy-related policies (see Annex A).

Energy and climate policy

In line with the EU energy and climate policy framework, Italy's energy policy aims to decarbonise the energy supply through the expansion of renewable energy, electrification and increased energy efficiency across the economy. This is also broadly consistent with the IEA roadmap to net zero (IEA, 2021). All the national and regional documents defining energy and climate policies were approved before Russia's invaded Ukraine and its consequences on energy supply and markets.

These events have shifted political attention to the security of supply and how to ensure energy security while striving for decarbonisation. The Italian government has announced that it will cease the import of Russian gas by 2025. Italy was the first EU country to issue the alert level for natural gas on 26 February 2022. And in mid-June 2022, Russia substantially cut its gas supply to Italy, as to other European countries, prompting the government to implement gas emergency measures (see Chapter 8). To address the security of gas supply, the government issued a National Plan for the Containment of Natural Gas Consumption in September 2022 (Box 2.2) (MiTE, 2022).

Box 2.2 Italy's National Plan for the Containment of Natural Gas Consumption

The national plan sets out a three-pronged strategy to contain natural gas consumption. The first is to accelerate the filling of gas storage facilities to reach a 90% storage level by November 2022. On 1 September the storage level was 83%.

The second is to further diversify gas imports, both via pipeline and as LNG; to install floating storage and regasification units as existing LNG terminals reached their maximum capacity; and to double domestic gas production. These measures are expected to replace around 30 billion cubic metres (bcm) of Russian gas with 25 bcm of gas from alternative sources by 2025. The 5 bcm difference would be covered by additional renewables and energy efficiency measures.

The government plans to install 8 GW of new renewable onshore and offshore electricity generation capacity every year starting in 2023 – which would imply a massive increase compared to the current additions that linger around 1 GW annually (see Chapter 5). The aim is to make 9.3 GW operational from 2022 to the end of 2023 of which, 7 GW would be installed from January 2022 to March 2023. In addition, the government plans to increase the production of biomethane by 2026.

The third point laid out in the document is the overall reduction of gas consumption in line with the EU rules dated 5 August 2022. The new EU rules imply a voluntary decrease of Italian gas demand of 8.2 bcm and a mandatory reduction of 3.6 bcm in case an alert level is issued at the EU level. To achieve these gas reductions, Italy would:

A. Maximise electricity production from alternative fuels, including coal-fired generation, which would temporarily result in higher GHG emissions. The expected savings from the fuel switch are 2.1 bcm.
B. Mandate a reduced heating season, shortening daily heating hours together with reduced maximum heating temperatures. This would save a further 3.2 bcm.
C. Behavioural changes would contribute 2.7 bcm of gas savings.
D. The industry sector would be called upon to decrease consumption through, among other measures, an increase in interruptible contracts.

Jointly, measures A + B + C would achieve 8.2 bcm of savings, and A + B alone would be sufficient to reach the mandatory 3.6 bcm in the case an EU alert is issued.

Source: Italy, MiTE (2022).

In 2019, the NECP, required for all EU countries, became the main strategic document guiding national energy policy to 2030. The NRRP 2021-2026 is expected to contribute to reaching the objectives of the NECP and the European Green Deal. Italy also adopted a Long-Term National Strategy on Reducing Greenhouse Gas Emissions (LTS) in January 2021 and the Ecological Transition Plan (ETP) to 2050 in March 2022. The government produced several other planning and strategic documents.[2] There is a need to rationalise the multitude of policy documents for the clean energy and low-carbon transitions.

[2] These include the 2017 "Elements for a Sustainable Mobility Roadmap", the "National Plan for Electric Vehicle Charging Infrastructure", and the "National Strategic Framework for the Development of the Alternative Fuels Market and Related Infrastructures" (see Chapter 4).

In the early 2010s, all regions and autonomous provinces developed and adopted their own regional energy-environment plans, which established regional energy policy objectives and their impact on GHG emissions. The procedures for developing, implementing and updating the plans vary across regions. As of June 2022, only 2 out of 20 regions (Piedmont and Sicily) had updated their plan after the approval of the NECP; 3 others had started the updating process (Apulia, Campania and Sardinia). The regional plans have not followed the evolution of energy and climate policies at national and EU levels, which hampers implementation.

The Italian energy information system includes a number of institutions that operate mainly for non-statistical purposes (ARERA, GSE, RSE, ENEA and Terna, see Annex A). They are co-ordinated by the MiTE, which is also responsible for all other areas of energy statistics. The Institute for Environmental Protection and Research is in charge of GHG emissions inventories and projections. This approach ensures that data responsibilities are allocated based on relevant competencies, but also adds transaction costs due to the need to validate data from different sources and share them among institutions. The roles and responsibilities of participating institutions should be better defined and ideally formalised (e.g., through memoranda of understanding), so that they can be sustainably maintained over time. The MiTE also lacks adequate human and financial resources for co-ordinating the energy information system.

Energy and climate policies and targets to 2030

The NECP defines 2030 targets for GHG emissions, renewable energy and energy efficiency that are intended to support the achievement of 2030 EU-wide targets in these areas.[3] The NECP is to be updated in 2023 in line with the enhanced EU goal of reducing net GHG emissions by 55% by 2030 (from 1990 levels). The ETP endorses this target at the national level, as well as the carbon-neutrality goal for 2050. It indicates a share of 72% of renewables in electricity generation as a fundamental step to achieve the 2030 climate target. Table 2.1 provides details of the current national targets and of the expected new 2030 targets under the FF55 package. As of end-June 2022, the new targets were under negotiation (see Chapter 3).

The NECP outlines a list of 101 policies and measures to achieve its targets. It estimates that achieving its goals requires EUR 183 billion in cumulative additional investments by 2030 compared to the Current Policies Scenario (equivalent to an 18% increase). The plan focuses on expanding the use of renewables, especially wind and solar electricity generation, and increasing energy efficiency across the economy, with a focus on the building stock and transport. The NECP sets out additional electricity storage targets by 2030[4] and mentions the potential role of hydrogen as a clean energy carrier (see Chapters 3 and 7).

Italy plans to ban coal use for electricity production as of 2025. The phase-out will be implemented taking into account an adequate capacity replacement, the development of the electricity grid and high penetration of renewable sources. However, the plan may be delayed due to energy security concerns. After Russia's Gazprom reduced gas supplies

[3] These targets were in line with the 2030 EU Climate and Energy Framework, which aimed to reduce EU-wide net GHG emissions by 40% from 1990 levels, improve energy efficiency by 32.5% and increase the share of renewables in gross final energy consumption to 32%.

[4] 6 GW of pumped hydro capacity and utility-scale electrochemical storage, as well as 4 GW of distributed electrochemical storage by 2030.

to Italy in mid-June 2022, the country considered activating its Emergency Plan, including increased coal power output. This will entail higher GHG emissions in the short term.

The instruments proposed by the NECP to stimulate investments and the uptake of more efficient equipment and technology do not differ from those already tried and tested in the past, although the incentives are higher. These include tax incentives for building renovations and purchasing zero-emission vehicles, subsidies for renewable electricity generation, biofuels quotas, and infrastructure investments. Less attention is paid to encouraging behavioural changes in favour of saving energy (and CO_2 emissions) at home and in the workplace, as well as to reducing travel demand or private car use, in line with the REPpowerEU plan and the recent IEA *Playing My Part* recommendations (IEA, 2022c).[5]

Table 2.1 Italy's 2030 energy and climate targets

		2020 status	2030 targets (NECP)	Expected or proposed targets 2030 (FF55)****
GHG emissions	**Net GHG emissions versus 1990 (including removals)**	-32%		-55%
GHG emissions covered by the Effort Sharing Regulation*	**CO_2-eq emissions versus 2005**	-25%	-33%	-43.7%
Energy efficiency	**Primary energy consumption**	6 084 PJ (2021)	5 238 PJ	4 681 PJ
	Final energy consumption	4 742 PJ (2021)	4 346 PJ	3 936 PJ
Renewable energy share (in gross final energy consumption)**	**Overall target**	19.0% (2021)	30%	36.7%
	Electricity	36.0% (2021)	55.4%	62-65%
	Heating and cooling	19.7% (2021)	33.9%	40%
	Transport	10.0% (2021)	21.6%	38%
Renewable electricity in total electricity generation (ETP target)				72%
Cross-border electricity interconnection***		8%	10%	
Energy dependence		77.7% (in 2016)	75.4%	

* The Effort Sharing Regulation (Regulation (EU) 2018/842) sets binding national targets for emissions from sectors that fall outside the scope of the EU Emissions Trading System (EU ETS). These sectors include transport, buildings, agriculture, non-ETS industry and waste.

** The overall renewable target and the transport target are binding. The sectoral renewables targets on electricity and heating/cooling are indicative.

*** The electricity interconnection target is based on the ratio of interconnection import capacity and generation capacity.

**** Targets obtained by applying the rules proposed by the European Commission in the Fit-for-55 package.

Sources: EC (2022); Italy, Ministry of Economic Development, Ministry of the Environment and Protection of Natural Resources and the Sea, and Ministry of Infrastructure and Transport (2019); information provided by RSE during the IEA visit in April 2022.

[5] The IEA report *Playing My Part* recommends simple actions such as turning down the heating and air conditioning, adjusting boiler settings, carpooling, reducing driving speed, replacing short car journeys with walking or biking or using public transport.

The NECP foresees Italy meeting its 2030 targets if all existing and planned measures are timely and fully implemented (see Chapters 3-5). However, new measures and additional investments will be necessary to achieve the more ambitious targets of the FF55 package (see Table 2.1). Achieving these new targets while reducing gas dependence from Russia at the same time will require significantly scaling up and accelerating efforts to expand renewables and improve energy efficiency (Box 2.3). IEA analysis shows that each addition of 2 GW of renewables (1 GW of solar PV and 1 GW of wind) would reduce Italian dependence on Russia for electricity generation by one percentage point (IEA, 2022b). Critical for implementation will be engaging local governments, households and businesses.[6] It is essential to swiftly remove the administrative barriers to the deployment of renewables, as indicated by the NRRP (see below). Reforming fossil fuel subsidies and introducing a form of carbon pricing could contribute to Italy's clean energy transition efforts. As the ETP emphasises, priority should be given to addressing energy poverty to make these measures socially acceptable and ensure a just transition.

Box 2.3 A preliminary scenario for achieving the updated 2030 targets

In December 2021, RSE updated the energy scenario used as a basis for the 2019 NECP to take account of the new economic outlook, the impact of the pandemic, the NRRP implementation and the European Green Deal objectives.

According to some preliminary results, cutting net GHG emissions by 55% would require reducing Italy's energy consumption by 22% by 2030 compared to 2019, or 9.5% below the level estimated by the NECP. Electricity would need to account for 28% of final energy consumption, compared to the 25% planned by the NECP. Renewables supply would have to increase by 11% compared to the NECP scenario, or by 52% from their 2019 level.

Renewables' electricity production capacity would need to be 20 GW higher than foreseen in the NECP, to reach 115 GW in 2030 (including renewable electricity to produce hydrogen). Overall, renewables would have to account for at least 70% of electricity generation. Increasing electrification would require a higher deployment of heat pumps (+10% compared to NECP projections); about 7.3 million EVs, or 20% of the car fleet in 2030 (an additional 1 million cars compared to previous forecasts); and 43% of electricity in industry consumption (compared to the 38% planned in the NECP). Industrial energy intensity would need to decline by 20% compared to the 2019 level.

The RSE model considers hydrogen use as essential to achieving the FF55 objectives. Green hydrogen should contribute 0.63 Mtoe to the energy supply in 2030. This would call for 9 terawatt hours (TWh) renewable electricity generation, or 5-7 GW capacity, to produce green hydrogen. A larger use of biomethane (2.6 Mtoe) in both transport and the gas network would also be required.

Source: Information provided by RSE during the IEA visit in April 2022.

[6] For example, several measures require the willingness of citizens and businesses to invest to reduce energy use.

The NRRP contribution to achieving the 2030 targets

The NRRP aims to unleash the economic growth potential and promote the ecological and digital transitions. It envisages a comprehensive reform package and investments of EUR 222.1 billion, of which EUR 191.5 billion will be from the EU Recovery and Resilience Facility (RRF).[7] The EU will likely make additional funds available for integrating the energy security objectives of REPowerEU in the NRRPs.

Outlays for the green and low-carbon transition amount to 37% of total RRF allocations to the NRRP.[8] In line with the NECP, most of these funds are allocated to renewables, hydrogen, grid and sustainable mobility (EUR 21.9 billion); the rail network (EUR 20.6 billion); and energy efficiency and building renovation (EUR 12.6 billion) (EC, 2021). The NRRP also foresees important reforms, including streamlining administrative procedures for renewable energy installations, reforming hydropower and gas distribution concessions, phasing out regulated electricity prices, and setting the regulatory framework for deploying hydrogen.

Energy and climate policies and targets to 2050

The LTS outlines possible pathways to reach carbon neutrality by 2050.[9] According to the strategy, Italy will need to cut GHG emissions by 84-87% to be carbon neutral by 2050. To do so, the LTS envisages more than doubling electricity production, with 95% generated from renewables by 2050; massive electrification, with over half of energy demand covered by electricity, and even more in the transport and buildings sectors; sector coupling and new forms of flexibility, like Power-to-X; progressively replacing natural gas with hydrogen and other synthetic fuels; shifting transport demand from private cars to public/shared transport modes; accelerating the energy renovation of buildings (from an "annual renovation rate" of 0.9% envisaged by the NECP to 2% by 2050, of which about 80% of deep renovations).

Energy prices, taxes and subsidies

Italy's energy prices are among the highest in the IEA. They generally increased between 2010 and 2020, with differences across sectors and fuels. Prices for business use are lower than prices for non-business use. Prices jumped in the second half of 2021 and the first half of 2022. The relatively high prices are the result of high energy taxes (including value-added tax, [VAT]).[10] The tax shares of the prices of natural gas, electricity and automotive fuels are generally higher than in most IEA countries, except for taxes on electricity used in industry (see Chapters 7-9).

Energy excise duties are levied within the framework of the 2003 EU Energy Tax Directive and are generally well above the minimum rates set by the directive. An excise tax on

[7] National funds contribute EUR 30.6 billion to the NRRP.

[8] The NRRP outlines six missions: 1) digitisation, innovation, competitiveness and culture (EUR 40.3 billion); 2) green revolution and ecological transition (EUR 59.5 billion); 3) infrastructure for sustainable mobility (EUR 25.4 billion); 4) education and research (EUR 30.9 billion); 5) inclusion and cohesion (EUR 19.8 billion); and 6) health (EUR 15.6 billion).

[9] The LTS decarbonisation scenario does not take into account the impact of the Covid-19 pandemic on emissions scenarios.

[10] The standard VAT rate of 22% applies to all fossil fuels and electricity. Electricity for households and natural gas used in the residential sector below a consumption threshold benefit from a reduced rate of 10%.

energy applies to most use of oil products, natural gas and coal. Biofuels are taxed only when used for transport. Fossil fuels used to generate electricity are taxed, albeit at low rates. Energy use, including electricity, in the residential sector is generally taxed at higher rates than in the industrial and commercial sectors. Several discounted rates and exemptions apply (OECD, 2019).[11] As a result of high excise rates, between 2010 and 2020, Italy had one of the top three implicit tax rates on energy (defined as the ratio of energy tax revenue to FEC in a calendar year) in the European Union. It dropped sharply to EUR 350 per tonne of oil equivalent (toe) in 2020 as a result of lower energy use, but it was 22% above its 2010 level.

Italy has made progress in reporting and analysing energy subsidies, and has become a leader in terms of transparency on energy subsidies (EC, 2020a).[12] The fourth and latest edition of the "Catalogue of Environmentally Damaging Subsidies and Environmentally Advantageous Subsidies" was released in early 2022. It identified 34 environmentally harmful subsidies in the energy sector, totalling EUR 9.5 billion in 2020. It also identified 12 energy subsidies that are beneficial to the environment, totalling EUR 12 billion in 2020.

Italy is among the main providers of fossil fuel subsidies in the European Union (EC, 2020a). OECD (2022b) appraises government support for fossil fuels at EUR 9.02 billion in 2020, 80% of which was provided in the form of tax discounts and exemptions. Government support for fossil fuels decreased by only 2% between 2015 and 2019 (in nominal terms) but dropped by 11% in 2020.[13] However, the decline in support in 2020 is the result of lower fuel consumption due to the pandemic (OECD, 2022b).

Table 2.2 presents Italy's main fossil fuel support measures. The differential excise tax treatment for diesel fuel accounts for a quarter of fossil fuel support. The excise duty on diesel is 23% lower than the rate on petrol. This is not justified from a climate mitigation point of view, for CO_2 emissions per litre (L) of diesel are higher than they are per litre of petrol. In addition, diesel engines generate higher emissions of local air pollutants like nitrogen dioxides and particulate matter, with negative impacts on human health.

The Inter-ministerial Committee for Ecological Transition tasked the MiTE with developing a plan for phasing out environmentally harmful subsidies in line with the EU FF55 package. The plan is expected to be completed by mid-2022. In March 2022, the Minister of Ecological Transition announced that five environmentally harmful subsidies had been eliminated for a total of EUR 105 million. However, this is a modest amount compared to the 26 millions provided in fossil fuel support.

Measures to limit the impact of soaring energy prices in 2021-2022

The government introduced several packages in a bid to contain rising energy prices. In March 2022, it introduced a 0.25 EUR/L discount on the excise duties for petrol and diesel, or 0.305 EUR/L when including VAT. The discount was supposed to apply for one month but was repeatedly renewed to apply throughout 2022 before finally being removed on 1st January 2023. The VAT rate on natural gas for households was cut from 22% to 5% in the

[11] Lower rates apply, among others, to natural gas used in transport, diesel used in agriculture and electricity used by energy-intensive companies. Fuels used for fishing, domestic navigation and commercial aviation, and electricity used by small residential consumers are exempt.
[12] Italy undertook a peer review on fossil fuel subsidies in 2019 as part of the G20 voluntary peer review programme.
[13] Government support to fossil fuels was EUR 10.3 billion in 2015, EUR 10.1 billion in 2019 and EUR 9.02 billion in 2020 (OECD, 2022b).

first quarter of 2022, and the exemptions from "general system charges" on electricity retail prices from the fourth quarter of 2021 until September 2022. Before this exemption, the general system charges accounted for 21% of electricity retail prices (see Chapter 7). In addition, various types of support were made available for businesses to partially compensate for the extra energy costs. These measures include support to road freight operators, as well as agriculture and fishing businesses.

As of April 2022, these measures implied additional costs for the central government budget of nearly EUR 14 billion in 2021-2022 (Table 2.3). This corresponds to 0.3% of GDP in 2021 and 0.7% in 2022 (Italy, Ministry of Economy and Finance, 2022). These additional costs were partly covered by, among others, revenue from auctioning CO_2 emissions allowances and from the extraordinary taxation on "extra profits" of energy companies. These support measures run counter to the objective of reducing wasteful fossil fuel subsidies and offset Italy's progress on this matter. The budget cost of these measures was 1.5 times higher than the total fossil fuel support in 2020 (Table 2.3).

Table 2.2 Main fossil fuel support measures in Italy, 2020

Support measure	Description	Amount in 2020 (EUR billion)	Share of total fossil fuel support (%)
Tax expenditure (discounts and exemptions)			
Differential excise tax treatment for diesel fuel	Diesel fuel benefits from a reduction of 23% of the excise tax *vis-à-vis* petrol.	2.257	25.0
Tax relief for road haulage companies	Road haulage companies operating in Italy can obtain partial refunds on the amount of excise tax paid for their fuel purchases as long as the trucks using the fuel comply with the Euro 2 emissions standards. Refunds usually correspond to a fixed amount of fuel. The increase in the excise rates on automotive fuels is also partially refunded.	1.294	14.3
VAT reduction on electricity for domestic use	Reduced VAT rate of 10% (compared to the standard rate of 22%) for household electricity use.	0.998	11.1
Direct transfers			
CO_2 allowance-free allocations	Some emissions quotas under the EU Emissions Trading System are distributed to companies free of charge.	1.708	18.9
Electricity demand response scheme	The electricity transmission system operator (TSO) contracts the annual capacity of demand response from energy-intensive industrial facilities with an electricity consumption usually higher than 7 gigawatt hours (GWh). Participation in this voluntary scheme implies that the provision of electricity to these facilities can be interrupted without prior notice in case of need. The compensations amount to EUR 150 000 per megawatt (MW) per year for sudden interruptions, 100 000 EUR/MW per year for emergency interruptions, and 300 000 EUR/MW per year for sudden interruptions to facilities located in Sardinia or Sicily.	n.a	

Source: OECD (2021).

The partial and total exemption from the electricity system charges was the most expensive measure, accounting for 45% of total costs in the biennium (Table 2.3). This measure is estimated to have limited the rise in households' electricity bills to 9.9% in the third quarter of 2021, compared to a potential increase of 20% (Italy, Ministry of Economy and Finance, 2021). Faiella and Lavecchia (2022) estimate that the government measures limited the contraction of energy consumption and contained the increase in energy expenditure.[14]

Energy poverty

Italy does not have an official definition or indicator of energy poverty.[15] According to estimates of the Italian Observatory on Energy Poverty (OIPE, 2021),[16] energy poverty increased from 7.3% in 2014 to 8% in 2020 (about 2.1 million households). The risk of energy poverty is higher in southern regions and is correlated with poverty. Families living in older multi-apartment buildings are at higher risk of energy poverty, as the energy performance of buildings is largely linked to the year of construction (OIPE, 2020).

Table 2.3 Budgeted costs of the measures to limit the costs of rising energy prices in Italy

(EUR million)	2021	2022
Reduction of VAT rate on natural gas	1 088	592
Discount on general system charges on electricity (all users)	1 200	
Exemption from the general system charges for households and small businesses	800	4 200
Discount on general system charges on gas		250
Discounts on excise duties on petrol and diesel		588
Extension of the social bonus on electricity and gas (low-income households)	450	503
Tax credit to partially compensate for the extra costs due to high electricity prices		2 328
Tax credit to partially compensate for the extra costs due to high natural gas prices		995
Support to road freight transport		601
Tax credit for fuels used in agriculture and fishing		140
Other measures to reduce costs due to high energy prices		26
Total	**3 538**	**10 224**

Note: Based on information available up to 6 April 2022.

Sources: Italy, Ministry of Economy and Finances (2021; 2022).

Between 2005 and 2021, the average Italian household spent between 10% and 11% of its budget on energy (electricity, heating and private transport). The share of energy

[14] Government mitigation measures led to a contraction in electricity and gas use of 6.8%, compared to a 7.9% drop in the absence of measures. Expenditure for electric heating increased by 6.2% with the government measures, against an estimated growth of 9% in the absence of measures (Faiella and Lavecchia, 2022).

[15] The NECP defines energy poverty as "the difficulty of acquiring a minimum basket of energy goods and services or the condition whereby access to energy services implies a diversion of resources (in terms of expenditure or income) beyond what is socially acceptable".

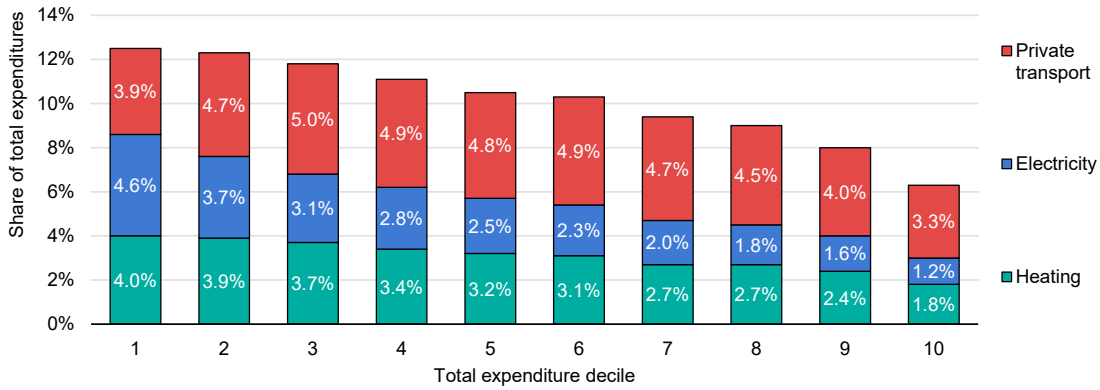
[16] The Italian Observatory on Energy Poverty is an informal network of researchers from universities, public and private entities, and institutions interested in the subject of energy poverty. It is hosted by the Interdepartmental Centre Giorgio Levi Cases for Energy Economics and Technology at the University of Padua.

spending varies with total expenditure distribution. In 2021, households in the first decile of the distribution (the poorest) spent nearly 13% of their budget on energy, compared to 6% of the tenth (wealthiest) decile (Figure 2.4). As a comparison, the poorest households spent 8.3% of their budget on average in the European Union in 2018 (EC, 2020b). This signals the presence of energy poverty in Italy.

Transport fuels account for a large share of energy expenditure for all households. However, the share of transport fuels in the total energy budget is lower for the poorest households, as less than two-thirds of households in the lowest income decile own a car (Faiella and Lavecchia, 2021). Therefore, reducing transport fuel taxes – as the government did – helps the vast majority of the population, including the wealthiest, but it is less effective in supporting the most deprived households.

In general, reducing energy prices is a regressive and non cost-effective measure to reduce the impact of rising prices on vulnerable households, as all households benefit from such measures, irrespective of their income and state of need. Faiella and Lavecchia (2022) estimate that the 2021-2022 government interventions to counteract rising energy prices mitigated the increase in the energy share of total expenditure less for the poorest households than for the average household. Targeted support schemes would be more appropriate to mitigate the impact of higher energy prices on low-income households.

Figure 2.4 Households' expenditure on energy by purpose and income decile in Italy, 2021



In 2021, the share of the budget spent on energy by the poorest households was nearly double that spent by the wealthiest households. Transport fuels are the largest energy expenditure category in all income groups.

Source: Faiella and Lavecchia (unpublished), calculations based on ISTAT data.

At the end of 2021, in response to surging energy prices, the government extended the social bonuses for electricity and gas bills to vulnerable households (Box 2.3). However, the cost of this measure was less than EUR 1 billion, compared to the EUR 8.7 billion allocated to directly mitigating the price of electricity, gas and transport fuels for all households (see Table 2.3). In 2020, some 4 million households were potentially eligible for the means-tested electricity and gas bonuses. This is nearly double the number of households that were estimated in energy poverty that year, indicating that the bonuses could be better targeted. Also, consumers not connected to the natural gas network cannot benefit from the gas bonus, although they usually use other sources for cooking and space

and water heating (Lavecchia and Stagnaro, 2018).[17] It would be more efficient and equitable to merge the electricity and gas bonuses into one single energy allowance, as indicated by the NECP.

The NECP does not set a goal to reduce energy poverty. It considers the incentive schemes for energy renovation of buildings as a means to address energy poverty. However, there is evidence that incentives such as tax deductions for energy renovation works (the so-called "Ecobonus") have regressive effects (see Chapter 4). They benefit homeowners and households with higher upfront spending capacity, while most of the low- and middle to low-income households rent their homes in Italy.[18] The lack of socio-economic eligibility requirements has exacerbated distortions. Direct public investment in renovating and building energy-efficient social housing would be more effective and efficient to address energy poverty risks. However, the NRRP allocates EUR 2.8 billion to social housing investment, compared to EUR 13.5 billion in tax incentives for the energy renovation of buildings.

Box 2.4 Social benefits for electricity and gas expenditure in Italy

The electricity and gas bonuses for vulnerable households (defined as those in economic and physical hardship) are means-tested benefits. Only households with an active electricity or gas contract, or living in a multi-apartment building sharing electricity or gas supply, are eligible for the benefit. The bonus is determined by the Italian Regulatory Authority for Energy, Networks and Environment (ARERA, Autorità di Regolazione per Energia Reti e Ambiente) and amounts to about 30% of the expenses incurred by an average household user for electricity and 15% of average expenses for gas. The bonus operates as a fixed discount on electricity or gas bills, with the amount varying with the size of the household and, for gas only, with the climate zone of residence.

Since 2021, social bonuses have been granted automatically to households that are eligible for welfare benefits of any kind, based on their socio-economic status. In 2020, before the reform, only 855 000 households benefited from the electricity bonus, due to a lack of awareness and complex application procedures. The reform resulted in around 2.4 million and 1.5 million households receiving the bonus for electricity and gas, respectively, in 2021. However, this was still below the 4 million households potentially eligible for the bonus.

In response to rising energy prices, in 2021-2022 the government strengthened the bonus mechanisms by raising the socio-economic ceiling to access the social bonus from EUR 8 265/year to EUR 12 000/year until end-2022. This implies extending the eligibility for the social bonus to an additional 1.2 million households. The cost for the state budget is estimated at EUR 953 million in 2021-2022.

[17] In 2021, at the national level, about 8% of households did not have any heating equipment. However, this share was 13% on average in the southern regions and 32% on the two main islands (Sardinia and Sicily). Income levels are lower in these regions than on average in Italy, but these are also warmer regions. In 2021, about 21% of households had no gas connection, but there are large regional differences. The gas network coverage is much lower in the southern regions and is absent in Sardinia (ISTAT, 2022).

[18] According to 2019 data from the National Institute of Statistics, nearly 79% of households own their homes in Italy. However, ownership varies largely with income. Overall, 70% of households in the bottom two quintiles of the income distribution live in rented houses.

Improving competition in the electricity and gas retail markets and reinforcing customer protection can also help to tackle energy poverty. In general, households with a higher risk of energy poverty are also those less educated and less reactive to price changes in the market. These customers tend to be less willing to switch energy providers (OIPE, 2020). There is, therefore, a need to improve information about energy prices and services provided by retailers, facilitate the switching procedures, and encourage the participation of customers in managing their energy use (see Chapter 7).

Assessment

Italy has taken steps towards the clean energy transition in the last 15 years. It has overachieved its 2020 targets for renewable energy, energy savings and GHG emissions (as part of the EU energy and climate framework). Total energy supply and the energy intensity of the economy have declined. The energy mix has shifted towards natural gas and renewables, and coal now has a residual role in electricity generation.

However, progress in improving energy efficiency, deploying renewables and curbing GHG emissions slowed down in the second half of the 2010s. Italy's primary and final energy demands were fairly stable, before dropping in 2020 with the onset of the Covid-19 pandemic, but rebounding in 2021 to similar levels as 2019. Progress on improving energy efficiency has been mixed, despite significant government expenditure and incentives, especially for the buildings sector. A time-consuming authorisation process and increasing local opposition resulted in a slow shift to renewable electricity, with only 4 GW of capacity added between 2014 and 2019. Fossil fuels still account for nearly 80% of the energy supply and are almost entirely imported. Natural gas is the main energy source and covers half of electricity generation.

Italy's heavy dependence on natural gas imports from Russia (41% of its gas imports in 2021), combined with volatile global energy markets in the wake of Russia's invasion of Ukraine, is a major risk to the country's energy security and economy. There is a high political emphasis on how to ensure energy security while striving for decarbonisation. The government expressed a determination to cease importing gas from Russia by 2025. Russia's decision to cut its gas supply to Italy in June 2022 is likely to lead to increased use of coal for power generation, leading to higher GHG emissions. This measure can only be temporary and should not derail plans for the transition. On the contrary, the clean energy transition should be accelerated. Italy should do more to reduce energy demand and fast-track renewable deployment in all sectors in line with the EC's REPowerEU plan. This would also help Italy to curb GHG emissions and control expenditure on energy commodities, thereby helping to fighting energy poverty.

Energy governance and policy

In line with the EU energy and climate policy framework and the IEA roadmap to net zero, Italy aims to decarbonise its energy supply mainly by expanding renewable energy, electrifying end-uses and increasing energy efficiency across the economy. In a welcome move, the government announced in the National Energy Strategy of 2017 its plans to ban coal use for electricity generation by 2025. This may be delayed due to increased energy security concerns, as well as insufficient progress to install renewables and develop the electricity grid.

Progress has been made in enhancing governance and policy coherence for the clean energy transition. Unifying responsibilities for energy and climate policy under the MiTE, established in 2021, has great potential to result in a more cohesive approach to energy and climate governance. However, the merger of these functions is not yet complete. The central and regional governments share legislative competences on energy. All regions have their own regional energy-environment plans, but most plans have not been updated and are not attuned to the evolution of energy and climate policies at the national and EU levels.

There is a need to rationalise the multitude of strategic documents and plans related to energy and climate policy. The governance of energy and climate policy could be strengthened by adopting a climate framework law that, among other things, allocates clear responsibilities and sets accountability mechanisms for achieving targets. There is also the need to track progress towards the energy transition in a more timely and complete manner to inform policy making. This requires adequate resources and clear responsibilities for data collection and co-ordination of the energy information system.

The 2019 NECP is the main document guiding Italy's energy and climate policies. It will need to be revised to reflect the enhanced targets of the EU Fit-for-55 package, including clear milestones to measure progress. The NECP's measures to achieve the 2030 targets on GHG emissions, renewables and energy efficiency focus on stimulating investment and structural improvements. They do not differ from those already tried in the past, although the incentives are higher. More attention should be paid to encouraging behavioural changes in favour of saving energy (and CO_2 emissions) at home, in the workplace and for travelling, in line with the IEA's recent recommendations made in *Playing My Part* (IEA, 2022c).

The NECP foresees Italy meeting its 2030 targets if all existing and planned measures are timely and fully implemented. However, achieving the more ambitious Fit-for-55 targets will require significantly scaling up and accelerating efforts to expand renewables and improve energy efficiency. With this aim, the government has been prioritising the implementation of the NRRP 2021-2026, which allocates over EUR 70 billion to the clean energy and low-carbon transitions.

The NRRP can provide a significant boost to Italy's efforts to decarbonise the energy sector while enhancing security of supply. In addition to substantial support schemes and public investments, it foresees important regulatory reforms in the energy sector. Implementing the reforms promptly will be key, as will measuring the effectiveness of spending and improving competences to deliver at the national and subnational levels.

Priority should be given to addressing the long permitting procedures and the lack of ownership of renewable energy targets by the regions. A series of simplification measures, implemented in late 2021 and early 2022, have started to unblock a backlog of authorisation requests. However, relevant institutions, especially at the local level, still lack the administrative capacity to speed up the permitting procedures for new plants and powerlines.

Energy prices, taxes and subsidies

Italy has high energy prices compared to most IEA countries. Taxes account for a larger part of final energy prices than the IEA average. However, several tax discounts apply. The government has made welcome progress in reporting and assessing energy subsidies

against the country's broader energy and environmental goals. However, Italy remains among the main providers of fossil fuel subsidies in the European Union. The fourth and latest survey of subsidies conducted by the MiTE (released in early 2022) identifies environmentally harmful subsidies in the energy sector totalling EUR 9.5 billion in 2020. The largest such subsidy is the lower excise duty on diesel compared to petrol, which cannot be justified from climate mitigation or environmental points of view.

In a bid to contain rising energy prices, in 2021-2022 the government introduced successive support packages comprising several discounts on energy taxes and charges (on automotive fuels, natural gas and electricity). The packages also provided fiscal support to businesses to partially compensate for the extra energy costs and expanded the population potentially eligible for the social bonuses for energy bills.

The efforts to adjust taxes and subsidies in light of increasing energy prices are politically understandable. However, this approach implies that the large majority of the relief aids households that are not in immediate need and suppresses market signals to save energy. The government should target relief to the most vulnerable segments of the population and economy. This could save public resources that could then be used to advance the energy transition and ensure that it is equitable. Extending the social benefits for vulnerable households accounted for less than EUR 1 billion of the support package, compared to the EUR 8.7 billion allocated to directly mitigating energy prices for all households and small businesses. This amount is comparable to total fossil fuel support in 2020. Reforming fossil fuel subsidies and introducing a form of carbon pricing could contribute to Italy's clean energy transition efforts. The MiTE is expected to present a plan to phase out environmentally harmful subsidies in line with the EU FF55 package by mid-2022. Priority should be given to addressing energy poverty to make these measures socially acceptable and ensure a just transition.

Energy poverty

Italy does not systematically monitor energy poverty. Estimates indicate that in 2020, 8% of households were at risk of energy poverty (about 2 million households). Italy's poorest households spend a larger share of their budgets on energy than, on average, the poorest households in the European Union. In addition to energy tax discounts, Italy's measures to address energy poverty include social bonuses for electricity and gas expenditures and various incentives for the energy renovation of buildings. However, energy renovations have had regressive effects. Due to the lack of socio-economic eligibility criteria, incentives for energy renovation have mostly benefited higher income homeowners. The NRRP's outlays for these incentives are nearly five times higher than those for direct public investment in social housing, which would be more effective and efficient for addressing energy poverty.

Electricity and gas bonuses are provided to vulnerable households that are connected to the networks, based on the household's socio-economic condition. In 2020, some 4 million households were potentially eligible for the bonuses, or nearly double the number of households that were estimated to be in energy poverty that year. This indicates that the bonuses could be better targeted. In addition, the design of the bonuses risks distorting consumers' choices in terms of both energy use and carriers by, among others, discouraging switching retailers or investing in energy efficiency. There is scope to better co-ordinate the social bonus with the incentives for energy renovations of buildings, as well as with awareness-raising initiatives about the electricity and gas markets.

Recommendations

The government of Italy should:

- Complete the restructuring of the ministry responsible for energy and climate and ensure coherence in all strategic energy and climate-related plans and implementation measures at the national and regional levels.
- Ensure that the Fit-for-55 and RePowerEU targets as well as Italy's 2050 carbon-neutrality target are fully taken into account in the upcoming revision of the National Energy and Climate Plan.
- Swiftly implement the reform of permitting procedures for renewables and grids foreseen in the National Resilience and Recovery Plan; improve capacity to deliver at all government levels by providing adequate staff and technical assistance to the relevant offices.
- Reform fossil fuel subsidies that hamper the clean energy transition and are not justified on economic and social grounds.
- Modify tax reductions and government spending programmes (social bonus) meant to alleviate the impact of high energy prices on citizens and companies, avoid distortions and target only households at risk of energy poverty and small companies.
- Conduct systematic information and education campaigns to improve people's understanding of the clean energy transition and the role of renewables in it, as well as to help households better manage their energy use and bills (including selecting prices and services provided by retailers).
- Rationalise the energy information system, formally define each participating institution's responsibilities, and ensure appropriate human and financial resources for the co-ordination of the system.

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3. Energy and climate change

Key data

GHG emissions with LULUCF (2020):* 348.9 Mt CO_2-eq; -37.2% since 2005, -32.4% since 1990

GHG emissions without LULUCF (2020):* 381.2 Mt CO_2-eq; -35.5% since 2005, -26.7% since 1990

CO_2 emissions from fuel combustion (2021): 302.2 Mt CO_2-eq; -35% since 2005, -23% since 1990

CO_2 emissions by sector (2020): electricity and heat generation 31%, transport 30%, buildings 22%, industry 17%

CO_2 intensity per GDP (2021):** 0.131 kgCO_2/USD (IEA average 0.186 kgCO_2/USD)

CO_2 intensity per capita (2021): 5.02 tCO_2/capita (IEA average 8.278 tCO_2/capita)

* Land use, land-use change and forestry.

** Gross domestic product in 2015 prices and purchasing power parity (PPP).

Sources: IEA (2022a), ISPRA (2022a).

Overview

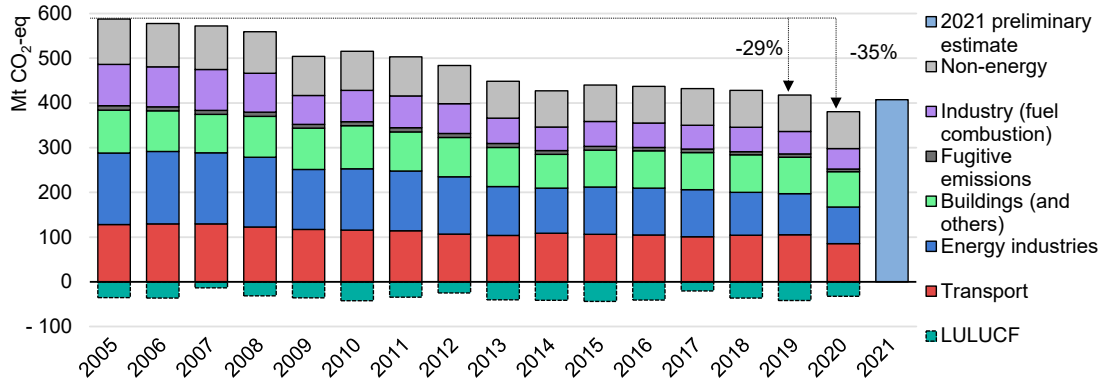
Italy has reduced GHG emissions at a faster pace than on average across the European Union since 2005 (European Parliament, 2021), in part due to sluggish economic performance. Energy industries and manufacturing accounted for most emissions reductions, while progress in transport and buildings was slower. The country achieved its 2020 emissions targets. However, it will need to accelerate the pace of emissions reductions to meet the more ambitious targets of cutting net GHG emissions by 55% by 2030 (from 1990) in line with the European Green Deal and the EU FF55 legislative package.

Italy is engaged internationally in the fight against climate change. It is a party to the United Nations Framework Convention on Climate Change (UNFCCC) and has integrated EU climate policies into its domestic strategies and plans. The 2019 NECP guides climate mitigation action to 2030, although it will have to be updated in line with the more ambitious EU climate mitigation objectives. Russia's invasion of Ukraine and the ensuing natural gas crisis may jeopardise Italy's decarbonisation plans. It will likely entail increased GHG emissions in the short term if coal use increases to replace natural gas.

Greenhouse gas emissions profile

Between 2005 and 2019, total GHG emissions in Italy, excluding land use, land-use change and forestry (LULUCF), declined by 29% (Figure 3.1). GHG emissions started to drop remarkably with the global financial crisis of the late 2000s and continued to decline, albeit more slowly between 2015 and 2019. They decreased in all sectors, and mostly in energy industries and manufacturing. In 2020, emissions fell to 381 million tonnes of carbon dioxide equivalent (Mt CO_2-eq), or by 9% from 2019.[1] This was a consequence of the exceptional restrictions on social and economic activity to contain the spread of Covid-19. The largest drop was in transport emissions (Figure 3.1; ISPRA, 2022b). Preliminary estimates indicate that 2021 GHG emissions were 6.8% higher than in 2020 (above the projected 1% growth), due to economic recovery and increases in transport activity (ISPRA, 2022c). Italy's LULUCF has acted as an emission sink, absorbing an average of 34 Mt CO_2-eq per year from 2005 to 2020.

Figure 3.1 Greenhouse gas emissions by sector in Italy, 2005-2021



GHG emissions have declined considerably in the last 15 years, with a dip in 2020 due to the onset of the Covid-19 pandemic. Energy production and use is the main source of emissions.

Notes: Non-energy sectors include agriculture (9% of 2020 total GHG emissions), waste (5%) and industrial processes (8%). Buildings represent the most important part of other emissions, as per the UNFCCC classification.

Sources: IEA based on data from ISPRA (2022a; 2022c).

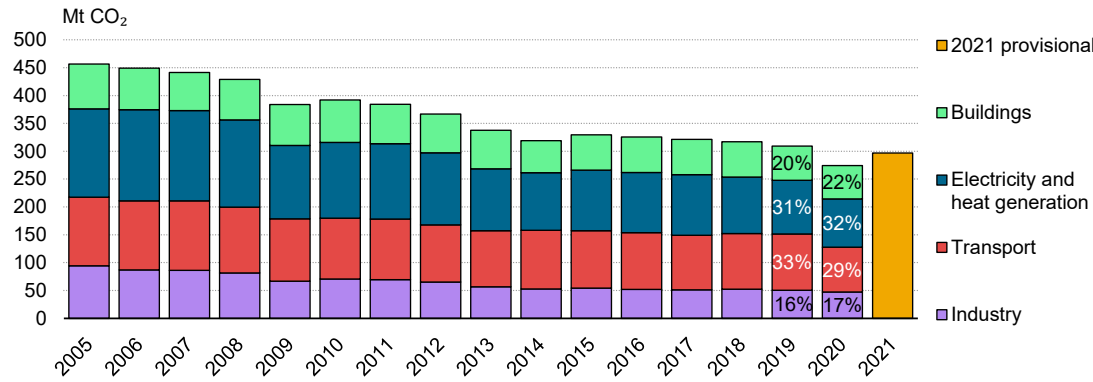
CO_2 accounts for 79% of Italian GHG emissions. Methane (excluding LULUCF) has averaged about 10% of the country's GHG emissions in the last decade. Agriculture is the main source of these emissions, followed by waste management. Fugitive emissions account for a relatively low share of methane emissions (9% in 2020). They originate mainly from the extraction of natural gas and oil. These emissions declined by 12% between 2005 and 2019, due to declining domestic production of oil and gas. However, they grew by 2% in 2020 following an increase in oil production (from the Tempa Rossa field) (see Chapter 9).

[1] GHG emissions without LULUCF were 418 Mt CO_2-eq in 2019.

Energy-related CO_2 emissions and intensities

Energy production and use have accounted for 80% of GHG emissions on average in the last decade. From 2005 to 2019, Italy's energy-related CO_2 emissions decreased almost steadily.[2] In 2020, CO_2 emissions dropped by 11% compared to 2019, as a consequence of the Covid-19 pandemic. In 2021, CO_2 emissions rebounded by 8% year-on-year, but they were still 4% lower than in 2019. In the last decade, electricity and heat generation and transport have been the largest sources of CO_2 emissions from fuel combustion (Figure 3.2).

Figure 3.2 Energy-related CO_2 emissions by sector in Italy, 2005-2021



Energy-related CO_2 emissions have declined steadily since 2005. They have declined in all sectors and notably in energy industries and manufacturing.

Source: IEA (2022a).

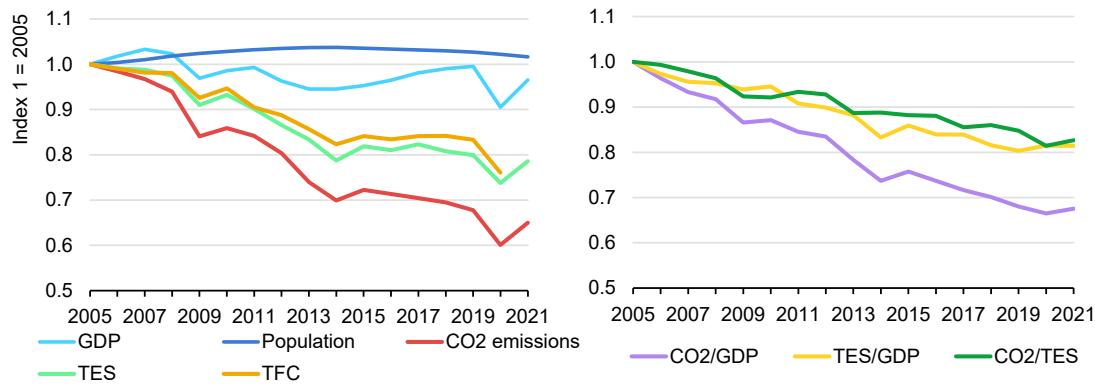
Overall, energy-related CO_2 emissions have declined much faster than GDP and continued to decline even while the economy was growing in 2015-19 (Figure 3.3). In 2019, prior to the Covid-19 pandemic, CO_2 emissions were 32% below their 2005 level, while GDP declined by 1% over that period. Although emissions rebounded in 2021 after the Covid-related fall in 2020, they were still 29% lower than in 2005. As a result, the carbon intensity of Italy's economy (CO_2/GDP) continued to fall and remains well below the IEA average. Similarly, CO_2 emissions declined faster than TES, resulting in a decrease in the carbon intensity of the energy supply (CO_2/TES).[3] This trend indicates progress towards the decarbonisation of Italy's energy supply. However, after the drop in 2020, both CO_2/GDP and CO_2/TES rebounded in 2021 to levels only 1.2% and 2.5% lower than in 2019 (Figure 3.3).

The energy industries (mainly electricity and heat generation) abated 42% of energy-related CO_2 emissions in 2005-19. In the same period, emissions from electricity and heat generation dropped by 39%, driven by increasing renewable generation, the switch from coal to natural gas and the entry into operation of more efficient gas-fired combined-cycle

[2] There were slight increases in 2010 and 2015 due to a particularly cold winter and hot summer, respectively.
[3] In 2020, the carbon intensity of Italy's economy was 0.129 kg CO_2 per unit of GDP (USD at 2015 prices and PPP), or 50% below its 2005 level. For comparison, the IEA average was 0.185 kg CO_2/USD in 2020. The carbon intensity of energy supply (CO_2/TES) decreased by 19% between 2005 and 2020, to 47.6 kg CO_2/Terajoule (TJ) (slightly below the IEA average of 49 kg CO_2/TJ).

plants (Figure 3.2). As a result, CO_2 emissions from coal use declined, partly offset by an increase in emissions from natural gas. The reduction in coal use accounted for a quarter of the reduction in energy-related CO_2 emissions. Natural gas is the main source of CO_2 emissions (Figure 3.4), accounting for nearly half of electricity generation. It is also widely used in the buildings and industry sectors. The CO_2 intensity of electricity and heat generation declined by 44% between 2005 and 2020.[4]

Figure 3.3 Energy-related CO_2 emissions and main drivers in Italy, 2005-2021
Key economic, energy and emissions trends (left) and CO_2 intensities (right)



Energy-related CO_2 emissions have decreased faster than GDP and energy supply, resulting in declining energy and emissions intensities.

Source: IEA (2022a).

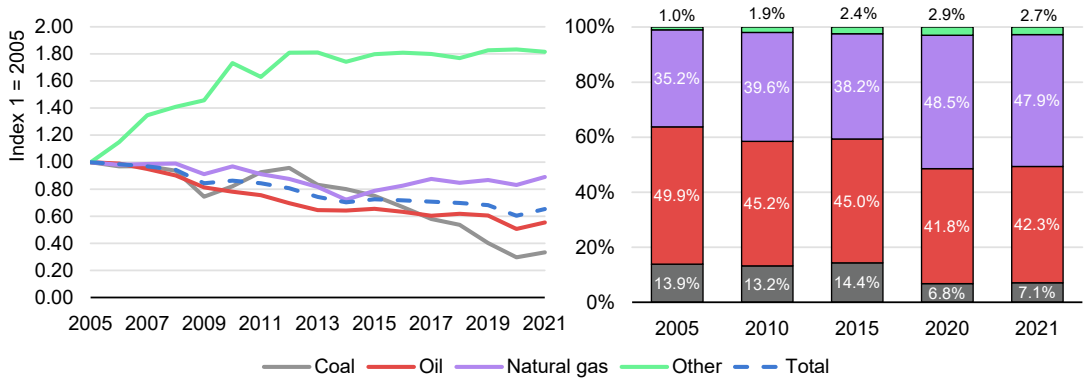
While industry already accounts for the lowest share of CO_2 emissions, it contributed to 30% of CO_2 emissions reductions between 2005 and 2019. Emissions from fuel combustion in industry almost halved over the same period, due to the prolonged economic recession (with a fall in cement production); structural changes; and a shift to electricity, heat, natural gas, and waste and bioenergy in some sectors (ISPRA, 2021a).

Emissions from energy-intensive industries and power plants, together with those from domestic aviation, are covered by the EU ETS.[5] As a result of their decline, in 2020, Italian emissions within the EU ETS were 44% below their 2005 level, having declined at an annual average rate of 6%, the highest among the countries in the system. Nonetheless, Italy remains among the top three participants in the ETS (with Germany and Poland). In 2020, the EU ETS covered about 33% of Italy's GHG emissions (down from 42% in 2005). Power plants are the source of more than half of the Italian emissions covered by the ETS in 2020 (ISPRA, 2021a).

[4] The CO_2 intensity of Italy's electricity generation was 252.82 g CO_2/kWh in 2020, below the IEA average of 313 g CO_2/kWh.

[5] The ETS uses tradable emissions allowances to drive emissions reductions at ETS regulated facilities in the European Union, Iceland, Liechtenstein and Norway.

Figure 3.4 Energy-related CO_2 emissions by fuel in Italy, 2005-2021
CO_2 emissions by fuel: Trend in 2005-2021 (left) and composition in selected years (right)



IEA. CC BY 4.0.

Natural gas and oil are the main sources of energy-related CO_2 emissions. Higher emissions from natural gas offset declining coal emissions.

Source: IEA (2021a).

GHG emissions from transport and buildings, together with those from agriculture, waste and small industrial facilities, are currently not covered by the EU ETS. They are subject to national binding targets under EU rules.[6] Italy overachieved its 2020 target of cutting non-ETS sector emissions by 13% from 2005 levels. In fact, in 2020, emissions from the non-ETS sectors were 23% below their 2005 levels.

CO_2 emissions from transport and buildings declined less and more slowly, especially in the second half of the 2010s. Building sector emissions decreased by 20% from 2005 to 2015, and then only slightly until 2020 (Figure 3.2). Transport emissions decreased by 19% between 2005 and 2013, then remained approximately constant at 100 Mt CO_2 until 2019. In parallel, CO_2 emissions linked to oil use have also stabilised in recent years (Figure 3.4). Oil is the second-largest source of CO_2 emissions; it is mainly used in transport, followed by industry then a small share for heating. In 2020, CO_2 emissions from the transport sector dropped by 20% due to the Covid-related mobility restrictions, resulting in a comparable decline in emissions linked to oil use (Figures 3.2 and 3.4).

Climate governance

Climate policy is mainly the responsibility of the central government. In 2021, Italy established the MiTE to oversee energy, climate and other environmental policies. Several other ministries have climate-related competences, such as the ministries responsible for transport and infrastructure, agriculture, and education and research. Regions and autonomous provinces share competences on several climate-related matters with the national government, primarily energy and transport. Municipalities also have relevant

[6] The Effort Sharing Decision for the 2013-2020 period, and the Effort Sharing Regulation between 2021 and 2030.

functions in implementing climate policy, for instance in terms of urban planning, public transport, building regulations and waste management.[7]

Italy is among the few European countries that do not have a national climate law in place. A climate framework law generally enshrines in legislation the long-term carbon-neutrality goal; it sets mechanisms to define intermediate targets; allocates responsibilities and accountability mechanisms for achieving the targets; and establishes an independent advisory body to support policy making and review implementation and progress (Box 3.1). The United Kingdom's experience, for example, shows that a climate law strengthens evidence-based policy making, stimulates public debate and helps keep the focus of climate change policy on the long-term goal.

Climate policy and targets

EU requirements have been the main driver of Italy's progress in planning for climate mitigation and integrating it with energy policy. Like other EU member countries, Italy has GHG emissions mitigation targets for 2020 and 2030 that are defined within the EU climate policy framework and are communicated internationally to the UNFCCC. Italy's 2019 NECP sets national targets to 2030 in line with the 2030 EU Climate and Energy Package, which aimed to reduce EU-wide net GHG emissions by 40% from 1990 levels. The European Green Deal and the 2021 European Climate Law raised this target to -55% by 2030 compared to 1990 levels (Table 3.1). The EC proposed a legislation package, the so-called "Fit-for-55", to achieve the new -55% target. Italy will have to update its NECP in 2023 and align it with the enhanced EU targets. Italy's ETP 2021-2050, adopted in March 2022, endorses the -55% target at the national level, as well as the carbon-neutrality goal by 2050. The LTS, adopted in January 2021, outlines possible pathways to reach carbon neutrality by 2050.

Table 3.1. 2020 and 2030 greenhouse gas emissions reduction targets for Italy and the European Union

		Italy 2020 status	Target 2020	Target 2030 (NECP)	New target 2030 (FF55)
GHG emissions	**Net GHG emissions versus 1990 (including removals)**	-32%	-20%	-40%	-55%
Non-ETS GHG emissions	**CO_2-eq emissions versus 2005**	-23%	-13%	-33%	-43.7%
ETS emissions cap	**CO_2-eq emissions versus 2005***	-44%	-21%	-43%	-61%

* EU-wide target.

Sources: EC (2022a); EEA (2022a); ISPRA (2022a); Italy, Ministry of Economic Development, Ministry of the Environment and Protection of Natural Resources and the Sea, and Ministry of Infrastructure and Transport (2019).

[7] Annex A provides detailed information about institutions and organisations with responsibilities in the energy sector.

Box 3.1 Examples of climate framework laws

France's Law on Energy and Climate of 2019 sets the goals of reducing GHG emissions by 40% between 1990 and 2030 and achieving carbon neutrality by 2050. The law also sets targets for the energy sector. These climate and energy objectives must be translated into the National Low-Carbon Strategy, which adopts a five-year carbon-budget approach. In addition, the law makes the High Council on Climate a permanent body. It also increases the emphasis on climate change adaptation and resilience, alongside mitigation efforts.

Ireland's Climate Action and Low Carbon Development (Amendment) Act of 2021 amends the original 2015 Climate Action and Low Carbon Development Act and enshrines the 2050 climate-neutrality goal in law. It requires the development of five-year carbon budgets to set sectoral emissions ceilings, as well as annual revisions of the Climate Action Plan. It also calls for developing a National Long-Term Climate Action Strategy every ten years. The act strengthens the role of the Climate Change Advisory Council, which is tasked with conducting an annual review of the GHG emissions mitigation progress. Ministers must report to a joint committee of the parliament. The 2021 amendment also incorporates the principles of climate justice and a just transition.

In 2019, New Zealand approved the Climate Change Response (Zero Carbon) Amendment Act, which amends the original 2002 Climate Change Response Act. The amendment sets a target to reduce net carbon emissions to zero by 2050, as well as to curb biogenic methane emissions. It sets the obligation of five-year rolling carbon budgets. The government is mandated to adopt national adaptation plans based on periodic national climate risk assessments. The Climate Change Commission provides independent, expert advice to the government and reviews progress towards emissions reduction and adaptation goals. The Zero Carbon Amendment Act sets consulting obligations with indigenous communities.

Norway's Climate Change Act, adopted in 2017, enshrines in law the national GHG emissions reduction target for 2030 (-50-55% from 1990 levels) and commits the country to become a low-emissions society by 2050 (defined as an emissions reduction of 90-95% from 1990 levels). The act introduces an annual reporting mechanism, as well as a system of five-year reviews of Norway's climate targets. Each year, the government must submit updated information to the parliament on the status and progress toward achieving climate targets, as well as on how Norway is preparing for and adapting to climate change.

The United Kingdom's Climate Change Act, adopted in 2008, sets a long-term emissions goal and requires the identification of interim targets. These are expressed in five-year carbon budgets, which the government is legally obliged to achieve. While there are limited penalties for non-compliance, the act sets out a transparent accountability framework. In 2019, the headline target of the act was amended to reflect the government's net zero ambition. The act also requires the government to publish a climate change risk assessment every five years and to develop a national adaptation programme to respond to it. The act establishes the Climate Change Committee, an independent expert body reporting on progress to parliament. Its mandate extends beyond parliamentary elections.

Sources: Grantham Research Institute on Climate Change and the Environment and Sabin Center for Climate Change Law (2022); IEA (2022b; 2021a); OECD (2021a).

Policies and progress towards the 2030 targets

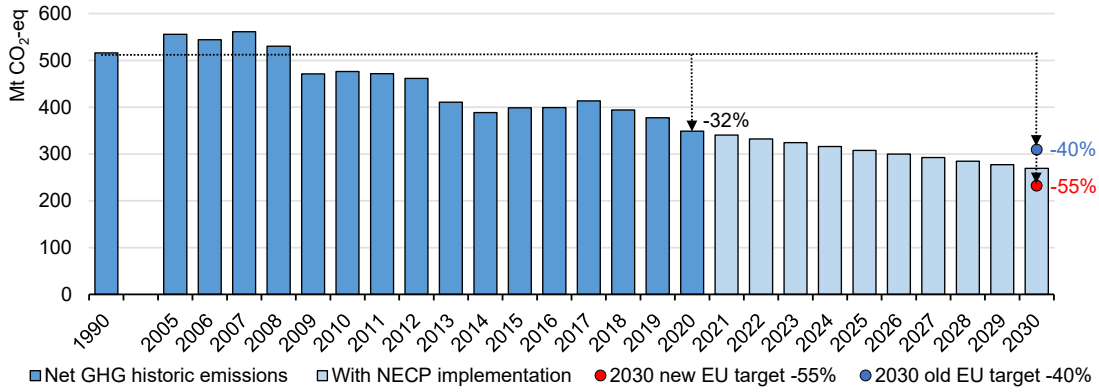
The NECP outlines a list of 101 policies and measures to curb GHG emissions. These measures focus on reducing the carbon intensity of the energy supply by using more renewables, phasing out coal by 2025 and increasing energy efficiency across the economy (see Chapter 2). The plan also mentions the potential role of hydrogen in reducing emissions but does not quantify it (see the section "Hydrogen"). The NECP provides GHG emission scenarios "with existing measures", including measures in place until the end of 2019, and "with additional measures", which assumes the implementation of all the additional measures planned in the NECP.

The regulatory reforms and public investments foreseen by the NRRP 2021-2026 are expected to contribute to reducing emissions and setting Italy on the right path to achieve its targets. The NRRP's measures supporting climate change objectives amount to 37.5% of the EU Recovery and Resilience Facility allocated to the plan (EUR 71 729 million out of EUR 191.5 billion). Most of these funds are allocated to clean energy infrastructure and projects, buildings renovation, and the rail network (EC, 2021) (see Chapter 2).

Under the NECP "with existing measures" scenario, in 2030 Italy's emissions covered by the EU ETS are projected to be half their 2005 level. This means a decrease above the current EU-wide targeted reduction of 43% between 2005 and 2030, but below the proposed new target of 61% in the FF55 package (Table 3.1). Italy will need to fully implement the measures foreseen in the NECP to reduce emissions within the ETS in line with this more ambitious objective. In particular, Italy should stick to its plans of phasing out coal by 2025. It should also increase the renewable share in electricity generation beyond the NECP target of 55% by 2030 to at least 72% as indicated by the ETP (see Chapters 5 and 7).

In 2020, net GHG emissions (including removals from LULUCF) were 32% below their 1990 level, and well below the average EU target of -20%. They will have to decline at an average annual rate of 4% in the period from 2020 to 2030 to achieve the new target of -55% from the 1990 level. This is much higher than the average annual decline of 1.3% in the period 1990-2020, as well as the average annual change of -3.1% in the 2010-2020 period, during which Italy experienced a double-dip recession and the Covid-19 crisis. According to the latest projections by the Italian Institute for Environmental Protection and Research, net GHG emissions in 2030 are expected to be well above the -55% target, even if all the measures planned in the NECP are implemented (Figure 3.5). Implementing the NECP would leave a gap of 37 Mt CO_2. Increasing the share of renewables to 72% of electricity generation, as indicated by the ETP, would not be enough to fill this gap.

Figure 3.5 Italy's historic net greenhouse gas emissions, projections and 2030 targets



Net GHG emissions have declined by 32% since 1990. In 2030, they are expected to be well above the average EU emissions reduction target of -55%, even if all measures planned in the NECP are implemented.

Source: ISRPA (2022a) and information provided by ISPRA to the IEA team.

Beyond increasing the share of renewables in all sectors, it is paramount to address FEC in all sectors to abate emissions in line with the target. Italy should focus on reducing energy consumption in transport, buildings and industry. In addition to stimulating the uptake of more efficient technologies, Italy should put more emphasis on encouraging less energy- and carbon-intensive consumption and mobility patterns. This includes urban planning and infrastructure to reduce the need for private cars and promote active mobility (walking and biking). Transport was the largest source of GHG emissions in 2019. Its emissions are expected to decline significantly only after 2030, when EVs are expected to account for a large share of the fleet. Emissions from buildings have declined in the last decade but at a relatively slow rate. In 2020, they were still slightly above their 1990 level. The recent energy efficiency incentives have accelerated the buildings renovation rate, but the pace is not fast enough. While industry has reduced its energy and carbon intensities in the last decade, they have generally stabilised since 2017; in some sectors (basic metals, ferrous metals, machinery) they increased slightly in 2019 (IEA, 2021b). Italy should strive to not lose the efficiency results already achieved in the industry sector (see Chapter 4).

Carbon neutrality to 2050

Looking ahead to 2050, achieving climate neutrality is an exceptional challenge for Italy, as it is for many other countries. According to the LTS, Italy will need to cut GHG emissions by 84-87% to be carbon neutral by 2050.[8] However, the strategy does not identify a trajectory of intermediate targets to get there. The LTS gives priority to reducing energy consumption, electrifying end-uses and fully switching to renewables, broadly in line with the IEA roadmap to net zero (IEA, 2021c) (see Chapter 2). It excludes the use

[8] The LTS decarbonisation scenario does not take into account the impact of the Covid-19 pandemic on emission scenarios. The LTS notes that the effects of the health crisis on the decarbonisation process will depend upon several factors, including the possible acceleration of economic recovery measures (both at European and national levels) or a structural change in citizens' working habits and methods (for example, greater recourse to smart-working).

of international carbon credits consistently with the European Union's long-term low GHG emissions development strategy.

Achieving carbon neutrality will require going beyond the measures proposed in the NECP to radically transform the energy system. There is potential to eliminate emissions from electricity generation and largely reduce those from manufacturing. Alternative fuels will be needed in transport and some industrial sectors for which electrification is not technically or economically viable. There will be incompressible residual emissions deriving mostly from industrial processes, the use of solvents and F-gases, waste, and the agricultural and livestock sector. Carbon capture and storage (CCS) will be necessary to offset emissions deriving from industrial processes. Adequate policies are also needed to control fires and manage soil sustainably to increase the emission-removal capacity of the LULUCF sector. Sink capacity could be brought up to 45 Mt CO_2-eq (Gaeta, Nsangwe Businge and Gelmini, 2021).

Carbon pricing

Italy's carbon pricing system comprises the EU ETS and taxes on energy products. Italy does not apply an explicit carbon tax.

Carbon pricing through the EU Emissions Trading System

Some energy uses are subject to carbon pricing through the EU ETS. After a long period of low levels (below 10 EUR/t CO_2), the ETS allowance price hovered around 25 EUR/t CO_2 in 2019-2020. This encouraged a switch from coal to natural gas in the Italian electricity market, with a consequent reduction in CO_2 emissions from electricity generation (Figures 3.2 and 3.4). CO_2 prices started climbing in December 2020 and were above 80 EUR/t CO_2 for most of the period from December 2021 to June 2022. Rising ETS allowance prices are expected to be a key element in energy and industry investment decisions in the years to come.

Between 2014 and March 2022, auctioning of ETS allowances contributed EUR 9.6 billion to Italy's state budget (GSE, 2022). In 2021-2022, part of the revenue from allowances covered the costs of the exceptional government measures to limit the costs of rising energy prices (see Chapter 2). As of 2022, a share of the annual proceeds from the auctioning of the ETS allowances will be used to cover the costs of promoting renewables and energy efficiency, which are currently covered by energy tariffs (through the system charges; see Chapters 5 and 7).[9]

Italy has not consistently met the EU requirement of spending half of the revenue from auctioning allowances on climate-related measures. The share of ETS allowance revenue allocated to climate action varied from 11.5% to 70% in the period 2017-2020. The number of programmes and measures to which these funds are allocated has increased.[10] However, outlays have been inconsistent over time. Allocation decisions are taken through annual inter-ministerial decrees, but there is a two-year delay between the allowance

[9] Legislative Decree 199/2021 transposing Directive 2018/2001 on renewable energy (RED II).

[10] Among others, the ETS allowance revenue feeds into the National Fund for Energy Efficiency and the Programme for Retrofitting Buildings of the Central Administration. About a third of ETS-funded climate spending has financed international co-operation programmes.

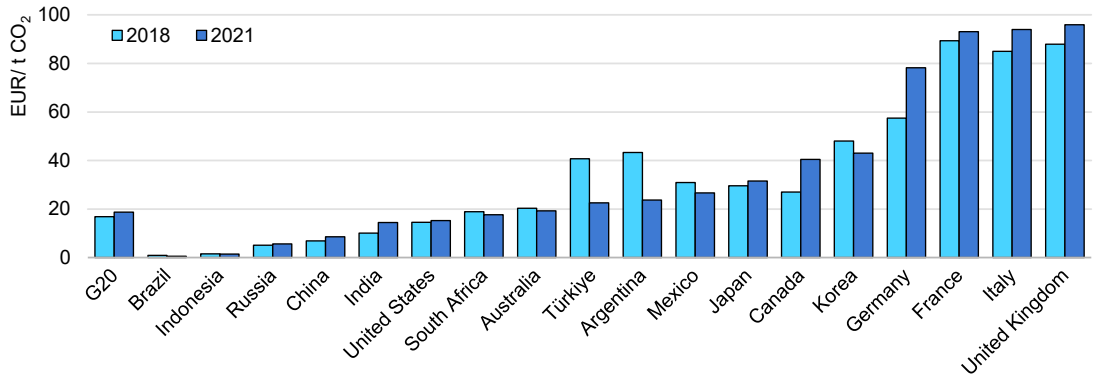
auctioning and the revenue allocation. This time lag and the irregularity of financial allocations create uncertainty and discourage long-term investment (Haase et al., 2022).

Carbon prices implicit in energy taxation

Taxes on energy products are relatively high in Italy. In 2020, Italy's implicit tax rates on energy (defined as the ratio of energy tax revenue to FEC in a calendar year) was 350 EUR/toe, the second highest in the European Union (see Chapter 2).

Under the simplified assumption that excise duties on energy products aim to reflect only CO_2 emissions linked to energy use, high energy taxes translate into a high effective tax rate on energy-related CO_2 emissions, in both the road and non-road sectors. In 2021, the average effective or implicit carbon tax across the economy was 93.99 EUR/t CO_2, up from 85 EUR/t CO_2 in 2018. This was the second-highest effective carbon tax rate among G20 economies in 2021 (Figure 3.6). However, the average hides large differences in the effective carbon taxes that are levied on different fuels and uses. As in all countries, the average effective carbon tax rate outside the road transport sector (22/ EUR/t CO_2 in 2018) is much lower than the rates applied on road fuels (243 EUR/t CO_2 in 2018). These were among the highest among IEA countries.

Figure 3.6 Average effective carbon rates on CO_2 emissions, G20 economies, 2018 and 2021



Italy's average effective carbon rate is one of the highest among G20 economies.

Source: OECD (2021b).

High energy taxes and effective carbon rates have provided relatively strong incentives to reduce the energy and carbon intensities of the economy. Italy has relatively low energy and carbon intensities in international comparison (as measured by TES and CO_2 per unit of GDP, respectively). This is in line with the observed correlation between high energy and carbon prices and low intensities across countries (OECD, 2019). In part as a response to traditionally high energy prices, the country's manufacturing sector is among the least energy intensive in the IEA, although with marked differences across sectors. However, price signals have not encouraged energy savings in residential heating, largely due to the poor energy performance of buildings, nor in road freight transport. The energy intensity of road freight transport in Italy is the highest among the European members of the IEA (IEA, 2021b; see Chapter 4). Road freight benefits from partial tax refunds on the excise duties paid on diesel, irrespective of the fuel efficiency of the vehicle. This subsidy

has dumped the price signal and the incentive to improve efficiency while costing taxpayers EUR 1.3 billion in lost revenue in 2020 (see Chapter 2).

A carbon tax for Italy?

Accounting for both energy taxes and the EU ETS, Italy priced about 85% of its carbon emissions from energy use in 2021. This is the fourth-highest share of emissions priced in G20 countries, after Korea, Canada and Germany (OECD, 2021b). Most unpriced emissions were from the residential and commercial sector and the electricity sector, reflecting some favourable tax treatment.

Recent estimates indicate that, in advanced economies, a carbon price of at least 100 USD/t CO_2-eq up to 250 USD /t CO_2-eq is needed to reduce emissions to net zero by 2050 (IEA, 2021c; World Bank, 2022). In Italy, more than 75% of total GHG emissions are taxed at lower rates. Only emissions from transport, i.e., about a quarter of total GHG emissions, face implicit carbon prices (via excise duties) in the 100-250 USD/t CO_2 range. However, excise duties on transport fuels should reflect not only the social costs of carbon, but the costs of air pollution, noise, congestion, accidents, use of road infrastructure and others as well.

The ETP indicates carbon taxation as a possible level of decarbonisation, but the NECP does not. According to IMF/OECD (2022), Italy would need to introduce a carbon price above 75 USD/t CO_2 to achieve its 2030 target. For comparison, more than half of European countries apply explicit carbon prices (carbon taxes or national carbon markets) in sectors outside the EU ETS, with rates varying between less than 1 USD/t CO_2 in Poland to 130 USD/t CO_2 in Sweden.[11] Faiella and Lavecchia (2021) estimate that the energy price hikes due to a carbon tax of 50-100 EUR/t CO_2 would cut energy demand and CO_2 emissions by 4-8% in a year while raising between EUR 4 billion and EUR 8 billion in revenue.

Italy should consider introducing a carbon tax in non-ETS sectors as part of its broad climate and energy policy package to accelerate emissions reductions in line with the FF55 targets. As Italy already has high energy taxes and prices, the carbon tax rate could be set at an initially low level to replace part of the current excise duties. The rate should be raised gradually according to a pre-determined schedule. A trajectory of carbon tax rates would provide a predictable price signal to investors and households. The government could use carbon pricing to encourage the self-consumption of renewable energy, which can help reduce reliance on foreign energy sources and provide some protection against global energy price shocks.

However, according to Faiella and Lavecchia (2021), the carbon tax would have regressive effects: poorer household expenditure on energy increases more while they also suffer a greater drop in their energy use. Therefore, the carbon tax should be introduced as part of a package of measures that includes targeted support to vulnerable households (e.g., means-tested lump-sum transfers), measures to help improve energy efficiency, and awareness-raising and education campaigns. Revenue raised from the tax could be

[11] As of June 2022, the European countries applying a carbon tax were: Denmark, Finland, France, Estonia, Iceland, Ireland, Latvia, Lichtenstein, Luxembourg, the Netherlands, Norway, Poland, Portugal, Slovenia, Spain and Sweden. Austria planned to implement a carbon levy in July 2022. Germany launched a national fuel ETS in 2021. There is a carbon levy in place in the United Kingdom, where a national ETS replaced the country's participation in the EU system after the United Kingdom's exit from the European Union. Also, Switzerland implements a carbon tax and its national ETS is linked to the EU ETS.

recycled for these purposes. For example, Ireland allocated the additional revenue from the carbon tax increase to spending on social welfare and prevent fuel poverty (OECD, 2021c).

Carbon capture, utilisation and storage

Carbon capture, utilisation and storage (CCUS) has little role in Italy's climate mitigation strategy. While using CCS technologies is technically possible in Italy, there is strong resistance from the public, largely due to the high earthquake risk in many areas of the country and the need to realise and locate additional infrastructure for CO_2 transport.

There are no CCUS plans in the NECP, which assumes that emissions above the 2030 target could be absorbed by natural sinks. However, the LTS considers CCS a necessary technology to offset emissions from hard-to-abate sectors, and particularly those from industrial processes, and to achieve net zero by 2050. The LTS estimates emissions between 20 Mt CO_2-eq and 40 Mt CO_2-eq to be captured via CCS technology in 2050 (Gaeta, Nsangwe Businge and Gelmini, 2021).

The legislation that regulates the authorisation procedures relating to the geological storage of CO_2 dates back to 2011 and is limited to the experimental phase. Offshore depleted hydrocarbon deposits are considered suitable sites for storage. The procedure to identify the exploitable storage areas (among those considered suitable) has started, but the related strategic environmental assessment (SEA) has not been completed. Authorisations are issued to the requesting parties with a single procedure (including an environmental impact assessment). There have not been any applications for CO_2 storage authorisations or exploration licences so far.

Eni plans to create the world's largest CCS hub by exploiting decommissioned gas fields off the coast of Ravenna (Emilia-Romagna Region). The Ravenna Hub would have an initial storage capacity of 4 Mt/year, to be extended to 10 Mt/year, for a total storage capacity of 500 Mt CO_2. The first storage is expected in 2026.

Hydrogen

Italy's policy focus on developing hydrogen has increased in recent years. Italy has been investing in research and development (R&D) for hydrogen deployment and participates in several international research projects, including Important Projects of Common European Interest and Mission Innovation (see Chapter 6). The natural gas crisis generated by Russia's invasion of Ukraine has heightened the attention on hydrogen not only as a decarbonisation option but also as an alternative energy carrier to increase security of supply.

In 2020, the MiTE released preliminary hydrogen guidelines (*Strategia Nazionale Idrogeno: Linee Guida Preliminari*) as a basis for consultation before approval of a final national hydrogen strategy. The strategy was expected to be finalised in 2021, but the process was delayed. The preliminary hydrogen guidelines indicate that up to 2% of natural gas could be replaced by hydrogen by 2030. The guidelines estimate that hydrogen can account for 2% of FEC by 2030, thereby cutting about 8 Mt CO_2, and for 20% of FEC by 2050, saving 97 Mt CO_2. The LTS integrates hydrogen in its decarbonisation options.

According to the LTS, by 2050, hydrogen is projected to be used mostly in the transport sector and to produce synthetic fuels, as well as in hard-to-abate industrial sectors and, to a lesser extent, for heating in buildings (blended with biomethane in the gas network). Hydrogen would be produced by using excess electricity generated from variable renewable sources, thereby providing system flexibility.

The NECP does not quantify the share of hydrogen in the 2030 national and sectoral energy mixes, nor does it include specific targets. The more ambitious targets of the proposed EU FF55 package will likely require accelerating hydrogen deployment. According to preliminary modelling results by RSE, achieving the EU FF55 targets would require using 0.63 Mtoe (26.4 PJ) of renewable-based hydrogen by 2030. This would imply producing 219 kilotonnes of hydrogen, needing about 9 TWh of renewable electricity, or 5-7 GW of additional renewables capacity by 2030 (see Chapter 5). Access to low-cost renewable electricity will be the most important factor in driving hydrogen costs down.[12]

In the short term, the NECP and the preliminary hydrogen guidelines foresee the application of hydrogen in the transport sector, in particular, long-haul road freight and non-electrified railways; in the industrial sectors in which hydrogen is already used as feedstock (e.g., chemicals and oil refining); and as hydrogen blending in the gas grid. The government foresees the installation of 5 GW of electrolysis capacity by 2030 to produce the hydrogen necessary to meet the increasing demand.

As of 2021, there were 13 hydrogen-powered buses, 45 passenger cars and just 1 refuelling point in Italy (EC, 2022b). These are relatively low numbers compared to other European countries.[13] The NRRP states the ambition of covering 5-7% of domestic road fuel demand with hydrogen by 2030. However, consideration should be given to prioritising the use of hydrogen in railways (Italy, MIMS, 2022). This could be a more cost-effective solution in the Italian context, where 28% of railways still use diesel (especially in the south of the country).

Developing hydrogen as indicated by the preliminary guidelines would require about EUR 10 billion in investments until 2030. The NRRP provides EUR 3.6 billion until 2026 for the hydrogen roll-out (Table 3.2). The NRRP also foresees filling the regulatory gap about hydrogen deployment. It commits the government to lay out, among others, the technical safety regulations, the administrative procedures for realising renewable-based hydrogen production plants and refuelling stations, and a system of guarantee of origin. In addition, the government is tasked with designing incentives for renewable-based hydrogen production and the use of hydrogen in transport.

The government believes that Italy could build on its strong gas network and interconnections to become the European hydrogen hub and act as a “bridge” between Europe and North Africa, where hydrogen can be produced from solar energy at lower costs. The preliminary hydrogen guidelines suggest the possibility of a progressive reconversion of natural gas infrastructures for transport and distribution for gas-hydrogen mixtures and, later, for pure hydrogen.

[12] The cost of producing renewables-based hydrogen varies between 3 USD/kilogramme (kg) and 6.55 USD/kg, compared to 1.80 USD/kg for producing unabated fossil-based hydrogen and 2.40 USD/kg for hydrogen produced from fossil fuels combined with CCS.

[13] For comparison, as of 2021, France had 1 bus, 396 passenger cars and 19 refuelling points; Germany had 87 buses, 1 236 cars and 19 refuelling points (EC, 2022b).

In 2019-2020, the gas transmission system operator (TSO), Snam, piloted hydrogen-natural gas blending in its infrastructures, with shares of 5% and 10% of hydrogen. According to Snam, 70% of its gas network was compatible with hydrogen transport as of 2021. About half of the EUR 7.4 billion investments outlined in Snam's development plan 2020-2024 target the upgrade and development of infrastructure compatible with hydrogen transport.

However, the cost of hydrogen transport and storage is high compared to other fuels (such as biomethane), and storage facilities are limited in Italy (Gaeta, Nsangwe Businge and Gelmini, 2021). In the Italian context, it appears more cost-effective to prioritise hydrogen use in industry rather than developing a distribution network for hydrogen. In this case, hydrogen production plants could be located close to the industrial facilities they serve, while transporting the renewable electricity necessary to produce hydrogen via the grid (Italy, MIMS, 2022).

Table 3.2 Hydrogen-related investment in Italy's National Resilience and Recovery Plan

Projects	Allocation of public funds (EUR billion)	Expected outcomes
Hydrogen use in hard-to-abate industry (refinery and steel)	2.00	Decarbonise at least one industrial plant
Production of green hydrogen in brownfield sites (hydrogen valleys)	0.50	10 projects of renewable electricity plants for the production of hydrogen, with an average capacity of 1-5 MW each
Hydrogen production plant	0.45	1 large electrolysis plant, with a capacity of 1 GW
Piloting hydrogen use in road transport	0.3	9 refuelling stations for trains along 6 non-electrified railway lines
Piloting hydrogen use in road transport	0.23	40 refuelling stations on highways, logistic terminals and ports
Research and development	0.16	At least 4 research projects on production, storage and distribution of hydrogen

Source: Italian Government (n.d.).

Adaptation and resilience to climate change

Italy has been experiencing tangible impacts of climate change. In the last three decades, the country's mean temperature has increased more than the average global temperature. Italy's mean temperature increased by 0.39°C per decade between 1981 and 2019. The year 2020 was 1.54°C warmer than on average in 1961-90, compared to an average increase in global temperature of 1.44°C (ISPRA, 2021b). Average annual rainfall has decreased slightly but the number of heavy episodes per year has increased. There is evidence that higher temperature has led to glacier melting. According to climate projections by the Italian National System for Environmental Protection, these impacts are

likely to worsen by the end of the century. Climate change is also expected to increase the frequency and extension of wildfires, thereby reducing forest sink capacity.

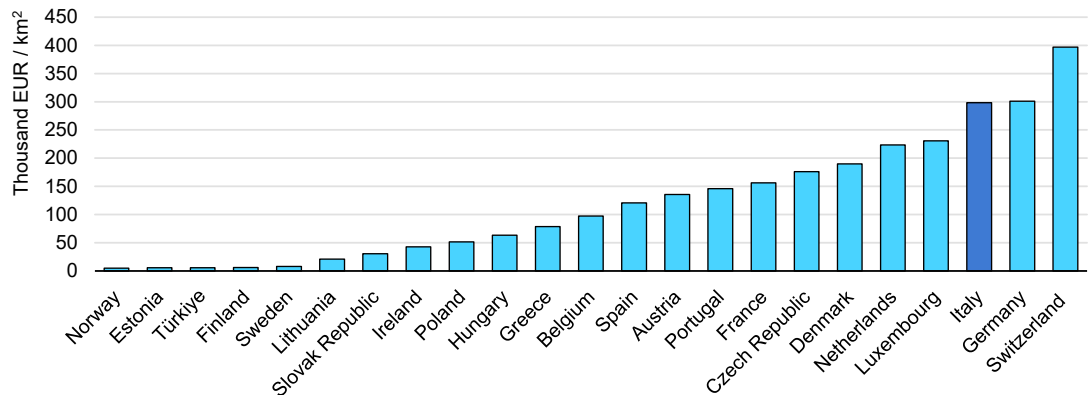
Italy has experienced various extreme weather events that can be related to climate change, including floods, drought, heatwaves and strong wings. Between 2010 and 2020, there were 946 intense weather phenomena, 251 victims and 50 000 displaced people. The number of events grew in the decade (Legambiente, 2020). The country's economic losses from extreme weather events are among the highest in Europe (Figure 3.7).

Some of these extreme weather events affected energy infrastructure, including the electricity grids, especially in the northern and central regions of the country. Thousands of households endured long blackouts due to heavy rains or snowfall and falling trees on power lines (IEA, 2022c). Damages were higher in inland areas, where the population is on average older and the risks caused by a prolonged interruption of supply particularly serious.

Current damage to energy infrastructure is estimated at EUR 40 million per year. This is projected to grow by 13 times by 2050 (Italy, MIMS, 2022). The temperature change has already affected hydropower production. The ratio between hydropower generation and installed capacity has significantly dropped over the century due to a decline in water resources, including because of glacier melting. In 2011-19, this ratio was 35% below the level in 1931-40 (ISPRA, 2022d). This shows how tackling climate change is also a matter of energy security.

The major climate risks and impacts on the Italian energy system include reduced electricity generation from thermoelectric and hydropower plants, as well as wind turbines, due to changes in hydrological cycles and wind conditions and average temperature increases. In 2022, an exceptionally dry year, hydropower generation could be 60% lower than historical averages (Assoidroelettrica, 2022). The higher frequency and intensity of heat waves expected for the Mediterranean area are likely to increase electricity consumption for cooling in the summer, with associated blackout risks (Italy, Ministry of Economic Development, Ministry of the Environment and Protection of Natural Resources and the Sea, and Ministry of Infrastructure and Transport, 2019).

Figure 3.7 Losses from extreme weather events in European IEA countries, 1980-2020



Italy ranks among the European countries that report the highest economic losses from extreme weather events.

Source: IEA based on data from EEA (2022b).

Following the adoption of the National Strategy for Adaptation to Climate Change, in 2016 the government started developing the National Plan on Adaptation to Climate Change (NPACC), as the main tool for implementing the strategy. The NPACC was still undergoing the SEA process at the time of writing. The draft NPACC identifies various measures to improve the resilience of the energy system, including: developing micro grids and smart grids to encourage self-generation in urban communities and industrial districts; improving interconnections with European networks to offset the use of discontinuous renewable sources; using an energy mix that guarantees the ability to adapt to extreme climate situations; improving energy efficiency and managing energy demand; and climate proofing of new buildings.

In 2021, Terna, the electricity TSO, developed the new Resilience 2.0 methodology to evaluate interventions to increase the resilience of the national transmission grid. The new methodology allows identifying the areas where network infrastructures are most vulnerable, determining the probability of faults caused by different types of weather events, and assessing their impact on the electricity system. Interventions for increasing the resilience of the electricity system include preventive upgrades of the infrastructure as well as measures and tools to manage emergencies and promptly recover normal service in the case of outages.

The 2021 Grid Development Plan outlines several investments to strengthen sections of the grid and prevent and mitigate outage risks. The NRRP allocates EUR 500 million to interventions aiming to increase the resilience of at least 4 000 km of the power grids in the event of strong winds, falling trees, ice, heat waves, floods and hydrogeological risks. Projects should be selected by the end of 2022 and completed by 2026.

Assessment

EU requirements have been the main driver of Italy's climate and energy policies. The 2019 NECP sets national targets for 2030 on energy efficiency, renewable sources and GHG emissions. The NRRP is expected to contribute to reaching the NECP's targets. Italy will have to update its NECP in 2023 and align it to the European Green Deal goal of reducing net GHG emissions by 55% by 2030 (from 1990). The NECP review provides an unmissable opportunity to enhance and accelerate the clean energy transition while strengthening security of supply.

One of the main challenges for achieving the Paris Agreement goals is the rapid pace required for the energy transition. Carbon neutrality by 2050 is not enough; there is also a limited carbon budget available until 2050 and developed countries should lead by example. It is therefore essential that within the next few years Italy put in place the regulatory reforms, incentive mechanisms and public investment needed to curb GHG emissions in line with the 2030 target. In addition, a package of measures should be implemented to address the social consequences of the transition in a targeted and cost-effective manner. Together, this would put the country on the right path towards climate neutrality in 2050 and lower the social and economic costs of the transition. The government should consider following the example set by other IEA member countries and develop and approve a national climate law that enshrines in legislation the long-term carbon-neutrality goal, defines mechanisms to set intermediate targets and monitor progress towards them, allocates responsibilities and introduces accountability instruments for achieving the targets, and establishes an independent advisory body to

support policy making and review implementation and progress. It would create powerful climate governance and foster investment certainty.

The radical transformation needed to achieve carbon neutrality calls for actively engaging local governments, households and businesses in climate action, as well as for stronger inter-institutional co-operation.

Progress towards climate mitigation targets and outlook

Italy's GHG emissions have declined at a faster pace than the EU average since 2005. GHG emissions (without LULUCF) were 381 $MtCO_2$-eq in 2020, or 35% below the 2005 level. Energy-related CO_2 emissions account for the bulk of Italy's GHG emissions. Emissions fell with the country's double-dip recession in 2008-13, continued to decrease during the ensuing mild economic recovery and plummeted in 2020 with the Covid-19 pandemic. Overall, energy-related CO_2 emissions declined faster than GDP and total energy supply, reducing the carbon intensity of Italy's economy and energy mix.

The drivers of emissions reductions include: the shift from coal to natural gas in electricity generation and some industrial sectors; increased use of renewables; and more efficient end-use devices. Power plants and industry respectively contributed to abating 42% and 30% of energy-related CO_2 emissions in 2005-19. Lower use of coal was responsible for a quarter of emissions reductions in the same period. Emissions from transport and buildings decreased less and more slowly than in the energy and manufacturing industries until 2019. Transport emissions plunged in 2020 due to the lockdowns to contain the pandemic.

As a result, emissions covered by the EU ETS (from energy industries, energy-intensive manufacturing and aviation) declined by 44% in 2005-2020, more than the emissions excluded from carbon trading (from transport, small industrial facilities, buildings, agriculture and waste). Nonetheless, Italy overachieved its annual targets for non-ETS emissions in all years from 2013 to 2020. However, according to preliminary data, total GHG emissions rebounded strongly and above expectations in 2021 (+6.8%), due to economic recovery and rising road transport.

Meeting the more ambitious 2030 targets under the European Green Deal requires accelerating the pace of emissions reductions. Fully implementing the existing and planned measures outlined in the NECP will not be sufficient to achieve Italy's 2030 target in non-ETS sectors. The EU's FF55 package (under negotiation) proposes to raise this target from 33% to 43.7% from the 2005 level. In addition, net GHG emissions will have to decline at an average annual rate of 4% in 2020-30 to be in line with the -55% target. This is higher than the average annual decrease of 3.1% from 2010 to 2020, during which the country endured two deep economic crises that affected emissions. With the EU ETS currently covering about a third of national GHG emissions, most of Italy's emissions should be abated through domestic measures.

Therefore, in addition to phasing out coal and increasing the use of renewables in all sectors, Italy should strengthen its efforts to reduce energy demand in transport, buildings and industry. The energy and carbon intensities of industry are low but have shown little, if any, progress since 2017. Transport was the largest source of GHG emissions in 2019. Its emissions are projected to decline significantly only after 2030, when EVs are expected to account for a large part of the fleet. The recent energy efficiency incentives have accelerated the buildings renovation rate, but the pace is not fast enough. In addition to

stimulating the uptake of more efficient technologies, Italy should put in place policies and infrastructure to encourage less energy- and carbon-intensive consumption and mobility patterns.

Looking ahead to 2050, achieving climate neutrality is an extraordinary challenge for Italy, like for many other countries. According to the 2021 LTS, Italy will need to radically transform the energy system by reducing energy use, electrifying end-uses, and fully shifting to renewables for electricity and heat generation. Alternative fuels (such as biomethane and hydrogen) will be needed in transport and some industrial sectors for which electrification is not technically or economically viable. CCS will be necessary to offset residual emissions, primarily deriving from industrial processes. Natural sink capacity should be expanded.

Carbon pricing

Italy puts a price on CO_2 emissions via the EU ETS and taxes on energy products. It does not apply an explicit carbon tax. As a result of high energy taxes, the average effective tax rate on CO_2 emissions from fuel combustion is the second highest among G20 economies (93.99 EUR/t CO_2). Accounting for both energy taxes and the EU ETS, in 2021 Italy priced about 85% of its CO_2 emissions from energy use. This is among the highest share of emissions priced in G20 countries. High effective carbon rates have provided relatively strong incentives to reduce the energy and carbon intensities of the Italian economy.

However, recent estimates indicate that a carbon price of 100-250 USD/t CO_2-eq is needed to reduce emissions to net zero by 2050. In Italy, more than 75% of total GHG emissions are taxed at lower rates. Introducing a carbon tax in sectors outside the ETS would help accelerate the pace of emissions reductions in these sectors in line with the higher target proposed by the FF55 package. As Italy already has high energy prices, the carbon tax rate could be set at an initially low level to replace part of the current excise duties. This would avoid creating immediate price pressure in a context where families and businesses are already struggling to pay their energy bills. A schedule of gradual rate increases would provide a predictable price signal to investors and households. To mitigate the potential regressive effect, the carbon tax should be accompanied by targeted support to vulnerable households, awareness-raising and education campaigns, and financial and technical assistance for improving energy efficiency.

Between 2014 and March 2022, auctioning of ETS allowances contributed EUR 9.6 billion to Italy's state budget. Italy has not systematically met the EU requirement of spending half of the allowance revenue on climate-related actions. In addition, allocations to programmes and measures have been inconsistent over time, which creates uncertainty and discourages investment.

Carbon capture and storage

As Italy is most likely going to rely on fossil fuels for at least part of its electricity generation beyond 2030, and in industry also after 2050, carbon-removing technologies are needed to achieve carbon neutrality. However, CCUS has little role in Italy's climate mitigation strategy. While using CCS technologies is technically possible, there is strong resistance from the public, largely due to the medium-high earthquake risk and the need to realise additional infrastructure for CO_2 transport.

Depleted hydrocarbon deposits offshore are considered suitable sites for storage in Italy. The legislation that regulates the authorisation procedures relating to the geological storage of CO_2 dates back to 2011 and is limited to the experimental phase. Such a legislative gap hinders the implementation of industrial application of CCUS.

The role of hydrogen

Policy focus on developing hydrogen has increased in recent years. The natural gas crisis generated by Russia's invasion of Ukraine has heightened the attention on hydrogen not only as a decarbonisation option but also as an alternative energy carrier to increase security of supply.

In 2020, the MiTE released preliminary hydrogen guidelines. A final national hydrogen strategy was expected to be adopted in 2021, but the process was delayed. In the short term, Italy foresees the application of hydrogen for road freight and railways, in the industrial sectors that use hydrogen as feedstock, and blended in the gas grid. The preliminary guidelines estimate that hydrogen can account for 2% and 20% of final energy demand by 2030 and 2050, respectively. The investment needs in the 2020s are estimated at EUR 10 billion. The NRRP provides substantial funds for R&D on hydrogen technology and industrial applications (EUR 3.6 billion until 2026). Italy has been investing in hydrogen R&D to overcome the technological barriers to, and reduce the costs of, renewable-based hydrogen production and use.

The government believes that Italy could build on its strong gas network and interconnections to become a hub for renewable-based hydrogen produced in North Africa at a lower cost. The preliminary hydrogen guidelines suggest the option of progressively converting natural gas infrastructures for the transport and distribution of hydrogen, initially mixed with natural gas. Snam, the gas TSO, plans large investments to prepare its network for hydrogen transport. However, given the high costs and safety concerns of hydrogen transport and storage, it could be more efficient to prioritise the use of hydrogen in hard-to-abate sectors, such as some industrial processes. Overall, the integration of hydrogen into Italy's future energy mix requires further technical and economic analysis.

Adaptation to climate change

Italy has experienced tangible impacts of climate change, with serious human and economic losses. Increased intensity and frequency of extreme weather events are likely to affect the energy networks and electricity production capacity. The warming expected in the Mediterranean area is likely to increase electricity consumption for cooling in the summer, with associated blackout risks. According to a study for the Italian government, the actual impact of climate change on energy infrastructure is estimated to cost EUR 40 million per year and is expected to increase more than tenfold by 2050.

In 2016, the government started developing the NPACC as the main tool for implementing the national adaptation strategy. The draft plan identifies various sensible measures to improve the resilience of the energy system. However, the plan had not been approved at the time of writing.

Terna, the electricity TSO, developed a new methodology to evaluate interventions to increase the resilience of the national transmission grid. The 2021 Grid Development Plan outlines several investments to strengthen sections of the grid and prevent and mitigate outage risks. The NRRP allocates EUR 500 million for increasing the resilience of power

grids, which is welcome. However, such investments should be better co-ordinated and included in a comprehensive package of adaptation measures for the energy system (including gas infrastructure) and beyond (e.g., measures to address hydrogeological risk).

Recommendations

The government of Italy should:

- Strengthen the focus on reducing final energy demand in transport, buildings and industry in the revision of the National Energy and Climate Plan.
- Reform the excise duty system to reflect the carbon intensity or the carbon content of energy products; raise the duty gradually according to a pre-determined schedule; and recycle part of the revenues to support vulnerable households and invest in climate mitigation action.
- Ensure that at least half of the revenue from auctioning Emissions Trading System allowances is consistently allocated to targeted climate actions; identify a few programmes and measures to be funded with priority to ensure stability of financing over time.
- Assess and clarify the role of carbon capture and storage in achieving the climate targets for 2030 and 2050; and adopt legislation to allow industry to implement projects at a commercial scale.
- Promptly develop and adopt a full-fledged national strategy for hydrogen deployment in the short, medium and long term, with a focus on hard-to-abate sectors; ensure that the updated National Energy and Climate Plan is consistent with the strategy.
- Finalise the National Plan on Adaptation to Climate Change as a matter of urgency; ensure that any investment in increasing the climate resilience of energy infrastructure is part of a coherent package of adaptation measures; include resilience to climate impacts in the assessment of energy infrastructure projects.

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4. Energy efficiency

Key data

(2021)

TFC: 4 895 PJ (oil 37.2%, natural gas 30.0%, electricity 21.5%, bioenergy and waste 7.6%, heat 2.7%, coal 0.8%), -9% since 2021

TFC by sector: buildings 40.1%, industry 29.7%, transport 30.2%

TFC per GDP: 2.15 MJ/USD (IEA average in 2020: 2.66 MJ/USD), -6% since 2011

TFC per capita: 82.8 GJ/capita (IEA average in 2020: 112.8 TJ/capita), -7% since 2011

Source: IEA (2022a).

Overview

Italy shows a decoupling of economic growth and energy consumption since 2010. However, this appears to be partly driven by the economic downturn and fallout from the Covid-19 pandemic on economic activity and mobility.

Based on consumption data for 2020, Italy is well on its way to reaching the energy efficiency targets set for 2030 in its NECP. However, data for 2021 show that energy consumption bounced back to 2019 levels, and as the economy starts recovering from the current dual crisis, reaching the 2030 targets may become more challenging. Moreover, current policy measures may not be sufficient to realise the likely increased ambitions for energy efficiency under the EU FF55 policy, the legislative process of which has not yet been finalised, and enhanced efforts across all sectors are required.

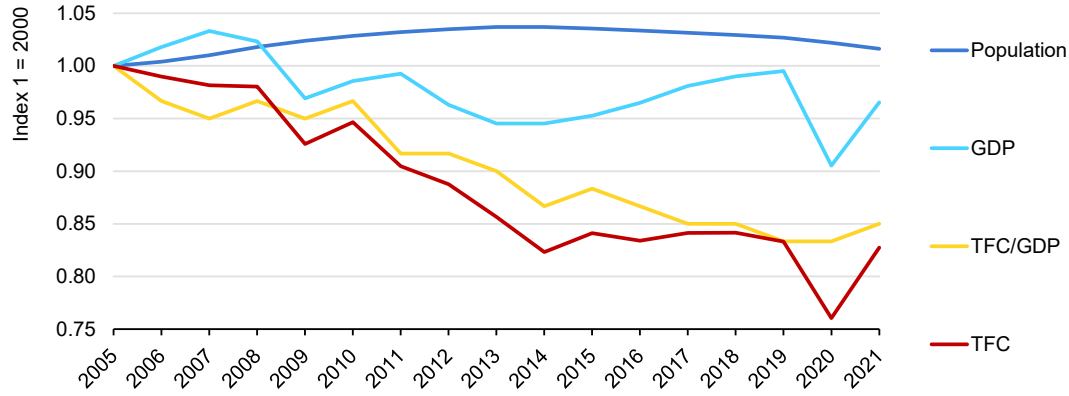
Natural gas is the second-largest fuel in TFC after oil, and Italy relies heavily on gas imports from Russia. Italy aims to become independent from Russian gas imports by 2025 Improving energy efficiency, especially in the building sector, will be an important contribution to reducing and eventually ending Italy's dependence on Russian gas.

Energy demand

Italy's TFC broadly followed the trend in GDP until 2010. Since then, energy demand has progressively decoupled from economic performance. The final energy intensity of the economy (as measured by the TFC/GDP ratio) declined by 7% between 2011 and 2021 (Figure 4.1). TFC decreased at a faster pace than GDP during the economic recession between 2010 and 2013, mainly due to a drop in industrial energy use over the same period. Energy demand tended to stabilise in all sectors between 2014 and 2019, then fell markedly in 2020 as a result of the Covid-19 pandemic. The drop was particularly steep in

the transport sector, due to the restrictions on mobility (Figures 4.1 and 4.2). In 2021, TFC bounced back to a level similar to that of 2019, driven by the rebound of transport sector demand.

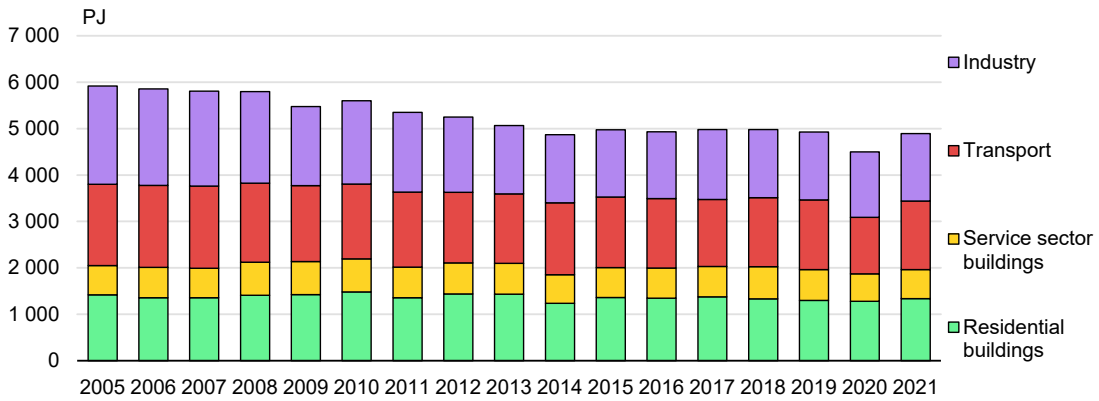
Figure 4.1 Energy demand and drivers in Italy, 2005-2021



The energy intensity of the economy declined by 17% between 2005 and 2021. TFC dropped by 9% in 2020 but strongly rebounded in 2021.

Source: IEA (2022a).

Figure 4.2 Total final consumption by sector in Italy, 2005-2021



The decrease in demand from 2005 to 2019 came mainly from the industry sector, while in 2020 demand in the transport sector dropped sharply due to the Covid-19 pandemic.

Note: industry includes non-energy use. Non-energy use refers to fuels used as raw materials, and not used as fuel or transformed into another fuel. This comprises typically raw materials used in the chemical and petrochemical sector.

Source: IEA (2022a).

Road transport (passenger and freight) and residential space heating are the largest final consumers of energy in Italy. They both heavily rely on fossil fuels, namely natural gas for heating and oil for transport. In addition to reducing energy consumption in these sectors, there is large scope for shifting to renewable electricity to lower the CO_2 footprint of these sectors.

Energy efficiency policy and targets

Italy set energy efficiency targets to 2020 and 2030 as required by the EU EED.[1] The 2017 National Energy Efficiency Action Plan (NEEAP) and the 2019 NECP set the targets and supporting policy measures to 2020 and 2030, respectively (Table 4.1).

Table 4.1 Primary and final energy consumption, status and targets in Italy

(PJ)	2019 status	2020 status	2021 status	2020 targets (NEEAP)	2030 targets (NECP)	2030 tentative levels (FF55)
Primary energy consumption	6 108	5 540	6 084	6 615	5 238	4 681
Final energy consumption	4 836	4 302	4 742	5 197	4 346	3 936

Sources: Eurostat (2022a); EC (2017); Italy, Ministry of Economic Development, Ministry of the Environment and Protection of Natural Resources and the Sea, and Ministry of Infrastructure and Transport (2019); information provided by RSE during the review visit.

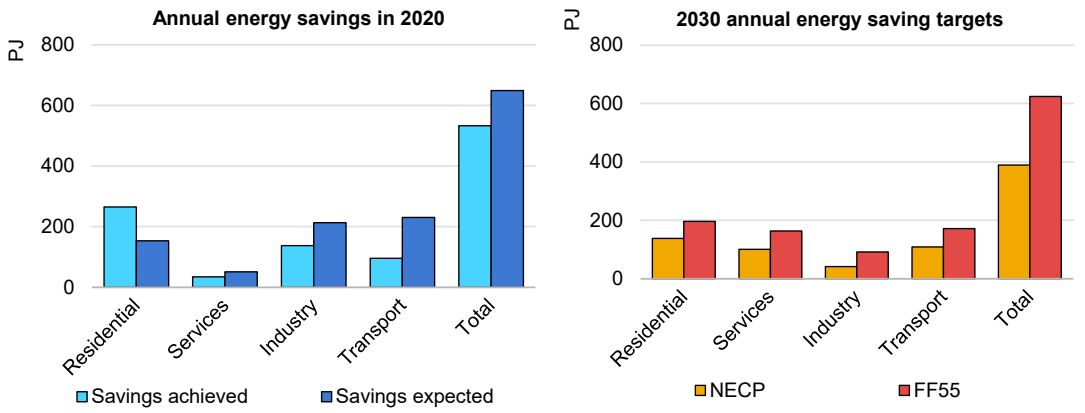
According to Eurostat definitions, Italy achieved its 2020 targets for PEC and FEC already in 2012. In 2020, PEC and FEC were about 16% below the 2020 targets and close to the 2030 target defined by the NECP (Table 4.1 and Figure 4.3). However, 2020 was an exceptional year, when energy consumption plummeted due to the Covid-19 crisis. In 2021, energy demand rebounded to levels similar to 2019, but did not exceed the target levels set for 2020. In addition, some lifestyle changes brought about by the Covid-19 pandemic can entail higher energy consumption (e.g., lower use of public transport and more residential energy use due to teleworking), but it is unclear to what degree those changes will be permanent. Staying on course towards the 2030 target set by the NECP will require additional cuts in energy use. Even more so, the revised targets for 2030 in line with the EC's proposed FF55 package are expected to be much more ambitious and challenging to achieve (see Table 4.1).

As a contribution to the 2020 FEC target, the 2017 National Energy Strategy and NEEAP set a target of 649 PJ/year (15.5 Mtoe/year) to be achieved by 2020 through selected energy efficiency measures. By 2020, the annual energy savings achieved were of 533 PJ/year (12 Mtoe/year), 18% less than the target. While the residential sector surpassed the target, other sectors fell short. Transport was the furthest from the target with only 42% of the targeted savings achieved (Figure 4.3).

[1] Directive 2012/27/EU on energy efficiency, as amended by Directive (EU) 2018/2002.

As required by Article 7 of the EU EED, Italy had a target of achieving cumulated energy savings of 1 068 PJ (25.5 Mtoe) between 2014 and 2020.[2] Several measures were put in place to achieve this target, but the government fell short by 9%, achieving 971 PJ (23.24 Mtoe) of notified energy savings in 2020. The largest part of these savings (45%) came from tax deduction measures for energy efficiency measures in buildings, followed by the white certificates scheme (36%) (see below).

Figure 4.3 Achieved and expected savings in 2020 based on the 2017 NEEAP; and NECP and likely target under FF55 for Italy for 2030



Note: The Fit-for-55 targets are tentative, based on estimates provided by RSE.

Sources: ENEA (2021a); Italy, Ministry of Economic Development, Ministry of the Environment and Protection of Natural Resources and the Sea, and Ministry of Infrastructure and Transport (2019); information provided by RSE during the IEA team visit in April 2022.

As required by the EED, the NECP sets a cumulative energy savings target of 2 152 PJ (51.4 Mtoe) to be achieved between 2021 and 2030. This corresponds to 390 PJ (9.3 Mtoe) of energy savings in 2030, 35% of which is expected to be achieved in the residential sector (Figure 4.3). The transport sector is estimated to contribute more than a quarter of the savings. The largest energy savings are expected to come from the white certificates scheme, tax incentives for energy renovation of buildings and measures in the transport sector (see the following sections). The NECP expects to exceed the target and save 2 403 PJ (57.4 Mtoe) of energy between 2021 and 2030, based on the proposed energy efficiency policy measures (Italy, Ministry of Economic Development, Ministry of the Environment and Protection of Natural Resources and the Sea, and Ministry of Infrastructure and Transport, 2019).

The proposed revision of the EED (as part of the EU's FF55 package) raises the annual energy savings targets to be achieved through energy efficiency policy measures until 2030.[3] If the proposed targets are confirmed, Italy will be required to save 3 081 PJ (73.6 Mtoe) of energy over the period 2021-30 and 624 PJ (14.9 Mtoe) of energy in 2030.

[2] According to Article 7 of the EED, each EU member state shall achieve from 2014 to 2020 new energy savings of 1.5% annually of the average annual energy sales to final customers in 2010-12. Between 2021 and 2030, each EU country shall achieve new annual energy savings for 0.8% per year of the average annual final energy consumption in 2016-18.

[3] The proposed revised EED nearly doubles the annual energy savings obligation to be achieved via energy efficiency policy measures. EU countries must achieve additional savings of 1.5% per year of the average annual final energy consumption in 2017-19, in the period from 2024 to 2030.

This would require targeting the most cost-effective energy efficiency measures. In particular, according to estimates by RSE, Italy would need to more than double energy savings in industry and boost savings in the commercial sector by 62% to achieve the possible revised 2030 targets that are currently discussed (Figure 4.3). ENEA (2021a) highlights that improving the energy efficiency of private buildings and transport will require substantial additional funding.

The instruments proposed by the NECP to stimulate investments and the uptake of more energy-efficient equipment and technologies do not differ from those implemented under the NEEAP, but the incentives are higher. The instruments include white certificates and tax incentives for building renovations and purchasing zero-emission vehicles (see the following sections). The NRRP allocates EUR 14 billion to energy efficiency and renovation of buildings, EUR 8 billion to sustainable mobility, and EUR 24.7 billion to investment in the rail network to increase the energy efficiency of transport (EC, 2021; see Chapter 2). It will be critical to engage local governments, households and businesses, as the success of several measures requires the willingness of citizens and businesses to invest to reduce energy use.

Energy efficiency in buildings

Energy use in buildings has hovered around the same level for most of the last decade and started to decline in 2017, in part as a result of energy efficiency measures. Residential buildings energy demand is almost twice that of service sector buildings, and accounts for 68% of buildings' TFC in 2021 (Figure 4.4). From 2005 to 2021, natural gas was the main source of energy in buildings (51% in 2021). The second-largest source of energy for buildings is electricity (27% in 2021), accounting for nearly half of energy in service sector buildings. Bioenergy and waste supplied 14% of energy to buildings in 2021. The use of oil has been continuously decreasing and accounted for 5.2% in 2020. Solar thermal represents a negligible share of buildings energy use (0.5%), despite the high solar radiation in most regions of the country (see Chapter 5).

Space heating is the largest energy use in residential buildings. It accounts for 66% of the energy used in Italian homes (Figure 4.5), compared to the IEA average of 53%. Natural gas accounts for 60% of the energy used for space heating, as well as for 65% of water heating and 69% of the energy used for cooking, all higher shares than the average in IEA countries.[4] Reliance on natural gas implies that space heating in 2020 accounted for 13% of CO_2 emissions from energy use, compared to 8% in the IEA as a whole (IEA, 2022b). This indicates that improving the thermal efficiency of buildings, as well as shifting to electricity and less carbon-intensive energy carriers, should remain a priority. This is also essential to reduce dependence on imports of natural gas from Russia.

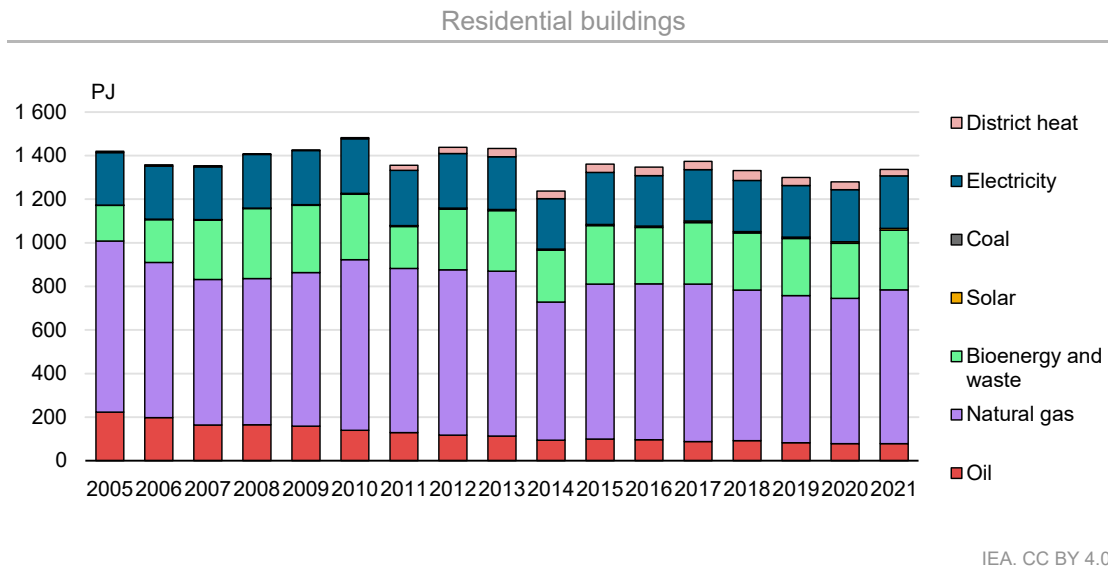
In 2020, district heating accounted for less than 3% of buildings energy demand, with a total installed thermal capacity of 9.65 GW. Heat plants using renewable fuels are only 8% of the installed capacity. District heating networks serve 282 municipalities, mostly in the northern regions of the country. The NRRP allocates EUR 200 million to projects for the construction of new networks or the extension of existing ones, with priority given to heat generation from renewable energy sources, waste heat, or co-generation of electricity and

[4] On average, in the IEA natural gas accounts for 54% of space heating, 53% of water heating and 39% of energy used for cooking.

heat. With these resources, the NRRP aims to develop 300 km of efficient district heating networks and 360 MW of newly installed thermal capacity, achieving 0.8 PJ of energy savings per year.

Italy issued a Strategy for Energy Retrofitting of the National Building Stock in March 2021 (Italy, MiTE, 2021). Buildings are expected to contribute around 60% of the annual final energy savings target to 2030 and the strategy sets out the technical, financial and regulatory measures to achieve it. In 2018, there were 12.4 million residential buildings in Italy, with a total surface of more than 3 billion m^2. More than 65% of buildings were built before the first law on energy efficiency (1976) and 22% of the total residential building stock is not occupied. In addition, close to 1.6 million buildings are being used for non-residential purposes.

Figure 4.4 Total final consumption by source in buildings in Italy, 2005-2021



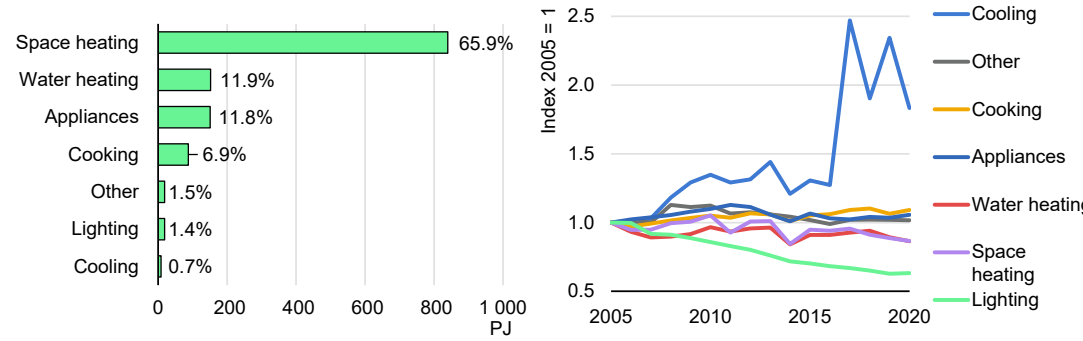
Energy demand from buildings has fluctuated since 2005. Natural gas is the main source for residential buildings, while service buildings have a higher share of electricity.

Source: IEA (2022a).

Since 2006, an energy performance certificate (EPC) is required for new constructions, sales or rental of a building. However, the issuance of an EPC does not automatically result in investments to improve energy performance. Analysis from 2019 shows that of 1.55 million EPCs registered in Italy's national EPC information system, only 3.7% related to major renovations and 2.7% to energy retrofitting, while 3.4% of registered EPCs were for newly constructed buildings; the remainder was for a transfer of ownership or rental purposes. Overall, 37% of EPCs for residential dwellings have the lowest energy performance class (G class), on a scale ranging from G to A4, and another 25% have an F rating. Of the non-residential dwellings, 22.6% are rated G and 15.5% are rated F, pointing towards a substantial potential for energy efficiency improvements (Italy, MiTE, 2021).

Italy issued a ministerial decree in 2015 for nearly zero energy buildings (nZEB). As of 31 December 2019, new buildings occupied and owned by public authorities should be nZEB. And since the beginning of 2021, all new buildings and buildings undergoing major renovation should align with nZEB standards. At the end of 2020, Italy's total nZEB stock was 7 831, 96% of which were residential and 4% for non-residential use. At the end of 2021, the estimated total number of buildings with nZEB standards was in the range of 15 000 (Italy, MiTE, 2021).

Figure 4.5 Residential energy consumption by end-use in Italy, 2020 and 2005-2020



Space heating accounts for two-thirds of energy use in homes. Energy use for heating has declined, but that for cooling has boomed in recent years, although from low levels.

Source: IEA (2022b).

Incentives for energy retrofitting of buildings

To achieve the targets set in the NECP and reach the total decarbonisation of the building sector by 2050, Italy needs to retrofit 2.6% of the residential and tertiary[5] building stock annually from 2020 to 2050 (Italy, MiTE, 2021). A key policy instrument for retrofitting are tax rebates to support the renovation of private buildings and direct subsidies for public buildings. Tax deductions for the energy renovation of buildings were introduced in 2007. Under the so-called Ecobonus, individuals and businesses may deduct from their income tax a percentage of the expenditure incurred for certain types of energy upgrading works on existing buildings. Deduction rates vary (from 50% to 90%) based on the type of project to better link the incentive to the costs and the energy savings that can be achieved from the intervention. From 2014 to 2020, the Ecobonus mobilised EUR 23.6 billion of

[5] The tertiary sector comprises offices, hotels, schools, hospitals and commercial buildings.

investments for approximately 2.6 million interventions, with corresponding energy savings of around 8 500 GWh/(5 PJ)/year (ENEA, 2021b).

To stimulate economic recovery after the Covid-19 crisis, especially in the construction sector, and promote energy efficiency, the Italian government launched the so-called "Superbonus 110%" in 2020, building on the existing Ecobonus, with a tax deduction rate increased to 110% of the incurred expense. To be eligible for the 110% tax deduction, investments need to occur between 1 July 2020 and 31 December 2022. The deduction decreases to 90% for expenses incurred in 2023, 70% for expenses incurred in 2024 and to 65% for expenses incurred in 2025.

As of October 2022, 326 819 interventions had been approved, for a total investment of EUR 55 billion and a total cost for the state budget of EUR 60.5 billion. The government had originally budgeted EUR 33.3 billion and refinanced the mechanism to accommodate the strong demand (ENEA, 2022a). To be eligible for the 110% deduction, the renovation works must improve the building's energy performance by two classes, or reach the highest class, in addition to meeting other conditions. The improvement must be notified with EPCs released before and after the interventions.

The NRRP foresaw energy savings of 190 thousand tonnes of oil equivalent (ktoe) (7.95 PJ) per year in the residential sector through the Superbonus 110%. However, based on ongoing surveys (to be published in 2023) the annual savings are around 34 PJ (810 ktoe), in addition to the installation of photovoltaic power for 1.9 GW. For 2022 and 2023, the Superbonus is expected to achieve about one-third of the annual energy savings in the residential sector targeted in the NECP and one-third of the annual renovation target (in square metres) set by Italy's Long-Term Renovation Strategy (EC, 2021). The NRRP allocates EUR 13.95 billion for this, which is more than one-quarter of the budget allocated by the NECP for the energy renovation of residential buildings (EC, 2021). While this amount is substantial, it was deemed to be insufficient to deliver the objectives set in the NECP, and additional public funds are needed (EC, 2021). It is therefore welcome that the government facilitated a much more substantial investment under the scheme that reached over EUR 55 billion by October 2022.

However, the Superbonus scheme resulted in some unintended distortions which should be corrected. Under the scheme, higher efficiency heating and cooling systems are eligible for the 110% tax credit irrespective of the energy carrier. This hampers the uptake of renewables-based systems and locks in fossil fuel-based devices in buildings for years.

Also, the time limits for the scheme have resulted in a high demand which is confronted with a shortage of available construction companies to realise the renovation works. According to some observers, the cost of some of the interventions has tripled as a result. Moreover, in February 2022, the Italian revenue/tax agency exposed a EUR 4.4 billion fraud obtained through multiple sales of the same tax credit (Il Sole 24 Ore, 2022). The Superbonus scheme allows transferring the tax credit to either the company that performs the works (only a limited number of companies have availed of this option and prefer immediate revenues to maintain their cash flow), or the deduction can be transferred to a third party, such as a bank or another financial institution. In this case, the bank repays the eligible share of investment costs at the end of works, or in three instalments when 30%, 60% and 100% of the works are realised. But the user of the scheme that opts for transferring the credit still needs to advance some or the totality of the expense, before getting reimbursed by the bank (Agenzia delle entrate, 2021).

There is hence concern that the Ecobonus and Superbonus may have regressive effects. They benefit homeowners and households with higher upfront spending capacity. To address this concerns the government introduced a new income condition from 1 January 2023 onwards. A one-person household that wishes to benefit from the Superbonus must earn less than EUR 15 000 annually and the income threshold is increased with every additional household member.

While over 70% of households own their homes, 70% of low- and middle- to low-income households rent their homes (OECD, 2022). Direct public investment in renovating existing social housing would address energy poverty risks more effectively. The NRRP allocates EUR 2.8 billion to social housing investment, one-fifth of the allocation for financing the Superbonus. In 2020, social housing comprised only 4% of Italy's housing stock, among the lowest in the EU (OECD, 2022). Owners of rented properties are eligible for the Ecobonus and Superbonus, but data are lacking on how many have used this option. However, according to observation by the government the possibility to transfer credits has helped economically weaker households to access investments.

Other support measures

The "Conto Termico" (Thermal Account), operational since 2013, mainly supports the installation of renewable heat systems in residential, service and public sector buildings (see Chapter 5), but also provides capital grants for small-scale energy efficiency interventions in public buildings. The grant can cover 40-65% of the investment cost, with a ceiling of EUR 5 000, for the installation of high-efficient or renewables-based heating systems. For public buildings, the incentives also cover interventions on the envelope of existing buildings. The annual budget is EUR 900 million, EUR 200 million of which is earmarked for public buildings. Between 2014 and 2020, the programme delivered 25.9 PJ of energy savings and is expected to deliver 3.85 Mtoe (161.2 PJ) of cumulated savings for the period 2021-30.

The "Energy upgrading programme for the central public administration" funds energy efficiency improvements in buildings owned by central government ministries (e.g., prisons, tribunal buildings, army buildings). It aims to achieve a yearly renovation of at least 3% of heated and air-conditioned surface area in the period 2014-2020. For this, a total of EUR 350 million was committed, with envisaged energy savings of 1.7 PJ/465 GWh. Only 48% of applications were accepted, with a total spending of EUR 314 million.

The programme will continue for the period 2021-30, with estimated energy savings of 4.3 PJ/0.1 Mtoe through the renovation of 3.2 million m^2 floor area with expected government expenditure of EUR 0.29 billion (Italy, Ministry of Economic Development, Ministry of the Environment and Protection of Natural Resources and the Sea, and Ministry of Infrastructure and Transport, 2019).

Encouraging behavioural changes

To reduce the use of natural gas and related imports from Russia, in April 2022 the government approved a decree limiting the cooling temperature to 27°C and the heating temperature to 19°C, in both cases with a 2°C margin. The decree applies to public buildings until 31 March 2023 (Italy, MiTE, 2022). Ministerial decree no. 383 of 6 October 2022 took the measures even further and provides for the limitation of temperatures and

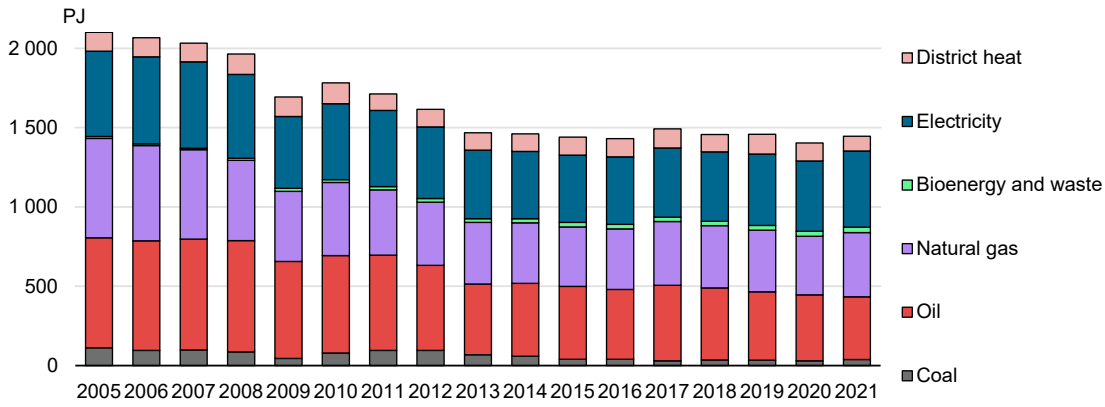
the duration of the switching on of the heating systems in the 2022/2023 heating season for all buildings, public and private. According to the gas emergency plan this will achieve gas savings of over 3 bcm.

Such measures can have a large impact. According to the National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA, Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile), reducing the heating temperature from 20°C to 19°C could cut gas use for residential heating by nearly 11%. If, in addition, heating time were reduced by one hour per day and the heating season by 15 days, Italy could save 2.7 bcm of gas, or 17.5% of current consumption. Households could save EUR 178/year on their energy bills. If half of households adopted these behavioural changes (which do not require upfront investment), Italy could save 1.8 bcm of gas in the 2022-2023 winter (ENEA, 2022b).

Industrial energy efficiency

Industrial energy consumption (including for non-energy use)[6] declined by 30% between 2005 and 2013, largely due to the fall in the production of cement and steel. Since then, energy use by industry has hovered around 1 450 PJ. In 2020, the main energy source in the industry sector was electricity (32%), followed by oil (30%) and natural gas (26%) (Figure 4.6).

Figure 4.6 Total final consumption in industry by source in Italy, 2005-2021



Between 2005 and 2021, total final consumption in industry decreased by 31%. Since 2019, electricity overtook oil as the first source of TFC in Italian industry.

Source: IEA (2022a).

[6] Non-energy use refers to fuels used as raw materials, and not used as fuel or transformed into another fuel. This comprises typically raw materials used in the chemical and petrochemical sector.

In 2020, basic metals and non-metallic minerals were the largest energy users in the manufacturing sector (together accounting for 37% of energy use in manufacturing). The other main sectors in terms of energy demand were machinery (15%), chemicals (14%), food (11%) and paper (9%).

In part as a response to traditionally high energy prices, the Italian manufacturing sector is among the least energy intensive (3.2 mega joule (MJ)/GDP in USD PPP 2015) in the IEA, although with differences across sectors. The energy intensity of manufacturing (as measured by energy consumption per value added) decreased by 25% between 2010 and 2019. Energy intensity declined in most manufacturing sectors. However, the energy intensity of the chemicals and food sectors stabilised in the second half of the 2010s, while that of the basic metals industry started to pick up again in 2017. Energy efficiency can still be improved in some sectors (such as iron and steel, cement, and paper) in line with the best available techniques.

Energy efficiency measures in the industry sector

The white certificate scheme and the energy audit requirements are the main mechanisms to stimulate energy savings in the industrial sector

White certificates

Since 2005, the white certificates or energy efficiency titles (EETs) system promotes energy efficiency across end-use sectors (industry, residential buildings, public lighting and transport). It does so by assigning annual mandatory savings quotas to electricity and natural gas distributors with more than 50 000 end customers. It is possible to fulfil the mandatory savings quota by either directly implementing energy efficiency projects or purchasing the EETs on the market.

Each certificate is awarded by the “Gestore dei Servizi Energetici” (GSE, Manager of Energy Services) for 1 toe of certified energy savings achieved through energy efficiency measures and projects. EETs are securities that can be traded on a dedicated market platform managed by the “Gestore dei Mercati Energetici” (GME) or through bilateral negotiations.[7]

The scheme is widely regarded as the most cost-efficient Italian energy efficiency policy. Between 2016 and 2020, the EETs mechanism contributed to achieving 6.7 Mtoe (280.5 PJ) cumulative energy savings, 53% of which were achieved in the industrial sector. The EETs also play a major role in Italy’s energy efficiency strategy to 2030. They are expected to contribute to 0.223 Mtoe (9.34 PJ) of energy savings per year between 2021 and 2030, equivalent to 12.3 Mtoe (525 PJ) of cumulative savings to 2030, or about 21% of the overall target under Article 7 of the EED (see the previous section).

However, following operational changes made to the scheme in 2017, its effectiveness sharply decreased, rendering the market almost illiquid with strongly increasing EET prices that peaked at EUR 480/EET. Following regulatory interventions in 2018 aimed at setting a price cap for the EETs, the market price stabilised around EUR 260/EET. Moreover, the application procedure for standardised projects opened the EETs to a wide-ranging fraud scheme. In 2017, a fraud investigation resulted in the annulment of a substantial number

[7] Annex A provides detailed information about institutions and organisations with responsibilities in the energy sector.

of fraudulently obtained EETs, which resulted in a supply collapse (di Santo and de Chicchis, 2019). Another scheme uncovered in 2021 resulted in losses of EUR 27 million through illegally obtained certificates (Eurojust, 2021).

To ensure the scheme can deliver the expected savings for 2030, the government introduced several changes in 2021 aimed at strengthening the EET system, including setting 2021-2024 obligation quotas, extending the types of eligible energy efficiency projects and introducing auctioning.

Energy audits

Since 2015, large and energy-intensive companies have to undergo an energy audit every four years. Over 70% of the audits are complemented by a monitoring plan allowing in-depth analysis of sectoral consumption and the identification of energy cost centres. However, the government noted that the audits did not have notable impacts on the sector.

For the period 2021-30, the government plans to revise the measure to increase its effectiveness by directing audits on companies and on industrial sites where potential energy savings are more relevant. The programme will also be extended to include energy-intensive companies in the gas sector. The financial support provided to energy-intensive users will be linked to the implementation of energy efficiency interventions.

Moreover, the government plans to strengthen support to small and medium-sized enterprises (SMEs) to encourage them to undertake energy audits and implement an energy management system. This will be done through, for example, co-financing energy audits, providing energy efficiency training in collaboration with industry associations and promoting voluntary agreements between companies to enhance energy efficiency.

Companies with an obligation of undergoing energy audits can choose as an alternative to comply with the ISO 50001 standard on energy management. Since 2021, and every two years until 2030, public tenders are issued for obtaining funding to finance the implementation of the ISO 50001 standard. As of 2021, 402 enterprises and 1 196 sites were compliant with the standards.

Industrial companies with an energy consumption over 10 ktoe/year (0.4 PJ/year) are obliged to appoint an energy manager. Energy managers are tasked with collecting and analysing the energy consumption data of the enterprise, identifying actions to promote energy efficiency and preparing energy data for the verification of interventions receiving public subsidies. In 2020, there were almost 2 500 energy managers in Italy; 1 700 worked in enterprises that are obliged to nominate an energy manager.

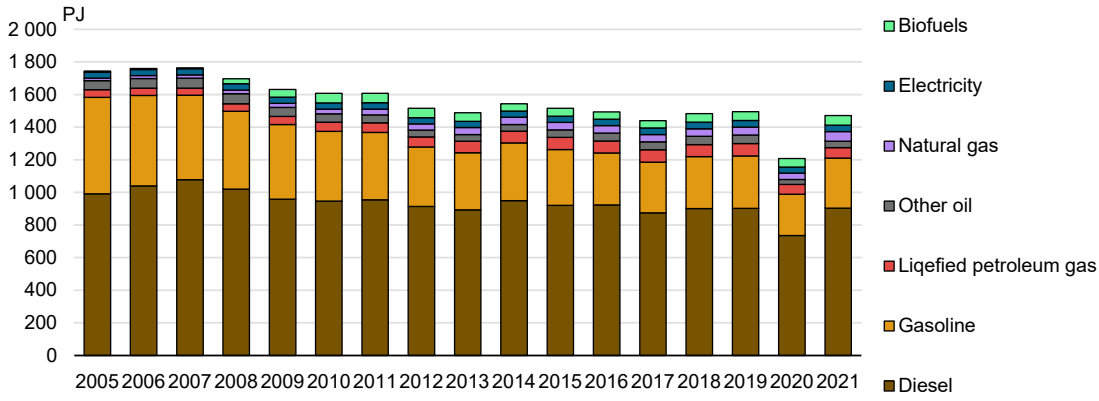
Energy efficiency in transport

Energy use in the transport sector decreased by 16% between 2005 and 2021, although at a slower rate in the second half of the 2010s. In 2020, the Covid-19 pandemic and the related restrictions caused a 19% drop in energy demand in transport compared to 2019, but a strong rebound in 2021 brought demand back to just 1.6% lower than in 2019. The main fuel used in the transport sector is diesel, which covered 61% of transport energy demand in 2021, followed by gasoline (21%) (Figure 4.7). Smaller shares come from liquefied petroleum gas (LPG) (4.4%) and biofuels (4.0%). Natural gas accounted for 4.0%

of the transport sector's energy demand in 2021. The shares of cars fuelled with LPG (6.4% in 2021) and natural gas (2.5%) in Italy are significantly higher than the EU averages (3% for LPG and 0.5% for natural gas) (EAFO, 2022).

Road transport accounted for 94% of transport energy use in 2019[8]. Passenger cars accounted for 51%, followed by heavy goods vehicles (36%), motorcycles (4%) and buses (3%). Domestic navigation, rail and domestic aviation only account for small shares at 1-2% each. While road transport relies mostly on oil products, electricity is used mainly in rail and accounts for around 3% of total transport demand. With the increase of EVs, the share of electricity in road transport grew fourfold from 2010 to 2020, though it still accounted for only 0.06%.

Figure 4.7 Total final consumption in transport by fuel in Italy, 2005-2021



Between 2005 and 2021, total final consumption in transport decreased by 16%. It dropped by 19% in 2020 due to the Covid-19 pandemic but recovered strongly in 2021. Diesel is the predominant energy source in transport.

Source: IEA (2022a).

Like in many other countries, passenger transport depends on private car use in Italy. With about 726 cars per 1 000 inhabitants, Italy has the second-highest car motorisation rate in the European Union after Luxembourg (EAFO, 2022). In most Italian regions, car ownership is higher than in most other European regions even at lower per capita income levels. This indicates a "forced car ownership" for mobility needs even for low-income households, especially in southern regions and on the islands, and in rural and semi-urban areas, where public transport is less developed (OIPE, 2020). Passenger cars accounted for 76% of passenger transport in Italy in 2019, in line with the IEA average. Italy's use of motorcycles is higher than the IEA average, accounting for 4% of passenger transport demand, compared to 0.7% in the IEA as a whole.

Improving the energy performance of vehicles

With 11.8 years, the average age of Italy's passenger car fleet is the same as that for the European Union (ACEA, 2022). Nonetheless, the energy intensity of passenger cars

[8] 2021 data are not available for transport modal split, and 2020 data are less representative due to Covid-related travel restrictions.

(1.02 MJ per passenger kilometre) is among the lowest in the IEA. This is partly due to the progressive dieselisation of the fleet, encouraged by the lower taxes and prices of diesel (see Chapter 2). While diesel vehicles are generally more fuel efficient, they have exacerbated local air pollution problems. In addition, Italy's car fleet is generally smaller and lighter and with less powerful engines than in many other countries.

The carbon intensity of newly purchased cars and light commercial vehicles (as measured by CO_2 emissions per km) decreased to 108.6 g/km in 2020. However, this is well above the EU fleet-wide 2020 target for new passenger cars of 95 g/km, and slightly above the EU average (107.8 g/km) (Eurostat, 2022b). Without a decisive shift to EVs, it will be challenging for Italy to achieve the EU 2025 target of 80.8 g/km and the 2030 target of 59 g/km.

The NECP envisages a reduction of the total car fleet from around 39 million in 2021 to about 36 million by 2030, as citizens are encouraged to shift their mode of transport towards walking, cycling, public transport, carpooling and car-sharing. The NECP foresees an acceleration in the deployment of EVs only in the second half of the 2020s, to reach 6 million EVs (of which 4.1 million of battery-electric vehicles, BEV) in 2030 or about 17% of the expected future fleet. However, to be in line with the FF55 proposed targets, EVs would need to increase to 7 million to make up 20% of the car fleet by 2030 (see Chapter 2).

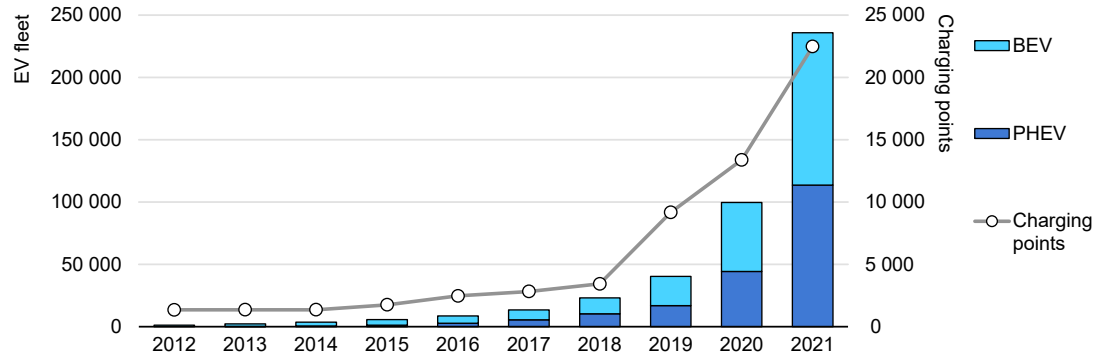
Italy's EV market is lagging behind other large EU countries, although recent developments are encouraging. In 2021, the share of EVs in the total car fleet was only 0.6% in Italy, compared to 2.3% in the European Union; while the share of EVs in new registrations is 9.5% versus an EU average of 16.6% (IEA, 2022c). EV deployment has been rising rapidly in Italy, with a steep growth since 2019 thanks to purchasing subsidies (Figure 4.8). The number of registered EVs increased from just 768 in 2012 to over 235 000 in 2021. It more than doubled between 2020 and 2021, in line with the global trend (IEA, 2022c). However, EV sales slowed down in the first half of 2022, in part as households were waiting for the implementation of the announced fiscal incentives.

Subsidies for EVs (and other vehicles) introduced in 2019 have stimulated sales. The amount of the purchase subsidies changed each year. In general, a lump-sum subsidy is provided for the purchase of passenger cars up to a certain sale price. The lump sum is the highest for passenger cars with CO_2 emissions up to 20 g/km and if an older vehicle is scrapped. The government has allocated EUR 650 million per year for vehicle subsidies between 2022 and 2024, including for low-emission passenger cars, motorcycles and fully electric commercial vehicles. The 2022 scheme provides a EUR 3 000 subsidy for the purchase of passenger cars with CO_2 emissions lower than 20 g/km, increased to EUR 5 000 if an older vehicle (with a pollutant emission class lower than Euro 5) is scrapped, with a price cap of EUR 35 000 (excluding taxes and fees). Lower subsidies are granted also for passenger cars with CO_2 emissions up to 135 g/km,[9] which is inconsistent with the EU CO_2 emissions targets for 2025 and 2030 and a very ineffective use of public funds.

[9] The purchase subsidy amounts to EUR 2 000 for passenger cars with CO_2 emissions between 21 g/km and 60 g/km, increasing to EUR 4 000 if scrapping another car, with a price threshold of EUR 45 000 (excluding taxes and fees). Cars with CO_2 emissions between 61 g/km and 135 g/km can receive a subsidy of EUR 2 000 only if scrapping another vehicle, with a price cap of EUR 35 000 (without taxes).

Increasing taxes on internal combustion engine (ICE) vehicles can help in this respect. Vehicles are subject to annual taxes, which are the competence of regional authorities. Rates vary across regions, but they are generally higher for vehicles with higher capacity engines and with higher pollutant emissions (based on the Euro standards). Tax rates are not based on fuel efficiency or CO_2 emissions levels. However, full exemptions are granted to EVs for the first five years of ownership and, at the discretion of the regions, to vehicles with dual fuel petrol/LPG or petrol/methane for the first owner and for five subsequent years.

Figure 4.8 Registered electric vehicles and public charging points in Italy, 2012-2021



Electric vehicles have increased exponentially since 2019. Since 2019, BEVs outweighed PHEVs in the total share of electric vehicle fleet.

Note: PHEV = plug-in hybrid electric vehicle.

Source: IEA (2022c).

Publicly available charging points have also ramped up since 2018, with more than 22 000 in 2021. This brings Italy close to the EU recommendation of having one public charging point for every ten EVs. However, this is far from Italy's target of more than 3.4 million EV recharging infrastructures by 2030, of which 32 000 public, fast and ultra-fast charging points. The NRRP includes a EUR 740 million provision for financing the construction of 21 355 public fast and ultra-fast charging points to be built along the highways and in urban areas. It also envisages phasing out regulated prices in charging infrastructure, requiring highway concessionaires to install charging points and introducing transparent procedures for the assignment of public spaces for electric charging and for the selection of charging station operators. The government also provides fiscal incentives for the installation of charging points for households, including through the Superbonus. As of July 2022, the government was in the process of updating its national plan for the EV recharging infrastructure, first adopted in 2016.

Less attention is paid to the electrification of the freight transport sector. Italy's road freight transport sector has the highest energy intensity (3.87 MJ per tonne-kilometre) among the European members of the IEA and the second highest overall after Japan. Road freight benefits from partial tax refunds on the excise duties paid on diesel, irrespective of the fuel efficiency of the vehicle. This subsidy is weakening the price signal and the incentive to improve fuel efficiency, while costing taxpayers EUR 1.3 billion in lost revenues in 2020 (see Chapter 2). The government is focusing on hydrogen as an option to decarbonise road haulage (see Chapter 3).

Encouraging a modal shift and sustainable mobility

The Italian government is aiming to follow the avoid-shift-improve model for its transport sector policies. This means avoiding the need for mobility; shifting transport modes to collective transport, also in the form of carpooling; and improving the environmental performance of means of transport, through infrastructural, technological and regulatory systems, and price and tax signals. The main policies focus on "shift" and "improve" (see the previous section). Given Italy's car dependence, urban planning and development need to play a greater role in reducing the need for private cars and also promote more walking and cycling).

In 2017, the government published guidelines to develop sustainable urban mobility plans. Such plans aim to improve accessibility to and within the urban area, through high-quality and sustainable mobility and transport modes. Developing safe cycling and walking infrastructure is essential to encourage active mobility and changes in transport habits. The Sustainable Urban Mobility Incentive Program, launched in 2019 with a total allocation of EUR 15 million, is aimed at municipalities with at least 50 000 inhabitants. It covers part of the costs incurred by a municipality for sustainable urban mobility actions on three themes: 1) development of cycling infrastructure; 2) shared mobility; and 3) mobility management activities. Municipalities need to apply for funds.

The NRRP will fund EUR 8 billion investments in sustainable mobility, in particular in new metro, tram and rapid bus transit infrastructures (EUR 3.6 billion), 3 000 zero-emission buses (EUR 2.4 billion), rolling stock for regional trains (EUR 0.8 billion) and cycling paths (EUR 0.6 billion). The plan also foresees simplifying the authorisation procedures for clean urban mobility. In mid-2022, as part of the measures to mitigate the impact of rising energy prices, the government allocated EUR 100 million to provide a EUR 60 subsidy for the purchase of annual public transport tickets.

The NRRP includes EUR 24.8 billion investment in railway infrastructure. This is mainly directed at improving high-speed train infrastructure and for the electrification of railways in the south of Italy. These investments are welcome, as they are key to moving passengers from roads to railways and reducing air transport over distances that can be covered by train.

The Marebonus and Ferrobonus were introduced in 2016 to encourage logistics operators to shift to intermodal transport and reduce freight transport on road. As of 2020, the two bonus systems allowed saving 6.7 PJ/year of energy.

Assessment

Italy's energy demand has been progressively decoupled from the country's economic performance. The final energy intensity of the economy (as measured by the TFC/GDP ratio) declined by 6% between 2011 and 2021. The steep fall in TFC by 8.5% between 2019 and 2020 is the result of the Covid-19 pandemic. Energy demand rebounded by 8.8% in 2021 along with a recovery in economic activity.

Italy overachieved its 2020 targets, with PEC and FEC about 16% below their respective targets. But Italy fell short of its 2020 target of cumulated energy savings. Italy expects to meet the 2030 target for cumulative energy savings by continuing to implement the measures currently in place. However, new measures and additional investments will be

necessary to achieve the more ambitious targets of the Fit-for-55 package. Estimates show that Italy would need to reduce its energy consumption by 22% by 2030 compared to 2019, or 9.5% below the level estimated by the NECP. Achieving these new targets, and reducing gas dependence from Russia at the same time, will require significantly scaling up and accelerating efforts to improve energy efficiency, as well as increasing the cost-effectiveness of energy efficiency policy measures.

Reaching the 2030 targets relies largely on the existing instruments and policy measures, although the incentives are higher. The biggest potential for making energy savings stands in the buildings and transport sectors, as road transport and residential space heating are the largest energy consumers in Italy. In line with this, the NRRP allocates EUR 14 billion to energy efficiency and building renovation, and more than EUR 32 billion to measures to reduce energy use in the transport sector.

The NECP pays less attention to encouraging behavioural changes in favour of saving energy at home and in the workplace and reducing travel demand or private car use. In line with the REPowerEU plan and the recent IEA *Playing My Part* recommendations (IEA, 2022d)[10] Italy should consider launching targeted communication campaigns to encourage households and businesses to undertake behavioural changes, in addition to offering financial measures to encourage energy savings. This could build on the successful national training and information programme for energy efficiency that is operating since 2014 and that has recently been refinanced and prolonged until 2030.

It is essential to provide consistent price signals, primarily by reforming subsidies that encourage wasteful energy consumption. In parallel, raising consumer awareness of the relationship between energy consumption and costs is needed and could be achieved by, for example, a wider diffusion of smart meters with real-time consumption and cost information and the implementation of systems of building automation.

Special focus should be given to energy efficiency measures that address the energy needs of the most vulnerable segments of the population. These groups often cannot benefit from the existing instruments to the same degree as other socio-economic groups. Providing tailor-made policies and instruments that successfully overcome the identified access barriers should be considered.

Building sector

In 2021, buildings accounted for 40% of TFC in Italy. Two-thirds of buildings energy demand comes from residential buildings. Natural gas accounts for half of TFC in buildings, the fourth-highest share among IEA countries in 2019. Italy's building stock is rather old, with two-thirds built before the 1976 law on energy efficiency. Over half of the buildings with an EPC are in the two worst-performing classes out of a total of ten classes.

Italy has put in place several measures to improve the energy efficiency in buildings. The "Conto Termico" (thermal account) provides subsidies mainly for the installation of highly efficient or renewable heating systems. Tax rebates are the main policy tool the government is using to encourage building renovation. Individuals or businesses can receive, in the form of tax credits, a share of the expenditure incurred for energy efficiency interventions in existing buildings (a so-called Ecobonus). Different deduction rates are

[10] The IEA report *Playing My Part* recommends simple actions such as turning down the heating and airconditioning, adjusting boiler settings, carpooling, reducing driving speed, replacing short car journeys with walking or biking, or using public transport.

applicable for different types of interventions. Since the measure was introduced in 2007, the deduction rates have ranged from 50% to 90%.

In 2020, the government increased the maximum deduction rate to 110% (the so-called Superbonus), as part of the post-Covid economic recovery package. Access to the 110% tax credit is granted if the investment improves the energy performance of the building by at least two classes of the EPC system. The NRRP allocates nearly EUR 14 billion to support the Superbonus, as a means to boost the economy and realise long-term energy savings.

However, the Superbonus is overly generous and has generated distortions. The most notable is that by granting a 110% discount the incentive to aim for the most cost effective of measures has been intrinsically eliminated. Also, while the Ecobonus scheme does discriminate between fossil fuel and renewables-based heating solutions, by granting different aid intensities of 50% for fossil fuel boilers versus 65% for heat pumps, the Superbonus does not. There could be good reasons to support a shift from the most inefficient and polluting heating systems to more efficient fossil fuel-based ones as not all buildings lend themselves to the installation of heat pumps, especially given Italy's old building stock.

The Superbonus was designed as a temporary measure to stimulate the post-pandemic economy. The government should consider designing any future measure in such a way as to address both, the country's energy efficiency and renewable ambitions for 2030 and beyond by for example differentiating between renewables-based and fossil fuel-based heating and cooling technologies.

Finally, any support scheme that provides tax credits is potentially regressive as investment funds need to be advanced, the benefits come with a substantial time lag and the support is related to the income tax paid by the investor. In theory, the government hopes to address these socio-economic concerns by allowing credit transfer and invoice discounts, but the reality has not yet borne out this hope. Information obtained during the review visit indicated that not many companies are interested in receiving a tax credit, as they would also need to advance costs while having to address their own cash flow needs to cover operational costs. And a credit transfer to financial institutions still requires an upfront financing capacity as the reimbursements are made after the expenditure. One possible answer could be to offer grants instead of tax credits for vulnerable households, or offering a combination of loans, tax credits and grants and to also offer free advisory services to ensure home owners are aware about their options for energy efficiency improvements. Creating a liquid and functioning market for energy-services companies is another possibility albeit not a short-term solution.

The "Energy upgrading programme for the central public administration" targets the buildings stock owned by the central government. In the period to 2020, the available funds were not all exhausted and less than 50% of applications were approved. Looking forward to 2030, the programme could be made more cost-effective by developing a limited number of medium to deep retrofit projects that could then be replicated. Experience in other IEA countries shows that small public bodies often lack the technical capacity to design energy efficiency interventions and that they benefit from the enhanced provision of technical assistance to ensure that the energy efficiency potential is optimally exploited.

Industry

Industry accounted for about 30% of TFC on average in the 2010s. Industrial energy consumption declined markedly between 2005 and 2013, largely as a consequence of the fall in production of cement and steel. Since then, energy use by industry has stabilised. Traditionally high energy prices have made the Italian manufacturing sector one of the least energy intensive in the IEA. Energy efficiency can still be improved in some sectors (such as iron and steel, cement, and paper), in line with the best available techniques.

The white certificates scheme has achieved a significant amount of energy savings (133 PJ/year between 2011 and 2020), mainly in the industry sector. However, frequent government interventions in the scheme to stem opportunistic behaviour have also reduced its effectiveness and made it less predictable for investors while opening it up to fraud through illegitimately obtained certificates. A new set of changes introduced in 2021 addresses the lessons learnt and aims to ensure that the scheme can deliver the expected savings for the period to 2030. It will be important to closely monitor the impact of the new changes and to take corrective steps early on if needed.

Energy audits carried out until December 2020 show that there is potential for further savings of 26 ktoe (1.09 PJ) per year of final and 39 ktoe (1.6 PJ) year of primary energy, and further efficiency could be achieved through the electrification of industrial processes. However, the government recognises that the energy audits did not deliver the expected outcomes. This could be achieved by more clearly linking the findings of the energy audit and the implementation of the recommended interventions. The government has considered shifting the focus towards energy management systems such as ISO 50001 and is also preparing new initiatives to unlock the energy efficiency potential of SMEs.

Transport

Between 2015 and 2019, the energy consumption of the transport sector remained fairly constant and accounted on average for 30% of TFC. In 2020, several restrictions due to the Covid-19 pandemic reduced transport energy demand by 19% compared to 2019. In 2021, transport demand rebounded to just 1.6% lower than the 2019 level. Road transport accounted for 94% of transport energy use in 2019. The main fuel used in transport is diesel, followed by gasoline. Italy has significantly high shares of LPG and natural gas in road transport compared to the average in the IEA. The share of EVs is increasing but is significantly below the EU average of 1.6%.

In Italy, passenger transport heavily depends on private cars. The country has the second-largest car motorisation rate in the European Union and more low-income households own a car than in other European countries, indicating a lack of alternative transport options.

The government has put much policy and spending effort into renewing the vehicle fleet towards more fuel-efficient vehicles and increasing the number of EVs to around 6 million by 2030, up from 235 000 in 2021. The NRRP will finance the installation of over 21 000 ultra-fast chargers. Subsidies are available for the purchase of EVs and the installation of electric charging points.

EV subsidies introduced in 2019 have stimulated sales that skyrocketed in 2021, in line with global trends. However, subsidies are also provided to ICE cars with CO_2 emissions up to 135 g/km, when scrapping another car. While this bonus promotes the renewal of

the fleet, the government should consider revising the threshold for this incentive to make it consistent with the EU CO_2 emissions targets for 2025 and 2030, which are significantly lower. More generally, as the experience of Norway shows, government incentive schemes should more effectively encourage replacing ICE cars with EVs, as opposed to supporting growth in the passenger car fleet (IEA, 2022e).

The government has made efforts to encourage a shift towards transport modes other than road vehicles for both passengers and freight. Existing policies include a programme to favour sustainable mobility in urban areas, investments and regulatory reforms to improve public transport infrastructure and services, and incentives for intermodal sea-road and rail-road freight transport. The NRRP allocates about EUR 25 billion to investments in transport infrastructure from 2021 to 2026, almost entirely for railway infrastructure.

Overall, Italy's energy efficiency measures in the transport sector have focused on improving the energy performance of means of transport and stimulating a modal shift. There is space to put in place more policies to avoid the need for mobility. Given Italy's car dependence, urban planning and development should play a more important role in reducing the need for private cars and promoting active mobility (walking and biking) and the use of public transport.

Recommendations

The government of Italy should:

- Revise the tax deduction schemes for the energy performance of buildings to maximise energy savings per euro spent; ensure that the schemes can be sustained for longer periods, thereby giving stakeholders market certainty. Monitor the results of the schemes and revise them based on the findings to make sure that they contribute to both the energy efficiency and climate targets effectively.
- Ensure that support schemes for energy efficiency in buildings target low-income households more specifically and address their identified barriers, including limited possibilities for upfront financing and use of tax rebates, taking into account the experiences made in Italy so far.
- Strengthen the existing schemes for investment in energy renovation of public buildings; consider developing a project pipeline that can easily be replicated to address the challenges faced by small public units such as schools.
- Review the white certificate system to change the trend of decreasing the volume of issued certificates by clarifying the rules and simplifying procedures.
- Reduce overall transport needs and shift to less energy- and GHG-intensive modes; enhance the focus on mobility and transport efficiency in infrastructure and urban planning; increase investments in public transport and focus support schemes for freight by rail or ship only.
- Strengthen measures to encourage households and businesses to undertake behavioural changes in favour of energy savings, including through targeted and systematic communication and information campaigns and dedicated assistance services at the national and local levels.

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5. Renewable energy

Key data

(2021)

Renewables in TFEC:* 822 PJ/16.8% of TFEC (bioenergy** 450 PJ, hydro 166 PJ, solar 102 PJ, wind 77 PJ, geothermal 27 PJ)

Renewables in electricity generation: 116.3 TWh or 40.5% of electricity generation (hydro 45.4 TWh, solar 25.0 TWh, wind 20.9 TWh, bioenergy 19.1 TWh, geothermal 5.9 TWh)

Renewables in gross final energy consumption:*** total 19.0%, electricity consumption 36.0%, heating and cooling 19.7%, transport 10.0%

* Total final energy consumption (TFEC) excludes non-energy use, which is counted in total final consumption.

** *Bioenergy* includes solid primary biofuels, liquid biofuels and biogases, and excludes non-renewable industrial and municipal waste.

*** Computed according to Eurostat definitions for consistency with EU targets. Eurostat definitions include the normalisation of wind and hydro renewable electricity consumption, and multiplication factors for advanced biofuels and renewable electricity in transport.

Sources: EC (2022); IEA (2022a).

Overview

Accelerating the deployment of renewable energy sources is essential for Italy to shift to a low-carbon energy mix, reduce its reliance on imported fossil fuels and, ultimately, reach carbon neutrality by 2050. Its NECP sets an ambitious trajectory to achieve the 2030 targets of covering 30% of gross energy consumption with renewables (Italy, Ministry of Economic Development, Ministry of the Environment and Protection of Natural Resources and the Sea, and Ministry of Infrastructure and Transport, 2019).

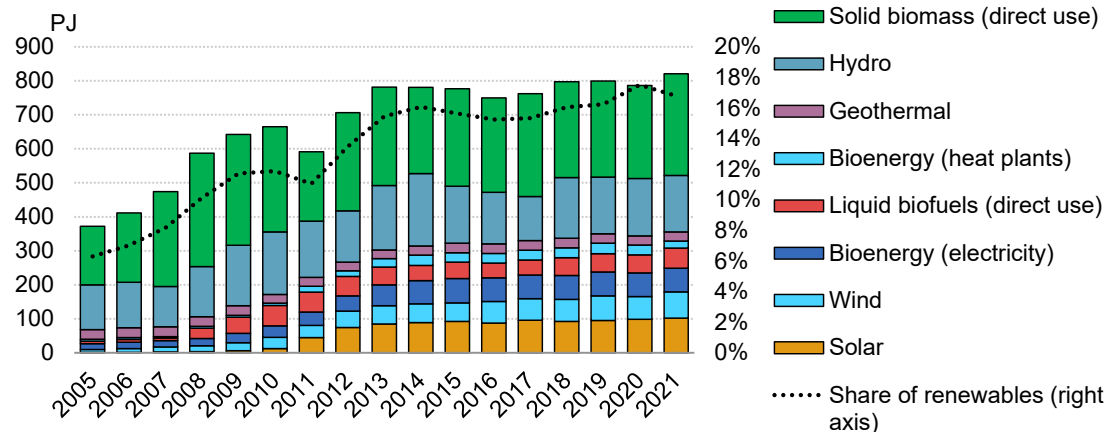
Italy will have to raise its ambition in line with the proposed targets of the European Union's FF55 package for a 40% share of renewables in the overall energy mix by 2030 for the EU as a whole. Moreover, the REPowerEU plan, introduced in May 2022, aimed at reducing the European Union's dependency on Russian fossil fuels by increasing the share of renewables in the European Union's gross final energy consumption to at least 45% by 2030 (European Parliament, 2022).

Italy's renewable energy use has grown in the last decade. However, the deployment of renewables has been slowing in recent years, as generous incentives have been phased out. The delivery gap is also due to the long permitting procedures, high administrative burden and lack of land availability. Several reforms are underway to speed up the uptake of renewable energy technology in electricity, transport, heating and cooling.

Renewable energy supply and demand

TFEC[1] from renewables more than doubled between 2005 and 2020. The share of renewables in TFEC increased from 7% in 2005 to 16% in 2014 and hovered around that level until 2021 (Figure 5.1). The electricity sector drove the growth of renewables, which was particularly fast between 2010 and 2013. In 2020, the share of renewables increased to 18% of TFEC, thanks to lower energy use due to the Covid-19 pandemic, while renewable energy use remained roughly stable at the level of the previous three years. In 2021, the share went back to 17%.

Figure 5.1 Renewable energy in total final energy consumption in Italy, 2005-2021



Renewable energy use grew until 2014 but has stabilised since. The fast development of renewable electricity was the main factor behind the rapid growth of the early 2010s.

Notes: The share of renewables is computed using IEA definitions. Total final energy consumption excludes non-energy use.

Source: IEA (2022a).

Italy exceeded its overall and sectoral renewable 2020 targets, as set out in the 2009 EU Renewables Energy Directive (RED) and Italy's National Renewable Energy Action Plan (NREAP). Using Eurostat definitions, in 2020, the share of renewables was 20.4% of gross final energy consumption, above the target of 17%.[2] Italy had already reached that target six years earlier.

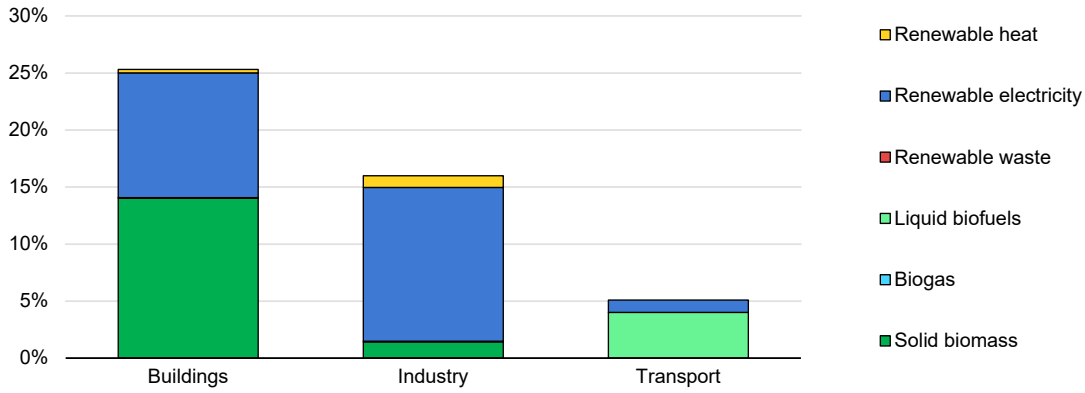
Bioenergy (solid and liquid biofuels for the direct use and production of electricity) is the main renewable energy source, covering 55% of total renewables consumption in 2021. Hydropower is the second-largest renewable source of energy, with variable production depending on temperature variation and water availability. It accounted for 20% of renewables use in 2021 (Figure 5.1). In 2022, an exceptionally dry year, hydropower generation could be 60% lower than historical averages (Assoidroelettrica, 2022).

[1] TFEC excludes non-energy use, which is counted in TFC. TFEC provides a more accurate assessment of the share of energy demand covered by renewable energy and is better aligned with the European Union's gross final energy consumption metric, which is used to set EU member states' renewable energy targets.

[2] These shares are based on Eurostat accounting. Eurostat applies formulas to normalise fluctuations of electricity generation from wind and hydro, and uses multiplication factors that give higher shares to advanced transport biofuels and to renewable electricity in transport.

Renewable sources are mainly used in the building sector, where they cover a quarter of energy demand. They account for 16% of industrial energy use (Figure 5.2). Bioenergy is mostly directly used as solid biomass for heating in buildings and, to a much lower extent, for industrial combustion (Figure 5.2). Renewables, largely liquid biofuels, cover about 5% of energy use in transport. District heat from renewable sources covers 1.0% of energy use in industry and 0.3% in buildings. Biogas covers just 0.04% of TFEC in Italy.

Figure 5.2 Share of renewables by end-use sector and source in Italy, 2021



Renewables are used mainly in buildings, especially as direct solid biomass. District heating from renewables and biogas covers a negligible share of final energy use.

Source: IEA (2022a).

Renewable energy targets and policies

The 2030 targets, under the second EU Renewable Directive (RED II of 2018) and the NECP, are ambitious (Table 5.1). In addition, Italy will revise them upwards to align them with the EU FF55 package (under negotiation at the time of writing). Moreover, those targets may be even further increased to align with the REPowerEU objectives that propose reaching 45% of renewables in gross final energy consumption EU-wide by 2030 (see Chapter 2).[3]

The government estimates that the use of renewables should grow to nearly 37% of gross final energy consumption in 2030 to be in line with the FF55 goals. This overall target would translate into higher sectoral targets (Table 5.1). In addition, Italy's ETP aims to generate 72% of electricity from renewable sources by 2030. The country's LTS to 2050 envisages that renewables should reach 85-90% of gross final energy consumption by mid-century to achieve the net zero goal.

To achieve the 2030 targets, the NECP focuses on expanding wind and solar electricity generation, developing offshore multipower systems (combining wind, floating PV and wave motion power), promoting energy communities and agrivoltaics (the simultaneous use of land for both PV and agriculture), and fostering the production and use of biomethane. To support the implementation of the NECP, the NRRP allocates about

[3] The FF55 package raised the 2030 target from at least 32% of renewables in gross final energy consumption for the European Union as a whole to 40%.

EUR 6.5 billion to 2026 to several renewables-related projects, as well as for upgrading and digitalising the electricity grids given the growing generation from renewables and higher electricity demand for end-uses (see Chapter 7). It also outlines several administrative reforms to foster investment (Italy, Government of Italy, 2021).

Table 5.1 Italy's 2020 and 2030 renewable energy targets, and status 2021

Renewable energy share	2021 status	2020 targets	2030 targets NECP	2030 FF55 targets (provisional)[4]
Overall target (renewables in gross final energy consumption)	19.03%	17%	30%	36.7%
Electricity	36.0%	26.4%	55.4%	65% (a)
Heating and cooling	19.71%	17.1%	33.9%	40%
Transport	10.0%	10.1%	21.6%	-13% (b)/ 28% (c)

Notes: The overall renewable target and the transport target are binding. The sectoral renewables targets on electricity and heating/cooling are indicative. The 2030 FF55 targets are provisional and were under negotiation at the time of writing. They correspond to the updated national targets that would result by applying the rules set out in the European Commission's proposal for amending the RED II.

a) Including renewables used to produce green hydrogen.

b) In terms of intensity reduction of greenhouse gases.

(c) Energy-based target.

Sources: EC (2022); Italy, Ministry of Economic Development, Ministry of the Environment and Protection of Natural Resources and the Sea, and Ministry of Infrastructure and Transport (2019); information provided by RSE during the team visit in April 2022.

Legislative Decree 199/2021 transposing the RED II (the so-called RED II Decree) implements the measures planned in the NECP and co-ordinates them with the NRRP. Among others, the decree simplifies administrative procedures related to the production and use of renewable energy and provides for new or adjusted incentive schemes for renewable electricity and thermal energy, for self-consumption and energy communities, and for biogas and biomethane production. The new measures are a step in the right direction to accelerate the deployment of renewables. However, the actual implementation of the RED II Decree is conditioned on the adoption of several regulations by the central government by mid-June 2022, as well as follow-up regulations to be approved at the regional level. As of end-June, some regulations were still missing.

Renewable electricity generation

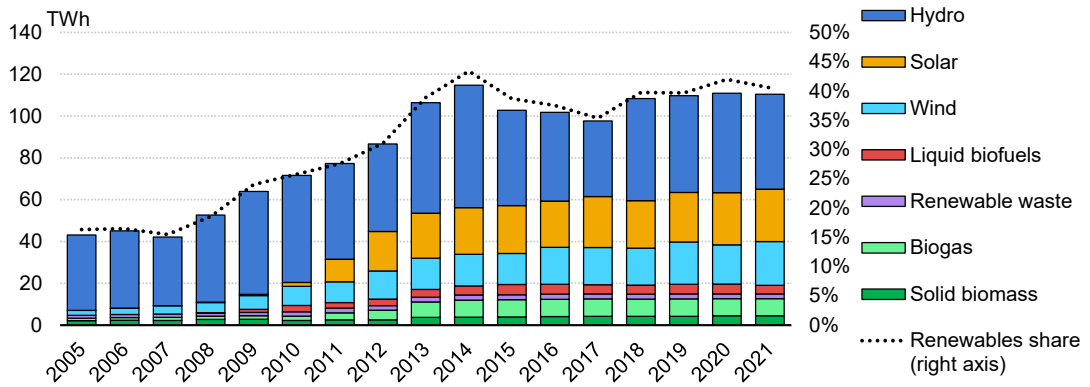
Status and trends

Electricity generation from renewable sources more than doubled between 2005 and 2021. It accounted for 40.5% of total electricity generation in 2021 and 36% of gross electricity consumption in 2020, far above the 2020 indicative target of 26.4% set by Italy's NREAP (see Table 5.1). Most regions in Italy achieved their 2020 targets as defined by the so-called national "burden-sharing" agreement. Overall, between 2010 and 2020, generation from solar PV increased more than twelve-fold, that from bioenergy (solid and

[4] Those targets may even be further increased once the REPowerEU proposal has been approved.

liquid biofuels) more than doubled, and wind power production doubled (Figure 5.3). Most growth occurred between 2010 and 2014, when about 20 GW were added to renewable electricity capacity. PV accounted for most of this capacity addition (15 GW), thanks to the generous incentives of the so-called “Conto Energia” (IEA, 2016). In the early 2010s, renewable electricity capacity and generation grew much faster than foreseen in the NREAP. In 2012, renewable electricity was already above the 2020 indicative NREAP target. However, this steep growth entailed high costs to consumers (IEA, 2016). Growth slowed down in the second half of the decade, when only 6 GW of capacity was added, due to less generous incentives, long and complex permitting procedures, and increasing local opposition (see below).

Figure 5.3 Renewable energy in electricity generation in Italy, 2005-2021



Solar, wind and bioenergy drove up electricity generation from renewables. However, the growth slowed down in the second half of the 2010s.

Note: The share of renewables is computed using IEA definitions.
Source: IEA (2021).

Hydropower has traditionally been the main renewable electricity source in Italy. In 2021, it accounted for 39% of renewable electricity and 16% of total power output (see Figure 5.3). Solar accounts for 22% of renewable electricity. In 2021, solar generated a record high of 25 TWh, or 8.7% of total electricity output. Electricity production from wind increased steadily to reach 7.3% of power generation and 18% of renewables electricity in 2021. Lower contributions come from biogas (2.8% of power generation); geothermal (2.1%); solid biomass (1.6%), liquid biofuels (1.4%) and renewable waste (0.8%). Italy has the third-highest share of geothermal in electricity generation among IEA countries.

There is a considerable disparity in renewable electricity generation across regions and the seven electricity market zones (see Chapter 7). Non-variable sources (hydro and bioenergy) are far more present in northern regions than in the south of the country. On the contrary, most of the renewable capacity installed in southern regions uses variable sources (solar and wind). In particular, wind capacity is exclusively located in the central and southern regions of the country. These territorial disparities, together with the concentration of electricity load in the north of the country, complicate the management of electricity flows along the national transmission grid (see Chapter 7).

Outlook to 2030

The NECP foresees achieving the 2030 target of 55% of renewables in electricity consumption (see Table 5.1) by increasing generation from PV and wind. The plan expects renewable electricity generation to grow to 187 TWh in 2030 (from 116 TWh in 2020). With current policies, the IEA forecasts an increase of about 7.5 TWh between 2021 and 2023 (IEA, 2022b). A similar growth pace would not be sufficient to achieve the 2030 target or to significantly reduce dependence on Russian natural gas use in electricity, as the government expressed its intention to stop importing natural gas from Russia by 2025 (see Chapter 2). In 2020, a fifth of the country's electricity generation (about 58 TWh) depended on Russian gas imports, the highest share among IEA countries (see Chapter 7). There is, therefore, a need to accelerate the implementation of the policies and measures planned in the NECP and the NRRP.

According to the NECP, installed solar PV and wind capacity, jointly considered, would need to more than double between 2020 and 2030. In particular, 31 GW of PV and 8 GW of wind capacity would need to be added. The installed capacity of other renewable sources is expected to remain stable (Table 5.2). Achieving the NECP target requires increasing renewables capacity by nearly 4 GW per year, on average, between 2020 and 2030. This is more than three times the average yearly addition of 1.2 GW between 2015 and 2020 but is in line with the annual growth experienced in the first half of the last decade.

Table 5.2 Italy's current renewables electricity capacity and 2030 indicative targets

Renewable electricity capacity (GW)	2022 status	2030 NECP targets	2030 FF55 target (provisional)
Variable sources	35.9	71	87
• PV	24.2	52	64
• Wind	11.7	19	23
Non-variable sources	27.4	24	27
• Hydro	22.8	19	
• Other (including biomass and geothermal)	4.6	5	
TOTAL	63.3	95	114

Sources: Terna (2022); GSE (2022); Italy, Ministry of Economic Development, Ministry of the Environment and Protection of Natural Resources and the Sea, and Ministry of Infrastructure and Transport (2019); Terna (2021); information provided by RSE during the team visit in April 2022.

The government estimates that to achieve the more ambitious targets of the FF55 package, 58 GW of additional renewable electricity capacity will be needed by 2030, of which three-quarters would be PV (see Table 5.2). This implies an even faster annual average growth of 5 GW.

As of 2021, Terna, the country's electricity system operator,[5] had received connection applications for a total capacity of variable renewables of 168 GW. Half of these are for PV, 31% for onshore wind and 19% for offshore wind. Contrary to Terna's National Trend (NT) Italia scenario, 90% of applications are for plants located in southern regions and on

[5] Annex A provides detailed information about institutions and organisations with responsibilities in the energy sector.

the island. While not all applicant plants will be authorised, and some may be double counted, the high number of applications highlights the large growth potential of renewable electricity.

According to NT Italia, most of the new PV capacity will be installed in the north of the country. There will be no wind capacity installed in the north and centre-north, due to the suboptimal conditions for wind power in these areas. Wind will continue to dominate in southern regions and on the islands. At the same time, an additional 10 GW of electricity storage systems need to be installed by 2030 (Terna, 2021).

The expected growth in generation from variable renewable sources and its uneven territorial distribution will result in increased electricity flows from the south and the islands to the north of the country, where demand is concentrated. This, coupled with the anticipated lower fossil fuel-based capacity, can exacerbate the complexity of power system balancing and calls for digitalisation and smart management of the electricity system. There is, therefore, a need to extend and upgrade the transmission and distribution networks, as well as to invest in storage capacity (see Chapter 7).

Policies and measures

To stimulate further growth in renewable electricity generation, the government plans to extend the use of competitive procedures and purchasing power agreements for large plants; accelerate permitting procedures; prioritise PV on buildings or areas not suitable for other uses; revamp and repower existing renewable plants; and promote self-consumption and energy communities, including on small islands.

The government considers energy communities and prosumers as means to engage citizens in the clean energy transition, encourage energy efficiency, reduce energy costs, and, ultimately, help improve public acceptance of renewable energy projects. Energy communities are also a way to improve system flexibility (see Chapter 7). The NRRP provides specific funding for establishing energy communities and a targeted incentive mechanism is in place (Box 5.1).

Financial support mechanisms

Italy has implemented different instruments to support renewable electricity generation, including support for produced electricity, grant aid and fiscal incentives. GSE is in charge of managing and paying the incentives. Feed-in tariff (FiT) and feed-in premium (FiP) schemes have been the main types of support programmes. In addition, electricity consumers that are also producing electricity from small renewables plants can benefit from net billing ("*scambio sul posto*").[6] The net billing, together with tax incentives for building renovations that include a renewable component (see Chapter 4), has been the main support for increasing small-scale PV applications on buildings after the end of the PV-dedicated FiP scheme ("Conto Energia") in 2013 (IEA, 2021). However, overall, the growth of distributed PV has been disappointing since 2013.

[6] They are paid at market price the electricity injected in the grid in excess of the withdrawals of electricity in a given calendar year. Production surpluses can be carried over to subsequent years.

Box 5.1 Energy communities in Italy

The first experiences of renewable energy communities in Italy date back to the early 2000s, mainly in the north of the country. Initially, the energy communities were small local initiatives. In recent years, they have expanded, enlarging their membership and projects, benefiting from economies of scale and becoming more efficient in providing services. As of mid-2021, there were about 20 energy communities in Italy, which was consistent with current legislation. This compares with 1 750 in Germany, the European leader, 70 in France and 33 in Spain. These energy communities are mainly pilot projects, built around small photovoltaic plants (Utilitatis and RSE, 2022).

Italy regulated energy communities for the first time only in 2019. The legislation defines energy communities and collective self-consumption as final consumers/renewables producers that foregather to share electricity locally produced by new renewables plants with a capacity of up to 200 kilowatts. Energy communities and prosumers benefit from a targeted incentive mechanism for shared electricity (EUR 100-110/MWh) for 20 years. The RED II Decree raised the capacity limit to 1 MW and adjusted the incentive mechanism. The NRRP provides EUR 2.2 billion to public administrations, households and micro-enterprises in small municipalities (up to 5 000 inhabitants) to build energy communities and install 2 GW of renewable power capacity. However, as of end-November 2022, the necessary implementation regulations were not in place yet. The uncertainty about the regulations and the incentives has discouraged potential investors so far. Public consultations on the issue ended in mid-December 2022.

Since 2019, the incentive mechanism introduced by the so-called Ministerial Decree RES1 has been the main support scheme for renewable electricity produced by mature technologies (PV, wind, hydro, sewage gas). It provides a FiT to smaller plants (up to 250 kW) and a sliding FiP to larger plants, including new, refurbished and upgraded plants.[7] The incentives are awarded based on competitive reverse auctions or registers depending on plant capacity.[8] The other incentives in place as of mid-June 2022 include the FiP scheme for energy communities and self-consumption (see Box 5.1) and the FiT/FiP scheme for small islands.

The new auction programme aimed at contracting 5.5 GW of new solar PV and onshore wind capacity through seven auctions by 2022. At the time of writing, only 3.2 GW had been awarded. The long and complex permitting process, as well as restrictions on the use of agricultural land, have been holding developers back from participating in the auctions (IEA, 2021). The new auction programme resulted in awarded tariffs, obtained as the difference between the incentive and the energy price, lower than energy prices for the first time since auctions were introduced in 2012. The RED II Decree requires the government to develop five-year plans indicating the capacity that can be awarded at each auction until the 2030 target has been achieved. This aims to provide potential investors with visibility over incentive availability and reduce the uncertainty that hampered

[7] With a sliding FiP mechanism, the plant operator receives the premium if the electricity price is lower than the guaranteed tariff, but pays back the difference between the electricity price and the guaranteed tariff if the electricity price is higher.
[8] Applicants to the register are ranked according to priority criteria, including the guaranteed tariff.

investment in the past (IEA, 2016). However, as Italy's example has shown, permitting issues can still result in auction volumes not being fully awarded.

As of end-2020, 933 000 plants were receiving some form of incentive, equivalent to 38 GW capacity. The vast majority of plants were PV, with an installed capacity of nearly 20 GW. The supported generation has remained stable at 65 TWh per year in 2018-2020. In 2020, the renewables incentive mechanisms cost nearly EUR 12 billion, more than half of which supported PV under the discontinued FiP "Conto Energia" (GSE, 2021).

The net cost of the support schemes is recovered through a component of the electricity tariffs that is included in the system charges.[9] The net cost of the renewable support schemes grew rapidly from around EUR 3.6 billion in 2010 to over EUR 14 billion in 2016. It has declined since, thanks to changes in the incentive mechanisms. GSE foresees the cost to continue to gradually decrease with the end of the incentive periods for the various supporting mechanisms (GSE, 2021).

In 2020, the renewables-related tariff component accounted for about 15% of the average electricity retail tariff for domestic customers. To contain surging energy prices in 2021 and 2022, the government set the overall system charges to zero from October 2021 to at least September 2022 (see Chapter 7). System charges cover mainly the incentives for renewables, social tariffs and the cost of the reduced rates for high-consuming manufacturing companies.

As of 2022, a share of the annual proceeds from the auctioning of the CO_2 allowances under the EU ETS will be used to cover the costs of promoting renewables and energy efficiency. Italy has not consistently met the EU requirement of spending half of the revenue from auctioning allowances on climate-related measures.

Administrative procedures

The long and complex permitting process is the main cause for the low level of actual capacity additions. The process starts with a connection request to the grid operator[10] and continues with the so-called "single authorisation procedure". This includes the environmental impact assessment (EIA) of both the plant and grid works and all other permits. The national or regional administrations are responsible for this authorisation, depending on the size and location of the plant.[11] The "single authorisation procedure" is the longest part of the process. In 2017-2020, it lasted on average 7.5 years, far above the legal limit of 1-2 years (Althesys, 2021). This has increasingly been due to local opposition to large wind and PV plants, coupled with a lack of interest by regional governments, as most of them had already achieved their 2020 targets a few years earlier.

The long process leads to many projects being abandoned. As of 2021, more than 100 GW of renewable capacity was stuck at various stages of the administrative process (IEA, 2021). Italy's first offshore wind plant (30 MW) opened in April 2022, after 14 years of legal and administrative battles.

[9] Enterprises with high electricity consumption pay only part of the tariff component related to the support of renewables. The cost of this exemption is paid through the general system charges by all other electricity customers.
[10] The first step of the permitting process is the request of connection of the planned generation plant to the grid operator (TSO or distributors, depending on the size of the plant). The grid operator provides the developer with a connection quotation and a preliminary project for the necessary works on the grid.
[11] Once the authorisation is granted, the developer can ask the grid operator to develop and implement the grid connection project.

The government has made welcome attempts to streamline the permitting process and improve planning. In 2020, it reduced the statutory timelines for the EIA and authorisation procedures. The 2021 RED II Decree introduced other adjustments. These include setting up an online platform for permitting and establishing a special EIA commission for large projects included in the NRRP. Importantly, the decree renews the "burden-sharing" approach. It mandates the government, in consultations with the regions, to set regional targets to 2030 as a contribution to the national objective. This should improve regions' ownership of the targets and engage them in implementation. However, the target-setting process, expected to be completed by mid-June 2020, had not been completed at the time of writing. The government is also tasked with the development of the maritime spatial plan (by mid-June 2022), which is essential for offshore renewable deployment.

The RED II Decree introduced the concept of suitable areas with fast-tracked permitting procedures for renewable energy development.[12] It mandates the government to issue a regulation with the criteria for the identification of such areas. This regulation, expected by mid-June 2022, had not yet been issued at the time of writing but a draft decree was prepared and was expected to be shared with other ministries by December 2022. Regions have six months from the release of this regulation to identify suitable areas in their territories. In the case of non-compliance by a regional government, the central government can substitute the region in the planning process. Pending the approval of the government regulation and the identification of suitable areas by the regions, the RED II Decree indicates the categories of areas considered immediately suitable for accelerated deployment. In the first half of 2022, in part as a response to surging fossil fuel prices, the government released new simplification measures. These included the extension of the immediately suitable area categories, as well as simplified procedures for transmission infrastructure for offshore plants, PV installations and agrivoltaics.

To avoid transmission and distribution congestion, higher deployment of renewables should be synchronised with targeted planning of grid capacity. The RED II Decree requires grid operators to plan grid developments in accordance with expected renewables growth, with a focus on the suitable areas (see Chapter 7). In addition, Terna is required to draw up a specific plan of urgent grid works based on the renewable plants that have requested connection and are undergoing the permitting procedure.

The recent simplification measures resulted in a slight increase in installed capacity in late 2021 and early 2022, compared to previous years (see Chapter 7). However, the effect of the measures adopted in 2022 will be visible later on. The effectiveness of these simplifications depends on the ability to move swiftly to the implementation phase. There are still numerous measures to be introduced to make the RED II Decree fully operational. Priority should also be given to improving the capacity of the public administration for the permitting procedures, as well as to building consensus among local communities and all stakeholders through communication and dialogue.

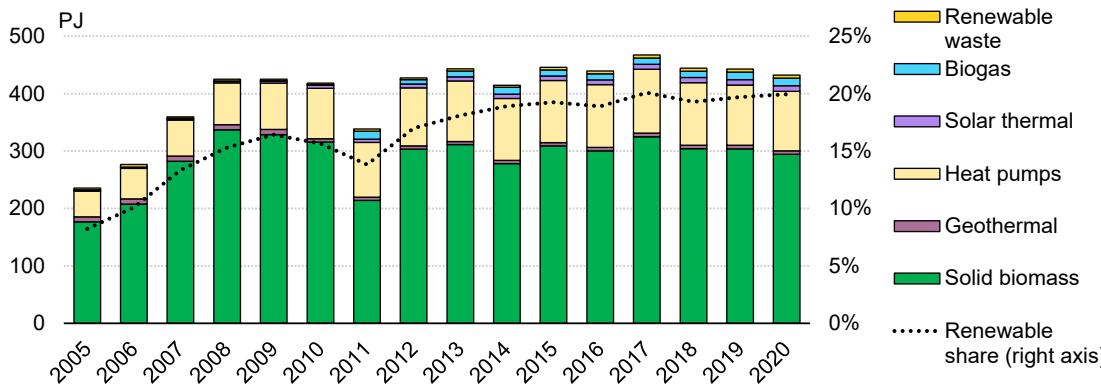
[12] Plants can also be built outside the identified suitable areas by undergoing standard permitting procedures.

Renewables for heating and cooling

Status and trends

The use of renewables for heating and cooling has grown moderately in the last decade, with annual fluctuations depending on climatic conditions (Figure 5.4). Nonetheless, in 2020, renewables accounted for 20% of gross thermal consumption, up from 16% in 2010 (using Eurostat definitions). This was partly due to a decline in the overall consumption of thermal energy in buildings, thanks to energy efficiency improvements since 2017. Hence, Italy exceeded the 2020 target share of 17.1% indicated by its NREAP (Table 5.1). However, natural gas still accounts for over half of the energy used for space heating in the residential sector (see Chapter 4).

Figure 5.4 Renewable energy in heating and cooling in Italy, 2005-2020



Solid biomass and heat pumps are the main sources of renewable thermal energy. Renewables covered 20% of the energy used for heating and cooling in 2020.

Note: The share of renewables is computed using the Eurostat methodology.

Source: IEA based on data from EC (2022).

Solid biomass (mainly firewood and pellets) accounts for most renewables in heating and cooling (68% in 2020), followed by heat pumps (24%). The remainder is covered by biogas, solar thermal and renewable waste. Despite a 20% increase in installed solar panel surface between 2015 and 2020 (to 4.5 million of square metres), solar thermal covers only about 2% of renewable energy used for heating and cooling. This compares with nearly 4% in Portugal and Austria, 6.5% in Spain, and 18% in Greece, the IEA leader. The southern regions and islands account for less than a third of thermal energy use from solar, despite their much higher solar radiation. Overall, the use of renewable thermal energy is more widespread in the northern and central regions than in southern Italy (GSE, 2022). This is linked to higher per capita investment in energy efficiency in the northern regions, reflecting higher per capita income and the higher capacity of the public administration (see Chapter 4).

Outlook

The NECP foresees achieving the 2030 target of 34% of renewables in the heating and cooling sector (see Table 5.1) primarily by increasing the use of heat pumps and, to a lesser extent, solar thermal. The use of bioenergy would remain roughly stable.[13] As acknowledged in the NECP, there is a need to encourage the replacement of old biomass-fired heating systems, which are a major source of air pollution. The government plans to link the incentives for biomass heat generators to more stringent performance and environmental requirements.

Policies and measures

The NECP's planned policies and measures do not differ from the instruments that have been in place for several years. However, their implementation regulations have changed over time, which has led to a stop-and-go uptake. These measures include: tax deductions for energy retrofitting and restauration of buildings; the so-called "Thermal energy account" (Conto Termico); and white certificates. They provide support for a combination of energy efficiency improvements and the installation of renewable heating and cooling equipment (see Chapter 4). This reflects the approach that reducing energy use by improving the thermal efficiency of buildings will contribute to achieving the renewables target. While the incentives can be used by the public sector, it is mostly the private sector that uses them. The central and local governments should consider investing directly to integrate renewable thermal equipment in public buildings, including social housing. This would help fight energy poverty (see Chapters 2 and 4).

The "Conto Termico", operational since 2013, provides capital grants for the production of thermal energy from renewables and, to a lesser extent, for small-scale energy efficiency interventions in public and private buildings. The grant can cover 40-65% of the investment cost, with a EUR 5 000 cap, for the installation of high-efficiency or renewables-based heating systems. The total budget amounts to EUR 900 million per year. Between 2014 and 2020, the programme delivered 25.4 PJ of renewable thermal energy.

The white certificates, introduced in 2005, are tradable securities that certify savings in final energy uses. They also support the replacement of heating and cooling equipment with renewables-based devices. The tax credits for energy efficiency renovations (the so-called Ecobonus and Superbonus) also support the replacement of heating and cooling systems to improve efficiency, but do not require that the more efficient equipment be fed by renewable energy carriers (see Chapter 4). This gap hampers the uptake of renewables-based thermal systems and locks in fossil fuel-based devices in buildings for years.

As of 2013, a share of the energy needs for heating, cooling and domestic hot water in new buildings and residential buildings subject to major renovations should be covered by renewable thermal energy. The share increased from 20% in 2013 to 60% for buildings requesting construction permits after mid-June 2022 (as per the RED II Decree). This is a condition to be granted the building licence, but compliance with the renewable integration requirements after the completion of the construction works should be reinforced. The NECP plans to extend the obligation to some categories of existing buildings (e.g., in the

[13] The NECP projects consumption of renewables for heating and cooling to be about 630 PJ in 2030. Thermal energy delivered through heat pumps would rise from 108.9 PJ in 2017 to 234.5 PJ in 2030. Solar thermal would grow from 8.4 PJ in 2017 to 31.4 PJ in 2030.

service sector) and to introduce minimum requirements for solar thermal. Such extensions should be given high priority. Italy also simplified the administrative requirements for installing renewables devices in buildings. As of 2022, a simple notification to the competent administration suffices (except for cultural heritage buildings). This is a welcome development that could help extend the use of solar thermal, as well as heat pumps (and PVs).

The NRRP provides funding for district heating networks, including those fed by renewables and waste. It also provides nearly EUR 2 billion for the production of 2.3 bcm of biomethane from agricultural or food residues by 2026, to be used for industry, transport and heating (blended in the gas network). This is about 60 times the amount produced in 2020. Italy's 2020 hydrogen preliminary guidelines suggest the possibility of injecting hydrogen produced with renewable electricity into the gas grid (see Chapter 2).

Meeting the FF55 renewable energy targets will require further increasing the target share of renewables in heating and cooling for 2030, from 34% as planned in the NECP to 40% (tentative target) (see Table 5.1). Introducing new measures or reinforcing the current ones will, therefore, be necessary. Italy would benefit from evaluating the cost-effectiveness of the implemented incentive measures in stimulating the uptake of renewables for thermal energy to identify those that should be continued and strengthened.

Renewables in transport

Status and trends

The use of renewable energy in transport has fluctuated in the last decade. In 2020 it was at the same level as at the beginning of the decade. Nonetheless, based on Eurostat definitions (which include multiplication factors for advanced biofuels and renewable electricity), the share of renewables in gross final energy consumption in transport grew from 4.9% in 2010 to 9.4% in 2019. In 2020, transport energy use declined with the mobility restrictions due to Covid-19. This pushed the share of renewables in transport energy use to 10.7% in 2020 and allowed Italy to meet the binding 10% target set by EU directives (Figure 5.5). Biofuels blended with diesel and gasoline are the main renewable energy carriers used in transport. In 2020, biodiesel covered 80% of renewables consumption for transport. Renewable electricity, which is used mainly in railways, followed by 19%.

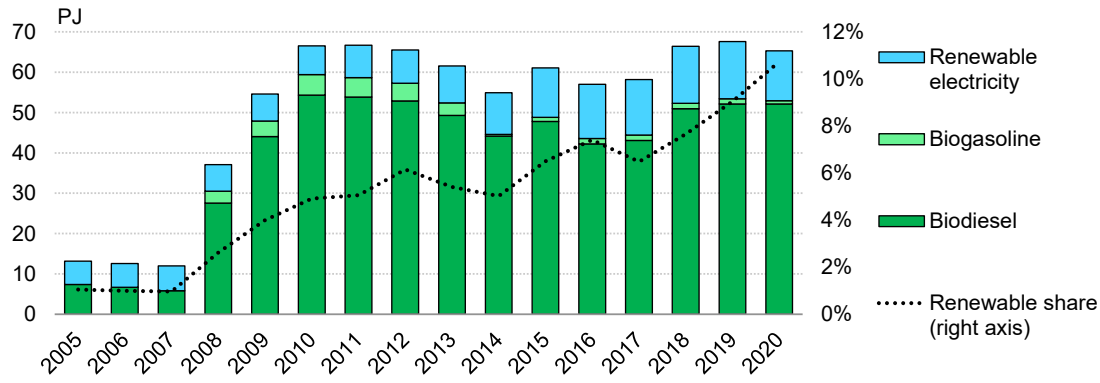
Over 90% of biofuels used in Italy in 2020 were biodiesel, mainly produced from animal fats and used cooking oil (GSE, 2022). In 2020, over 40% of the sustainable biofuels consumed in Italy were produced in the country, thanks to the expansion of biorefinery capacity in recent years (see Chapter 9). Domestic production of biodiesel and biomethane increased between 2017 and 2020. Raw materials sourced in Italy contributed to producing 13% of the biofuels used in the country (GSE, 2022).

Outlook

Italy committed to cover 21.6% of transport energy use with renewables by 2030, exceeding the binding target of 14% set by the RED II. The target is expected to be further raised in line with the FF55 package (see Table 5.1). The NECP plans to achieve this

target primarily by increasing the use of advanced biofuels, including biomethane.[14] According to the government, biofuels are a cost-effective solution in the Italian context (Italy, Ministry of Economic Development, Ministry of the Environment and Protection of Natural Resources and the Sea, and Ministry of Infrastructure and Transport, 2019). Advanced biofuels are expected to account for 7.7% of energy use in transport (compared to 3.5% as set by the RED II), while the contribution of non-advanced biofuels is expected to decline to 6.7%. The plan sets a target of 1.1 bcm by 2030 for advanced biomethane originating from agricultural waste and the organic fraction of municipal solid waste. This corresponds to the quantity needed to replace with biomethane the projected consumption of methane in road transport by 2030.

Figure 5.5 Renewable energy in transport in Italy, 2005-2020



Renewable energy accounted for more than 10% of the energy used in transport in 2020. Biodiesel is the main renewable energy carrier used in transport.

Note: The share of renewables is computed using Eurostat definitions, which include multiplication factors for advanced biofuels and renewable electricity.

Source: IEA based on data from EC (2022).

The use of renewable electricity in road transport and railways is expected to cover respectively about 6% and 1.7% of energy use in transport in 2030. Jointly considered, this will be half the contribution of biofuels. The government has taken and plans to take several measures to encourage the deployment of EVs and railways (see Chapter 4). In addition, the NECP expresses an ambition to use hydrogen for transport, which could account for 1% of transport energy use by 2030 (see Chapter 3).

Policies and measures

All biofuels released for consumption in Italy must comply with the sustainability criteria set at the EU level. They must be certified as per the Italian National Biofuels and Bioliquids Sustainability Certification System, established in 2012, or according to voluntary schemes approved by the European Commission or agreements with third countries. Of the 1.5 million tonnes of biofuels consumed in Italy in 2020, only 1 000 were unsustainable (GSE, 2022).

[14] Advanced biofuels are produced from a list of non-food materials and include agricultural and industrial wastes, residues, ligno-cellulosic materials, cellulosic materials, and algae, among others.

The biofuel blending obligation has been in place since 2006. Suppliers of fossil fuels (diesel and gasoline) can meet the obligation by acquiring, in whole or in part, the equivalent quota or corresponding rights from others, buying so-called biofuel certificates (*certificate immissione in consumo*, CICs). The CICs are tradable through a dedicated platform. The quota has been gradually raised to reach 10% in 2021. In 2018, the government also introduced a mandatory quota for advanced biofuels (2% in 2021 and 3% from 2023). Three-quarters of this quota must be fulfilled by biomethane and the remaining by other advanced biofuels. The RED II Decree sets the quota to 16% by 2030, half of which should be covered by advanced biomethane and other advanced biofuels.

The government, through the GSE, provides incentives for the production of advanced biomethane. Producers receive one CIC for every 5 giga calories of biomethane produced for ten years (each CIC is worth EUR 375). The cost of the incentive is borne by fossil fuel suppliers. The total production capacity eligible for support corresponds to the 2030 target of 1.1 bcm per year. In 2020, a fifth of this capacity was in place and produced advanced biomethane mainly from the organic fraction of municipal solid waste. The NRRP also provides support for the production of biomethane to be used in transport, as well as in the industrial and residential sectors.

Italy's focus on biomethane for road transport reflects the relatively high diffusion of methane-powered vehicles and related refuelling infrastructure. In 2021, gas-powered passenger cars accounted for 3.5% of the car fleet, the highest such share in the European Union, and there were more than 1 500 gas refuelling points, also the highest number in the European Union (EAFO, 2022). The government foresees that in mid-2025, gas-powered cars would still outnumber EVs, including BEVs and PHEVs. The NECP foresees an acceleration in EV deployment only in the second half of the decade (see Chapter 4). In 2030, the government forecasts 6 million EVs (or 17% of the expected future fleet of 36.7 million cars), compared to 2.4 million (or 6.5% of the fleet) gas-powered cars. However, according to the RSE scenario, EVs should account for 20% of the car fleet by 2030 to be in line with the FF55 proposed targets (see Chapter 2).

The Italian government favours a technology-neutral approach for clean mobility. This would allow passenger vehicles with combustion engines to be sold beyond 2035 provided they run on climate friendly fuel such as e-fuels and pure (100%) biofuels like hydrotreated vegetable oil. Biomethane can be efficiently used in sectors that cannot easily switch to direct electrification, such as some industrial facilities, as well as to produce electricity in case of insufficient production from variable renewable sources. Similarly, advanced biofuels could be better used with priority in aviation and shipping, whose direct electrification is hardly feasible. Advanced biofuels are relatively costly to produce and the domestic supply of feedstocks meeting sustainability requirements is limited (Italy, MIMS, 2022).

Assessment

The use of renewable energy has grown in Italy in the last decade, driven by the electricity sector. In 2014, Italy had already achieved its 2020 target of covering 17% of gross final energy consumption with renewables. Since then, renewable energy production has remained relatively stable. The complexity of permitting procedures, the variety and instability of support schemes, local opposition to renewable power plants, and restrictions on land use have held back investment. There is an urgent need to address these

obstacles and enhance co-ordination among all levels of government to accelerate the deployment of renewables, meet future targets and reinforce energy security.

The government estimates that the use of renewables should grow to nearly 37% of gross final energy consumption in 2030 to be in line with the EU FF55 package. This overall target would translate into higher sectoral targets than those indicated by the NECP. The LTS envisages that renewables should reach up to 90% of gross final energy consumption by 2050 to achieve carbon neutrality. The government considers the deployment of PV and wind power, heat pumps, biomethane, advanced biofuels, and renewable-based hydrogen as cornerstones towards decarbonisation. The NRRP outlines several administrative reforms to foster investment and allocates substantial funding to several renewables-related projects and interventions on the grids.

There is a wide gap between intentions and development on the ground. The government is introducing appropriate legislative changes to reduce administrative barriers and promote the use of renewable energy technology in all sectors. However, the implementation of reforms has been lagging. While the government offices and agencies in charge of renewable energy are very qualified, they are understaffed. Administrative capacity in regional and local governments is often inadequate to support the required scale and pace of renewables deployment, especially in southern regions.

Renewable electricity generation

Electricity generation from renewables more than doubled between 2005 and 2020, to cover 38% of gross final electricity consumption. This is well above the 2020 target of 26.4% set by Italy's NREAP. Solar PV, bioenergy and wind were the main drivers of this achievement. Most growth occurred between 2010 and 2014, bolstered by generous incentives to PV. However, this steep growth entailed high costs to consumers. Growth slowed down in the second half of the decade.

There is a considerable disparity in renewable power generation across regions. While most electricity demand is in the north of the country, most of the actual and potential generation from variable renewable sources is in the southern regions. A massive development of solar and wind power, coupled with anticipated lower fossil fuel-based capacity, calls for investing in grids and storage capacity, as well as for encouraging consumers to take an active part in energy markets as "prosumers". This would help improve power system flexibility and avoid curtailment of renewables.

The NECP foresees achieving the 2030 target of 55% of renewables in electricity consumption by adding 39 GW of PV and wind capacity in the decade, or nearly 4 GW per year, on average. This is more than three times the average yearly addition of 1.2 GW over the period 2015-2020 but is in line with the annual growth experienced in the first half of the last decade. Higher annual capacity additions will be needed to meet the more ambitious FF55 renewable target (estimated at 62-65% of gross electricity consumption) and the national target of 72% of renewables in electricity generation.

As of 2021, the TSO had received connection applications for a total capacity of variable renewables of 168 GW, 90% of which were for plants located in southern regions and on the islands. This extraordinary number seems to imply a significant untapped potential for renewable power. However, under current policies, the IEA forecasts an increase of about 17 GW between 2021 and 2023. A similar growth pace beyond 2023 would not be sufficient to achieve the 2030 target or to significantly reduce dependence on imports of

Russian natural gas for power generation by 2023, in line with the stated ambition of ending such imports by 2025. Therefore, there is a need to accelerate the implementation of the policies, measures and reforms planned in the NECP and the NRRP.

The government has given priority to streamlining the permitting process for renewable plants and related grid works. The long and complex permitting process is the main cause for the low level of actual capacity addition and remains a challenge for the scheduled rapid deployment of renewables to 2030. Between 2017 and 2020, the authorisation procedure took on average 7.5 years, far above the legal limit of 1-2 years. This has increasingly been due to local opposition to large wind and PV plants, coupled with a lack of interest by regional governments.

The RED II Decree, approved at the end of 2021 to transpose the EU RED II, introduces several measures to improve planning and streamline the permitting process. Notably, the decree mandates the government, in consultation with the regions, to set regional targets to 2030 to contribute to the national objective. This should improve regions' ownership of the objectives and better engage them in implementation. The 2030 renewables targets should be seen as intermediate steps towards achieving a nearly 100% renewable-based electricity system by 2050. Hence, they should be part of longer-term trajectories at national and regional levels.

The decree also introduced the concept of suitable areas for renewable energy projects that would benefit from fast-tracked permitting. This is in line with, and even anticipates, the EC's 2022 Recommendation on speeding up permit-granting procedures as part of the REPowerEU plan. Italian legislation mandates the government to issue a regulation that sets the criteria that regions must follow for identifying suitable areas. However, it would be advisable to establish coherent criteria also for the areas where no plant can be built. This would reduce discretion in permitting decisions and provide more certainty to investors.

Some simplification measures resulted in a slight increase in installed renewable capacity in late 2021 and early 2022, compared to previous years. The effectiveness of these simplifications depends on the ability to move swiftly to the implementation phase of the RED II Decree. Many of its measures are good steps forward. However, there are still numerous measures to be introduced to make the decree fully operational. Among them is the development of the maritime spatial plan, which is essential for offshore renewable deployment. The effects of these policy changes should be monitored closely.

Priority should also be given to improving the capacity of the public administration, with additional human resources and training, as well as access to e-government solutions. In this respect, the ongoing development of an online platform for permitting applications is welcome. There is also a need to improve communication and dialogue with local communities and stakeholders to build consensus around renewable power projects. In this respect, the government has taken steps to promote energy communities and prosumers as means to engage citizens in the clean energy transition and help improve public acceptance of renewable energy projects.

Italy has adopted different instruments to financially support renewable power generation. FiT and sliding FiP schemes have been the main support instruments. Several such schemes coexist. Currently, the main incentive mechanism (in place since 2019) provides a FiT or a sliding FiP depending on the technology (PV, wind, hydro, sewage gas), capacity and age of the plant. The incentive is awarded based on competitive procedures, including

reverse auctions. However, participation in the new auction programme has been disappointing. 3.4 GW out of the auctioned 6.1 GW for all renewable technologies were awarded through seven auctions by 2022. The new auction programme resulted in awarded tariffs lower than electricity prices for the first time since auctions were introduced in 2012. A five-year schedule of competitive auctions will be implemented to provide potential investors with visibility over incentive availability. This should also enable new competitors to enter the market and encourage incumbents to ramp up their capacities promptly. However, this needs to be accompanied by an accelerated approval process across all stages of the administrative process.

After growing rapidly in the first half of the 2010s, the net cost of support schemes gradually declined, thanks to changes in the incentive mechanisms. In 2020, it was nearly EUR 12 billion, over half of which was for supported PV. The net cost of the incentives is recovered through part of the system charges applied to electricity bills. In 2020-2021, the renewable support component of the system charges was about 15% of the net electricity price of the average residential customer. Reducing the burden of incentives on electricity customers is a priority for the government.

Renewables for heating and cooling

In 2020, renewables accounted for 20% of gross thermal consumption, up from 16% in 2010. Despite moderate growth, Italy achieved its 2020 target (17.1%). Solid biomass is the main source of renewable thermal energy, followed by heat pumps. Despite high solar radiation, solar thermal covers a negligible share of energy demand for heating and cooling, even in southern regions. Natural gas still accounts for over half of space heating. Therefore, increasing the use of renewables in the thermal sector is key not only to mitigating CO_2 emissions but also to reducing reliance on gas imports and mitigating households' vulnerability to gas price volatility.

The NECP foresees reaching 34% of thermal energy demand covered by renewables by 2030, primarily via an increase in the use of heat pumps and, to a lesser extent, solar thermal. The plan emphasises the need of encouraging the replacement of biomass heat generators with more efficient and less polluting devices. Meeting the FF55 renewable energy targets will require further increasing the share of renewables in heating and cooling to 40% (tentative target). Introducing new measures or reinforcing the current ones is necessary, as is improving co-ordination with measures for encouraging energy savings.

Targeted instruments to support the use of renewables for heating and cooling have been in place for several years. However, their implementation regulations have changed over time, which has led to a stop-and-go uptake. These measures, including tax incentives and capital grants, generally aim to improve the thermal efficiency of buildings. They often provide support for building renovations that combine energy efficiency measures with renewable heating and cooling systems. However, under the Ecobonus and Superbonus schemes for energy efficiency renovations, higher efficiency heating and cooling systems are eligible for the same tax credits irrespective of the energy carrier. This mechanism hampers the uptake of renewables-based systems and locks in fossil fuel-based devices in buildings for years. Italy would benefit from evaluating the cost-effectiveness of the incentive measures to identify those that should be continued and strengthened or adjusted.

As of mid-2022, 60% of the energy needs for heating, cooling and domestic hot water in new buildings and residential buildings subject to major renovations should be covered by

thermal energy from renewable sources. As foreseen by the NECP, Italy should gradually extend this obligation to other categories of existing buildings. Additional emphasis should be given to direct investment in renovating and integrating renewable thermal equipment in public buildings, including social housing. This would help fight energy poverty. In a welcome move, the government replaced the permitting requirements for installing renewables devices in buildings with a notification to the competent authority (except for cultural heritage buildings). This could help expand the use of solar thermal, as well as heat pumps. Introducing minimum requirements for using solar energy for space and/or water heating in buildings may accelerate uptake further.

Renewables in transport

The share of renewables in transport energy demand increased from 4.9% in 2010 to 10.7% in 2020, meeting the 10% EU renewables target. The bulk of renewables in transport (about 80%) consists of biofuels blended with diesel and gasoline. The remainder is renewable electricity in rail. All biofuels used in Italy must comply with sustainability criteria. Over 40% of the biofuel consumed in Italy was domestically produced, but feedstocks were mostly imported.

The NECP sets a target of covering nearly 22% of transport energy use with renewables by 2030. This target is expected to be revised upward in line with the FF55 proposals. The NECP foresees achieving the target primarily by increasing the use of advanced biofuels, including biomethane. The contribution of biofuels to the target is expected to be double that of renewable electricity.

A biofuel blending obligation, in place since 2006, has been the main policy measure driving biofuel uptake. The obligation is associated with tradable biofuel certificates. The quota has been gradually raised to reach 10% in 2021 and is set to be 16% in 2030. The government introduced a mandatory quota for advanced biofuels in 2018; three-quarters of it must be fulfilled by biomethane.

The government provides incentives for the production of advanced biomethane, intending to produce 1.1 bcm of advanced biomethane by 2030. This corresponds to the quantity needed to fuel with biomethane a growing fleet of gas-powered cars. In 2021, Italy had the highest share of gas-powered cars in the fleet (3.5%) in the European Union. This share is expected to nearly double by 2030. On the other hand, Italy is lagging in the deployment of EVs, and the NECP foresees a slow uptake until 2025, when gas-fired cars would still outnumber EVs.

Recommendations

The government of Italy should:

- Rapidly develop and approve binding targets and sub-targets for renewables by 2030 in line with the EU Fit-for-55 and the more recent REPower EU proposals, at the national and regional levels, to encourage investment, improve energy security and pave the way towards carbon neutrality.
- Facilitate, also through the Conference of the State and the Regions, regional and local authorities' ability to assess renewable electricity projects, as well as to proactively engage communities to accelerate the permitting process; monitor in a timely fashion the effectiveness of measures taken to simplify permitting procedures; and adjust them as needed.
- Implement the measures foreseen in the RED II Decree without delay; ask regional governments to identify suitable areas for fast-tracked renewables development in each region; co-operate with them to establish clear and consistent criteria for identifying areas.
- Progressively extend the minimum requirements for renewable thermal energy to existing buildings; introduce minimum requirements for using solar energy for space and/or water heating in buildings; and modify the tax credit schemes for energy-efficient renovation to increase their cost-effectiveness.
- Enhance the policy focus on the electrification for the transport sector while prioritising the use of biomethane and other advanced biofuels in sectors whose direct electrification is more difficult, such as some industries, heavy-duty road transport, aviation and shipping.
- Continue supporting the production climate friendly fuels such as e-fuels and pure (100%) biofuel such as HVO.

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6. Energy research, development and innovation

Key data

(2019)

Government energy RD&D budget: EUR 509 million (nominal)

Energy RD&D budget as a share of GDP: 0.28 per 1 000 GDP units (IEA median: 0.34)

Energy RD&D budget per capita: EUR 8.8/capita (IEA median:* EUR 11.4/capita)

* Median of 29 IEA member countries for which 2019 data are available.

Overview

Italy is a moderate innovator. In 2019, its overall research, development and innovation (RDI) intensity, as measured by RDI expenditure on GDP, was 1.5% compared to an EU average of 2.3%. Its overall patent application rate was 2.1 (number of patents per billion EUR GDP), compared to 3.3 in the European Union. Italy ranks 23 out of 27 EU countries in terms of the Digital Economy and Society Index, a composite indicator summarising the digital performance of countries (EC, 2022). There is a large disparity between the more dynamic and innovative northern and central regions, and the southern regions.

The NRRP pays attention to strengthening the legal, financial and regulatory framework for RDI, and also to encouraging more private sector engagement. Energy RDI is identified as a vital contributor to the decarbonisation of the energy supply, for strengthening economic competitiveness and enhancing energy security.

Historically, energy RDI has focused mainly on renewables, energy efficiency in buildings, fossil fuels and nuclear. Looking forward, hydrogen is emerging as an important technology to support the decarbonisation of the Italian economy.

Key actors in the energy innovation ecosystem

Numerous institutions at both the national and regional levels are involved in setting and implementing energy RDI policy. The Inter-ministerial Committee for Economic Planning and Sustainable Development[1] provides high-level political governance for overall research and innovation and approves the National Research Programme (NRP). The committee allocates overall financial resources to public research institutions.

[1] Annex A provides detailed information about institutions and organisations with responsibilities in the energy sector.

Implementation of the country's NRP occurs at the national and regional levels. The Ministry of Education, University and Research and the MiTE channel the funds for energy RDI. The National Research Council (CNR) is the main public institution conducting research in several fields. Universities also play a key role in the RDI system. Invitalia (the National Agency for Inward Investment and Economic Development), owned by the Ministry of Economy and Finance, manages all national incentives for the creation of new companies and innovative start-ups. However, it is unclear how energy RDI policy design and implementation is co-ordinated between the ministries and institutions with RDI responsibilities. Specifically in the energy sector, ENEA and RSE are the key public RDI institutions.

Energy research, development and innovation policy

Italy does not have a dedicated energy RDI policy document. Instead, several documents and strategies define its approach to energy RDI. The country's latest NRP 2021-2027 sets the framework within which the overall national strategic research guidelines are outlined. The NRP is divided into six missions that align with the European Union's Horizon Europe programme, the EU Framework Programme for Research and Innovation, and Italy's National Strategy for Smart Specialisation. Mission 5 is dedicated to RDI in "climate, energy and sustainable mobility" (Italy, MUR, 2021). Mission 5 of the NRP is further divided into four sub-themes: 1) sustainable mobility; 2) climate change mitigation and adaptation; 3) industrial energy; and 4) energy and environment.

This is the first NRP that was developed not only through consultations between the central government, the scientific community, and the state and regional administrations, but also with the participation of public and private stakeholders and civil society. This consultation process reflects a recommendation made in the last IEA in-depth review of Italy in 2016 to apply a multi-stakeholder process to define a policy for energy RDI (IEA, 2016).

The government plans to define key performance indicators to analyse the achievements and impacts of the supported RDI, based on the results of monitoring and evaluation. However, the monitoring system is not in place yet. More generally, there is only limited information available about how Italy monitors, evaluates and tracks the results of RDI.

Italy's energy RDI strategic framework revolves around the research dimension of the NECP (EC, 2020). The NRP, the NRRP and the National Electric System Research programme (dedicated to developing technologies of interest to the electricity sector and funded through a levy to the electricity tariff) all support the NECP's objectives (Italy, Government of Italy, 2021). All documents place energy RDI in the context of supporting the decarbonisation of the energy supply, strengthening economic competitiveness and enhancing energy security. The goals are in line with EU priorities and directions in this area. The Italian NECP is based on two pillars: the participation to the multilateral initiative Mission Innovation, together with the participation to the European Strategic Energy Technology (SET) Plan as a fundamental instrument for meeting the new challenges posed by decarbonisation and the targets to be achieved in the European Green Deal initiative.

The NECP identifies relevant areas for energy research and innovation priorities for 2030 and 2050. These mostly relate to renewables, energy storage, the integration of renewables within the energy system, green hydrogen, innovative material for energy

applications, electrical system security, e-mobility, biofuel, materials processes, and energy efficiency in industry and buildings.

The NECP also emphasises the development of an industrial renewable energy sector, as well as industry linked to digital architecture and automation systems. The identified energy research and innovation priorities and objectives are ambitious and achieving them will require a substantial increase in RDI investments (EC, 2020).

The NRRP is committed to Italy's ecological transition that is based on achieving a green and digital transition for which RDI, including in energy and sustainable mobility, is considered a critical component (Italy, Government of Italy, 2021). One of the NRRP's six missions is dedicated to investments in and reforms of the education and research sector. The NRRP supports basic and applied research and technology transfer to strengthen the research system along the different stages of technological maturity. Special attention is given to strengthening the RDI chain through the creation of large research infrastructures and extended partnerships for the development of research projects. This will be supplemented by a focus on enhancing technology transfer mechanisms and encouraging innovation through the systemic use of research results by industries and businesses. Partnerships and public and private investments will support the technology transfer.

The NRRP aims to overcome the obstacles to fully developing the Italian RDI sector. Structural barriers include a low level of digitalisation; weakness in the co-operation between universities, the private sector and the government; and the lack of business support for technology innovation. The lack of a stronger presence of seed capital and early-stage finance in the Italian financial market is one of the most important barriers to the development of innovative start-up SMEs (see the section below).

Resource push

Public spending on energy RD&D

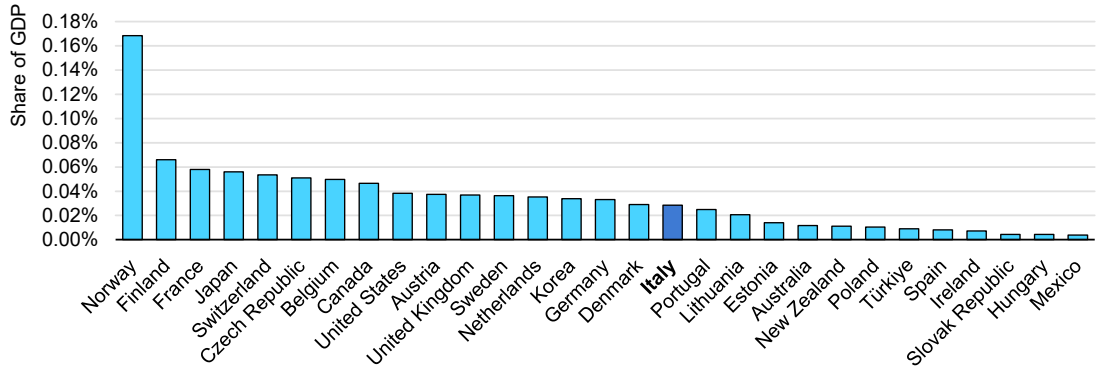
Italy's public budget on energy-related research, development & demonstration (RD&D) was 0.026% of GDP in 2019, which is 25% lower than the IEA average of 0.032% (Figure 6.1). Italy ranks in the bottom half of IEA countries reporting their RD&D data. Government and state-owned companies' energy RD&D budget was EUR 509 million in 2019. It has been increasing since 2016 (Figure 6.2).

In 2019, fossil fuels and energy efficiency were allocated 21% of the budget each, followed by renewables (20%) and nuclear (16%). The shares of budget allocated to fossil fuels and renewables have fluctuated around 20% since 2010, while the average share of energy efficiency increased from 15% between 2010 and 2018 to 21% in 2019.

The share of nuclear decreased between 2010 and 2019, while the share of the RDI budget for power and storage technology fluctuated noticeably. Cross-cutting technologies had an average share of 11% from 2010 to 2019, while the average share of the budget in hydrogen was 3% over the same period.

The government noted that the Covid-19 pandemic has caused delays in achieving the targets set through the various research programmes, not just related to energy innovation. Limited access to research infrastructures and difficulties in procuring materials have lengthened the time needed to carry out experiments.

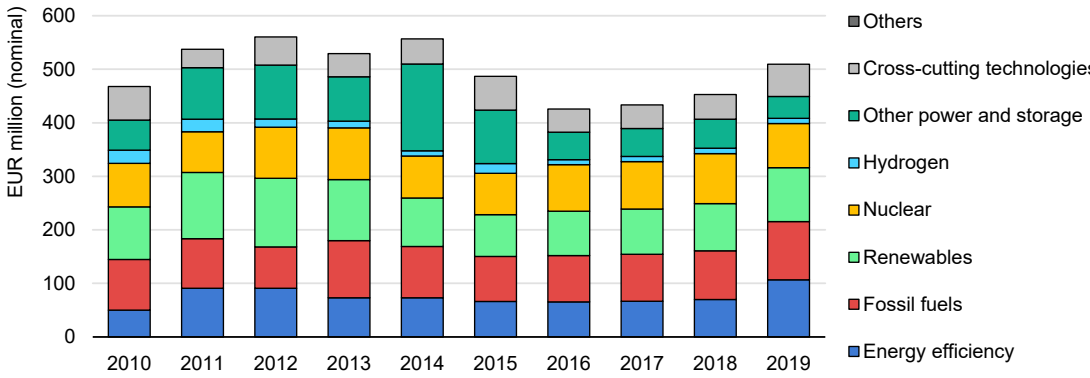
Figure 6.1 Public budget on energy RD&D per GDP in IEA countries, 2019



In 2019, Italy was in the bottom half of IEA countries in terms of RD&D spending per unit of GDP.

Note: 2019 data are not available for Greece and Luxembourg.
Source: IEA (2022a).

Figure 6.2 Energy-related public RD&D spending by technology area in Italy, 2010-2019



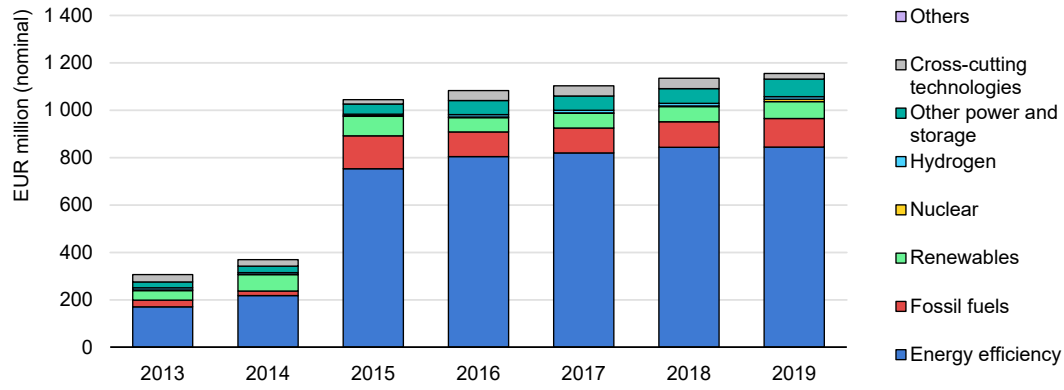
The state budget for energy RD&D has followed the same trend as Italy's economic development. In 2019, energy efficiency, fossil fuels, renewables and nuclear received roughly one-fifth of the budget each.

Source: IEA (2022a).

Private spending on energy RD&D

Italy is one of a few IEA countries that undertakes surveys to track private energy RD&D spending. Since 2013, the National Institute of Statistics collects private sector energy RD&D data in alignment with the seven categories of the IEA classification. The private sector invested EUR 1 155 million in energy-related RDI in 2019. A steep increase in private RDI investments was recorded in 2015, driven by spending related to energy efficiency and a larger number of private companies responding to the government's survey. This has exceeded EUR 800 million per year since 2016 and has been by far the sector with the highest private RDI budget since data became available in 2013 (Figure 6.3).

Figure 6.3 Energy-related private RDI spending in Italy, 2013-2019



Private funding in energy RDI more than doubled public funding in 2019. Energy efficiency accounted for 73% of private investment in energy-related research and development.

Source: IEA (2022a).

Energy efficiency dominates private energy RDI funding, followed by fossil fuel technologies and renewables. Growing allocations are made to power and storage technologies, while RDI funding for other energy sectors remains negligible.

RDI investment targets

Italy's NECP set a 2020 target for overall RDI spending to reach 1.53% of GDP (EC, 2020). Italy reached its target. The European Union has adopted a 2030 target for overall RDI spending to reach 3% of EU-wide GDP by 2030. Neither Italy nor the EU set a specific target for energy RDI spending.

The NECP aims to double the public funds for research into clean energy, from around EUR 222 million in 2013 to approximately EUR 444 million by 2021, with R&D investment in efficiency, biofuels, renewables, advanced materials, hydrogen and smart grids. This is in line with Italy's commitment under the multilateral initiative Mission Innovation (MI) (see also the "International collaboration" section below). However, according to the European Commission's assessment of the NECP, maintaining the MI commitment appears very ambitious and challenging (EC, 2020). In addition, the plan does not clarify the national objectives or funding targets, and the links with the EU Strategic Energy Technology Plan priorities remain weak.

Energy RDI funds

There are a large number of funds to support RDI in Italy. EU programmes, namely Horizon 2020 and Structural Funds, have contributed EUR 9.3 billion (as of end-2021), to Italy's research and innovation activity. Under Horizon 2020, Italy received EUR 385 million from 2014 to 2020 for energy research (APRE, GSI, 2021). Overall, Italy received 9% of all EU funds targeting energy research. The share of funding under EU Horizon accounts for about 3.5% of the total Italian RDI funding.

The general RDI funds and incentives can be used for energy-related RDI. These include projects of relevant national interest, which are selected through a competitive mechanism. The 2022 call for projects will allocate EUR 750 million to at least 3 000 projects proposed

by universities and research centres. Some programmes target energy RDI, among others. For example, the National Plan for Industry 4.0 offers a range of support instruments to facilitate the digitalisation of the energy sector.

In the coming years, the MiTE will manage public funds in the order of EUR 765 million for energy RDI under three pillars.

(i) The Fund for Research of the Electricity System supports research of general interest and industrial research. The MiTE elaborates a three-year plan for the fund, which is financed by the revenue of a levy on the electricity bill. The three-year national plan (2022-2024) allocates EUR 210 million to RDI for decarbonisation and digitalisation. Decarbonisation includes support of RDI in hydrogen, storage, PV, solar thermal, wind and geothermal energy. Digitalisation includes RDI areas such as smart grids and the integration of renewables into the electricity grid. The national programme is managed through ENEA, the CNR and RSE, with strong involvement of other partners such as national universities and companies.

(ii) Through MI, EUR 395 million will be spent for RDI supporting public institutions and with two calls for tenders.

(iii) The NRRP foresees investments of EUR 160 million (2022-2026) for RDI in hydrogen and fuel cells. The NRRP also provides financial incentives for the participation of Italian companies in strategic value chains through initiatives such as “Important Projects of Common European Interest”; 12 Italian companies participate in 2 projects related to batteries and hydrogen to push forward innovative projects in collaboration with other EU member states.

Other funds specifically targeting energy RDI include:

- The Fund for Interventions and Measures for Technological and Industrial Development provides financial support in the fields of renewables and energy efficiency. The fund is financed by a levy on electricity and natural gas bills. It provides up to EUR 100 million per year in funding.

- Part of the funds available from CO_2 auctions can cover experimental development costs incurred to build a first-of-a-kind project to support the ecological transition.

Support to start-ups and entrepreneurs

The government has identified the lack of sufficient seed capital and early-stage finance as one of the important barriers to the development of innovative start-up SMEs. To address this, the government has put in place several supportive laws and programmes over the last decade (IEA, 2022b).

A dedicated programme supports innovative start-ups, including in the energy sector. The programme has four pillars: i) exemption of stamp duties when registering a start-up; ii) “smart & start Italia” (zero interest loans of up to 80% of the expenditure incurred); iii) “smart money” (financial support for the implementation of development projects); and iv) “voucher 3i program” that accompanies a project through the process of patentability by providing subsidies for the verification process and for drafting and filing fees. Regional public agencies also provide support for innovative SMEs and several regions have set up their own investment vehicle for this purpose.

Box 6.1 Future focus on hydrogen in Italy

Like many other IEA countries, Italy considers hydrogen a key technology for the decarbonisation of the energy system. Investments in hydrogen RDI are therefore increasing in prominence in the country's RDI policies. The government plans to spend at least EUR 360 million on hydrogen RDI in the period 2022-2026: EUR 160 million funded by the NRRP and EUR 200 million through MI's clean hydrogen mission.

Of the total amount, EUR 110 million will be made available to support hydrogen-focused research in four priority areas: 1) clean and green hydrogen production; 2) innovative technologies for hydrogen storage and transport and its transformation into derivatives and e-fuels; 3) fuel cells for stationary and mobility applications; and 4) integrated smart management systems to increase the resilience and reliability of smart hydrogen infrastructure.

An additional EUR 50 million is foreseen for joint public-private projects to accelerate the implementation of the most innovative projects under the second priority area. A special focus is placed on supporting the introduction of hydrogen for rail and heavy transport.
Of the remaining EUR 200 million, over EUR 20 million will be allocated for pre-normative research and a yet to be determined share will be allocated to demonstration projects.
The Hydrogen Demo Valley is a flagship project of ENEA. It aims to create an at-scale, fully integrated hydrogen cluster within the precinct of ENEA Research Centre for showcasing hydrogen products across the value chain. The project was kicked off in 2021 and funded with EUR 14 million under the first MI Hydrogen Challenge (Hydrogen Central, 2021).

The 2020 Preliminary Hydrogen Guidelines indicate that hydrogen can account for 2% of final energy consumption by 2030, thereby cutting about 8 Mt CO_2. However, the government has not set specific quantitative targets for the role of hydrogen in the Italian energy sector (see Chapter 3).

Italy also offers various tax incentives for private investors in innovative start-ups, either as equity or through the provision of risk capital. However, the scheme is set to expire at the end of 2022. Since 2020, Italy has been operating a National Fund for Innovation. It provides financial support to boost the Italian start-up ecosystem through a variety of means, including risk capital, subsidised loans, direct investment in venture capital or indirect investments for incubators. The fund targets technologies and sectors that have been identified as strategic for Italy. However, no detailed information is available about energy-related start-ups supported under the fund, which has a budget of EUR 1 billion.

Special attention is given to the technological transfer from research to business. The government has set aside more than EUR 11 billion to address the fact that Italy lacks the enabling organisational structure and supportive framework needed for translating research outcomes into new businesses and patents.

The Invitalia Network offers dedicated support to start-ups based in the five southern regions of Italy. It supports entrepreneurial skills developments and helps establish contacts with large private sector companies.

An interesting initiative is the direct support for SMEs aiming to gain international exposure and the operation of so-called innovation desks in international cities including Paris, London, Mumbai and Singapore, and the global start-up programme that operates in ten countries. Italian companies aiming to enter markets abroad can also make use of the Italy Cleantech Network.

In 2017, Italy approved the creation of public-private research partnerships to establish national energy technology clusters. Since then, over 90 public and private entities have joined the initiative, which is closely aligned with priorities set under the NRP, the National Energy Strategy, the Industry 4.0 initiative and the country's Smart Specialisation Strategy.

In its assessment of the country's NRRP, the European Commission notes that measures proposed in the NRRP to overcome the identified shortcomings have a high potential to allow Italy to more fully exploit the potential that start-ups and SMEs offer (EC, 2021).

Education and skills

Italy is considered to be a moderate inventor (EC, 2022). This is due to an insufficient institutional, administrative and taxation framework, but also the result of insufficient attention to and investments in education and research capacities. Moreover, Italy is suffering from a notable brain drain of graduates with tertiary education and researchers. In 2022, the government allocated EUR 660 million to reverse the brain drain of researchers to encourage up to 900 researchers to return to Italy (Turone, 2022).

In 2018, Italy allocated 0.6% of its public education spending on tertiary education, below the OECD average of 0.9%. Italy spent about USD 12 300 per student per year; below the OECD average of just above USD 17 000 (OECD, 2021). Italy has a higher share of engineering graduates from tertiary education (15.3%) compared to the OECD average of 14.2% (OECD, 2022a).

The NRRP notes that only 28% of Italy's population between the age of 25 and 34 has acquired a tertiary education compared to an OECD average of 44% (Italy, Government of Italy, 2021). Consequently, the NRRP includes a dedicated mission to reform the education, skills development and research sectors and allocates over EUR 19 billion for necessary investments.

Investments will be made along the entire education value chain and will target teachers, teachers' education, revising curricula but also investments in physical assets such as upgrading educational infrastructure and research facilities, establishing stronger links between business and science, and creating more mobility for researchers to make the area more attractive. This addresses the fact that Italy is lagging behind other European countries regarding the share of personnel employed in RDI. Those plans are considered to have the potential to enhance the country's human capital as well as its research capacities in the long term (EC, 2021).

Knowledge management

International co-operation

Italy's public and private sectors are actively engaged in numerous international collaborations in the energy RDI sector.

The MiTE and the Ministry of Education, University and Research closely co-ordinate the country's energy research innovation activities with the European Union Strategic Energy Technology Plan. Italy actively participates in European networks such as the European Technology and Innovation Platforms, the European Energy Research Alliance, the Clean Energy Transition Partnership, and the European Covenant of Mayors for Climate & Energy initiative. ENEA is one of the founders of the European Energy Research Alliance and Italy participates in all of its 18 joint research programmes. Italy is also home to the European Commission Joint Research Centre Ispra, which is considered to be one of the leading research institutes in Europe with numerous laboratories also in the energy sector.

Italy participates in 23 out of the 38 IEA technology collaboration programmes (TCPs) (Table 6.1). Through European Atomic Energy Community (EURATOM), Italy also indirectly participates in eight TCPs related to nuclear fusion. The Italian government pays particular attention to the TCPs on renewables, hydrogen, electricity and cross-cutting issues. Notably, Italy chaired the IEA's Committee on Energy Technology for six years from the beginning of 2014 until the chairwomen retired at the end of 2019 and has been holding the position of vice-chair since. Since the last in-depth review in 2016, Italy has joined seven additional TCPs.

Table 6.1 Italy's participation in IEA technology collaboration programmes

	Contracting parties	Sponsors
Cross-cutting	3	1
Buildings	4	0
Industry	1	2
Transport	2	0
Electricity	3	1
Fossil fuels	2	1
Renewable energy and hydrogen	8	0

Italy, through the MiTE, is a major financial supporter of the IEA Digital Demand-Driven Electricity Networks initiative to foster power system digitalisation and modernisation, the effective utilisation of distributed energy resources, and demand response.

Italy is actively involved in the Clean Energy Ministerial (CEM) and is a founding member and chair of the International Smart Grid Action Network (ISGAN) within the CEM and the IEA. Italy participates in all ISGAN annexes.

Mission Innovation

Italy joined MI Phase 1 in 2015. Under this umbrella, it set up the Hydrogen Task Force, promoted the Smart Grids Innovation Accelerator and participated in all eight innovation challenges.

In June 2021, Italy joined MI members in launching MI Phase 2. Italy has allocated a total budget of EUR 395 million for the period 2021-2026 for MI Phase 2. Of this budget, around EUR 358 million will be used for calls for tender. The remaining EUR 36 million are allocated to the creation of a fund established by the MiTE, which is implemented through a three-year RDI programme. The programme is managed by ENEA in co-operation with the CNR, RSE and Italian Institute of Technology. It focuses on clean energy/innovative materials (EUR 8.6 million), smart grids (EUR 9.7 million) and hydrogen (EUR 17.5 million).

Italy participates in two out of three missions of the second phase of MI: Green Powered Future and Clean Hydrogen. Italy, through RSE, leads together with the People's Republic of China and the United Kingdom, the MI "Green Powered Future Mission", a global collaborative framework to demonstrate that, by 2030, power systems in different geographies and climates will be able to effectively integrate up to 100% variable renewable energy sources.

ENEA co-ordinates the Italian partners (the CNR, RSE and the Italian Institute of Technology) participating in the Clean Hydrogen mission. Through this engagement, Italy aims to create a national hydrogen research cluster and pioneering industrial hubs in several regions, in line with the NRRP funding for hydrogen R&D.

The MiTE is the lead administration of the Italian participation in MI. To this end, it co-operates with the other concerned ministries (foreign affairs, economy, research) and relevant public RDI institutions (including ENEA, the CNR and RSE). The government believes that participation in MI can offer a significant contribution to facing problems such as low private sector participation in RDI investment in the energy sector and the high degree of fragmentation among the RDI actors.

Italy endorsed the Glasgow Breakthrough Agenda, launched at COP 26 in 2021, which aims to make clean technologies the most affordable and accessible choice globally in each of the most polluting sectors for all countries by 2030, and supports the developing world to access the tools needed to transition to net zero.

Gender equality in the energy sector

The international energy community recognises the importance of encouraging more females to be involved in the clean energy transition. Italy encourages gender equality and diversity in the energy sector and initiatives that promote a more inclusive and equitable energy future. In 2019, the share of male tertiary graduates in science, technology, engineering and mathematics (STEM) was significantly higher than the share of female graduates. However, compared to the OECD and G7 averages, Italy had a notably higher share of female STEM graduates (OECD, 2022b).

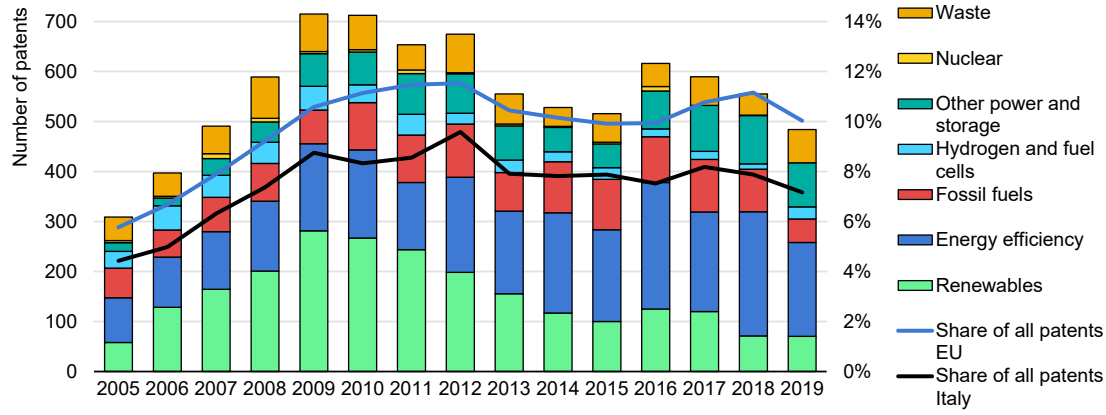
Italy is one of the founding members of the CEM initiative "Clean Energy Education and Empowerment" (C3E), which deals with the role of women in clean energy. In June 2017, the CEM C3E Initiative was reorganised as an IEA TCP, of which Italy is a member. ENEA and Italian energy companies Edison, ENEL, Falck renewables and Snam participate in the Equal by 30 initiatives. Equal by 30 is a commitment by public and private sector organisations to work towards equal pay, equal leadership and equal (technical) opportunities for women in the clean energy sector by 2030. Equal by 30 asks companies and governments to endorse principles, then take concrete action to increase the women's participation in the clean energy sector and close the gender gap. It is not clear to what extent this is supported by the government.

Intellectual property

Italy has a relatively low number of patents in energy- and climate-related technologies. After growing between 2005 and 2009, patent applications declined with the global financial crisis. The share of climate-related patent applications in all technologies followed the EU trend, growing at the beginning of the decade and declining or stabilising afterwards. However, Italy's share of climate-related patent applications in all technologies

remained steadily below the EU average (Figure 6.4). New patents in climate change mitigation technologies were 7% of all patent applications in 2019, compared to 10% in the EU OECD countries (OECD, 2022c).

Figure 6.4 New patents in energy-related climate change mitigation technologies in Italy, 2005-2019



Since 2013, the majority of Italian patents relate to energy efficiency technologies and accounted for 39% in 2019.

Source: OECD (2022b).

The NRRP includes provisions to reform Italy's intellectual property (IP) system, which the government has identified as one of the obstacles preventing the transfer of research output into productive systems through commercial agreements and the creation of new businesses. A five-point plan for the period to 2023 was launched in June 2021, aiming to:

(i) improve Italy's IP protection system
(ii) encourage the use and spread of IP, in particular by SMEs
(iii) increase knowledge of, and ease of access to, patents
(iv) guarantee more rigorous enforcement of IP rights
(v) strengthen Italy's role in IP at the international level (Vaccarello, 2022).

The action plan is rather ambitious given the short implementation period. But if it is indeed implemented, it has the potential to significantly enhance the IP system and boost Italy's ambition with regard to knowledge creation and its manifestation in new businesses and employment creation.

Assessment

The Italian government is increasing its policy focus on energy-related RDI to support Italy's energy transition. Consequently, the public budget for energy-related RDI increased from 2016 to 2019 to 0.026% of GDP. However, this is still lower than the IEA average of 0.035%. In 2019, fossil fuels, energy efficiency and renewables accounted for almost equal shares of the public energy RDI budget followed by nuclear (16%). Looking forward, the government is planning to notably increase the funding for RDI in hydrogen, which has been identified as a key technology for the decarbonisation of the Italian energy system.

Italy does not have a dedicated RDI strategy for the energy sector. Instead, the sector is covered by several documents and strategies including the NRP 2021-2027, the NECP and the NRRP. “Climate, Energy and Mobility” is one of the six priority areas of the NRP 2021-2027. The NECP’s research priorities include renewables, storage, electrical system security, e-mobility, bio-refineries and energy efficiency. The NECP reiterates the country’s commitment under MI to double the public funds for research in clean energy, from EUR 222 million in 2013 to EUR 444 million by 2021. At the time of writing, data for 2021 were not yet available. The NRRP considers energy RDI essential for the green and digital transitions. The NRRP includes a dedicated mission to overhaul Italy’s education and research sector to contribute to Italy’s green and digital transition.

Public funds for energy-related RDI will substantially increase in the coming years, in line with Italy’s commitment under MI, and also due to European support programmes. The MiTE plans to spend an additional EUR 765 million on energy-related RDI over the period 2022-2026. By far the single largest commitment is for RDI on hydrogen, of at least EUR 360 million. These additional funds must be absorbed by national projects/activities in a short time frame, while it is not clear what the funding situation will be after 2026 when some of these funds end. Additional funding after 2026 will be needed to maintain momentum.

For the national energy RDI programme, there are annual reviews of the plans to check progress and compliance with the goals. However, it is not clear how the overall success of public energy RDI efforts is measured and evaluated.

Numerous national and regional institutions are involved in setting, funding and implementing energy RDI policy. The process for setting RDI strategies and targets is not entirely clear. An independent expert body overseeing these institutions and reporting and making recommendations directly to the government would ensure the coherence of RDI strategies and targets. A central public body offering information on funding opportunities specifically for energy-related RDI would be helpful for companies, start-ups, public institutions and universities. With regard to strengthening Italian participation in EU RDI programmes such a body already exists in the form of the Agency for the promotion of European research by providing information, education and assistance services.

Private spending on energy RDI was more than double the public budget in 2019. It has increased strongly since 2014, driven mainly by investment in energy efficiency research. In addition to a few large players, there are several smaller players (SMEs, start-ups) that could benefit from being integrated into larger RDI projects. New energy concepts often need to be tested on a larger scale, for which technology platforms are suitable, where different actors from industry and academia work together.

Energy RDI suffers from the same structural weaknesses as the entire Italian RDI system: a low level of digitalisation, weak co-operation among the various RDI stakeholders and insufficient business support for technology innovation. The SME and start-up sector suffers from insufficient access to funds, which limits its ability to fully develop its potential. To address these barriers, the government has created several loan facilities and other support mechanisms, including tax credits and a guarantee fund for SMEs. To judge the effectiveness of these instruments, the government should implement a comprehensive evaluation and monitoring system.

As a manufacturing country, the availability of well-skilled human capital is important for Italy, and higher education, especially in technical disciplines, is crucial to provide the

industry with appropriately skilled professionals. Italy's share of climate-related patent applications (which include several energy-related technologies) has steadily remained below the EU average in the last decade. New patents in climate change mitigation technologies were 7% of all patent applications in 2019, compared to 10% in the European Union. It is a welcome step that the government has placed a priority on modernising the Italian patent system to ensure that more research outcomes are translated into actual businesses. Since 2017, a network of public-private partnerships is being rolled-out to set up energy technology clusters. These are all steps in the right direction.

Italy's energy research is strongly focused on technological aspects. The government should consider enhancing this through targeted efforts to ensure the acceptance of new energy technologies and behavioural changes by the population. For example, one IEA country had to stop the roll-out of hydrogen charging infrastructure due to opposition by the local population related to security concerns. This could have been avoided through upfront engagement with the concerned residents.

Recommendations

The government of Italy should:

- Develop a dedicated energy research, development and innovation policy and strategy and a long-term action plan for energy-related RDI, which is in line with Italian energy strategies and policies. Such a plan can serve as a basis for various research and innovation programmes. Its implementation should be monitored by an independent body.
- Create a one-stop shop to provide information free of charge about all available funding opportunities at the national and EU levels to help develop funding proposals, and to serve as an intermediary contact point between energy research institutions, large companies and start-ups.
- Specify what hydrogen research is needed, both on supply and applications, to avoid wide-ranging research proposals with little potential.
- Analyse the strengths of the Italian manufacturing industry and target research programmes to further strengthen this sector in value creation associated with the development and use of new energy technologies through innovation.

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7. Electricity

Key data

(2021)

Electricity generation: 287.0 TWh (natural gas 50.2%, hydro 15.8%, solar 8.8%, bioenergy and waste 7.5%, wind 7.3%, coal 5.6%, oil 2.7%, geothermal 2.1%), -5% since 2011

Electricity net imports: 42.8 TWh (imports 46.6 TWh, exports 3.8 TWh)

Electricity consumption: 300.6 TWh (industry 46.9%, service sector buildings 27.0%, residential buildings 22.4%, transport 3.7%), -4% since 2011

Peak load: 55.2 GW (July 2020)

Installed capacity: 118.4 GW (2022)

Overview

The Italian electricity system has undergone major changes since 2010. While total generation has mirrored the economic cycle, the electricity mix has changed with increasing shares of renewables (from 28% of generation in 2011 to 40% in 2021) and a decreasing role of coal (from 17% to 6%) and oil (from 7% to 3%). Generous support schemes have pushed the deployment of renewable electricity, especially solar until 2013, but deployment has since slowed down. However, natural gas dominates electricity generation, covering half of the total output in 2021.

The Russian invasion of Ukraine presents an extraordinary challenge for Italy's electricity system, as its reliance on fuel imports from Russia for electricity generation is the highest among IEA countries. This dependence, combined with volatile global energy markets, is a major risk to the country's energy security. However, the reduction of Russian gas may also entail increased GHG emissions in the short and medium term if coal use increases to replace natural gas. In October 2017, the government pledged to close down all coal-fired power plants by 2025 and set up a capacity market to ensure the adequacy of supply while coal is phased out.

At the same time, the current energy crisis can be an opportunity to accelerate the transition towards a low-carbon electricity mix and the deployment of renewable electricity generation, which is needed if Italy is to meet the 2030 renewable targets (within the EU FF55 package), as well as carbon neutrality by 2050. Sizeable new capacity from renewables, mainly solar and wind, will be required to meet increasing electricity demand due to the planned progressive electrification of end-uses. A large number of applications for new renewable plants have already been submitted, but long permitting procedures are slowing down their deployment. Large investments in the grid, storage capacity and

system flexibility are needed to integrate the new capacity from variable renewables and a secure future electricity system. Integrated planning is paramount to ensure the cost-effectiveness and reliability of the electricity system.

Italy has one of the highest electricity prices among IEA member countries. The liberalisation process of the electricity retail market started in 1999 as part of the EU internal energy market reform and is expected to increase competitiveness in the retail market and help reduce electricity costs for final customers. However, the deadline for the full liberalisation of the market has been postponed several times. More than 10 million household customers are still served with partially regulated tariffs ("enhanced protection services"). The government plans to progressively eliminate regulated tariffs by 2024.

Electricity supply and demand

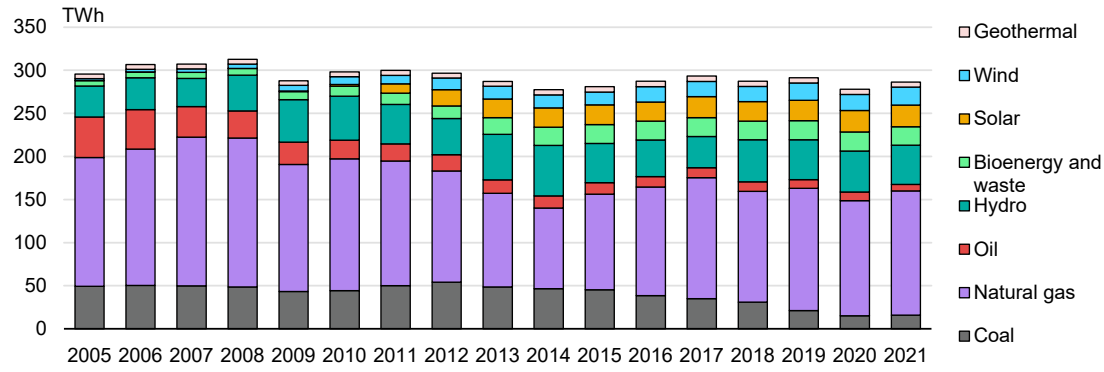
Generation

Electricity generation fluctuated around an average of 288 TWh between 2011 and 2021, below the levels of the previous decade (Figure 7.1). In the last ten years, the role of renewables in the electricity mix grew, while that of oil and coal declined. Nonetheless, Italy's electricity mix heavily relies on fossil fuels, which accounted for 58% of total electricity generation in 2021. This is one of the highest shares among European IEA countries. Natural gas is the main source for electricity generation, covering 50% of total generation in 2021, the second-highest share among European IEA member countries (Figure 7.2). The share of natural gas decreased from 2010 to 2014, when it reached a minimum of 34%, to later increase again to compensate for the slowed growth of renewables and declining generation from coal and oil. Electricity generation from coal dropped significantly from a peak of 18% in 2012 to 5.6% in 2021, as a part of a plan for the coal phase-out by 2025. Oil decreased from 6.6% in 2011 to 2.7% in 2021 (Figure 7.1).

Italy had the second-highest dependence (23%) on electricity generation from Russian fuel imports among IEA member countries in 2021, just after Hungary (Figure 7.3). The main reason for this dependence is the high share of natural gas in electricity generation, combined with Italy's high reliance on imports of natural gas from Russia (41% of natural gas net imports in 2021). Italy also depends on coal imports from Russia (62% of coal net imports in 2021). IEA analysis shows that an additional 2 GW of renewables (1 GW of solar PV and 1 GW of wind) would reduce Italian dependence on Russia for electricity generation by 1%.

Renewable energy sources accounted for 40% of electricity generation in 2021, similar to the average of European IEA countries (40%). Hydro is the second source of electricity generation after natural gas. It has experienced yearly variability due to changes in precipitation patterns but has fluctuated around an average of 16% of total generation since 2011. Driven by a generous FiT regime, electricity from solar increased rapidly from 0.6% of total electricity generation in 2010 to 7.5% in 2013. With the change in the support scheme, PV generation has grown only slightly since and reached 8.8% of electricity generation in 2021. Similarly, bioenergy and waste experienced a fast increase from 3.9% in 2010 to 6.7% in 2013, to later slow down and reach 7.5% in 2021. The fifth source of electricity is wind, which had a more gradual growth and more than doubled its share from 3% in 2010 to 7.3% in 2021.

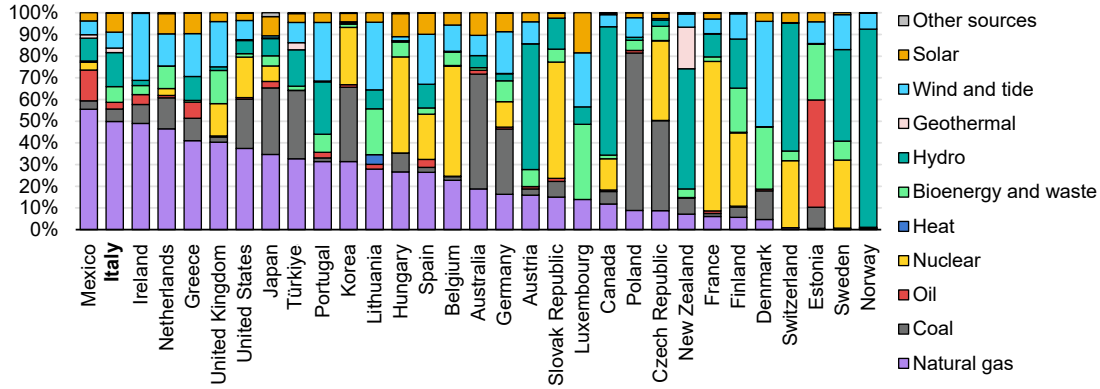
Figure 7.1 Electricity generation by source in Italy, 2005-2021



Electricity generation has remained nearly stable since 2005, but the mix has changed in favour of natural gas and renewables.

Source: IEA (2022a).

Figure 7.2 Electricity generation by source in European IEA countries, 2021

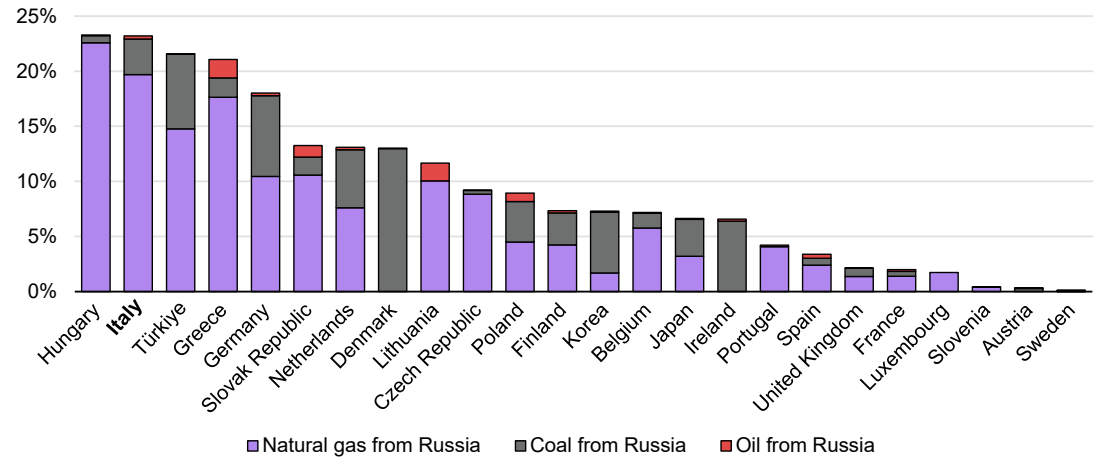


Gas-fired electricity generation covered half of Italy's generation in 2021, the second-highest share among European IEA countries.

Note: Countries are ordered by share of natural gas in electricity generation.

Source: IEA (2022a).

Figure 7.3 Dependence of electricity generation from Russian imports, selected IEA countries, 2021



Italy is the IEA country with the second-highest dependence on electricity generation from Russian fuel imports.

Source: Based on IEA (2022b).

Installed capacity

Italy's total gross installed capacity was 118 GW in 2022 (Table 7.1). Thermal capacity was 58.8 GW, 58% of which was combined electricity and heat generation and 42% was plants producing only electricity. While total thermal capacity is decreasing, renewable capacity is on the rise, with wind and solar adding respectively 1.7 GW and 3.0 GW of capacity since 2016.

The peak load is typically around 55 GW, but it exceeded 60 GW in 2015, as a consequence of strong heat waves hitting the country in the summer (WMO, 2015). While before 2005 the peak load was typically in winter, since 2008 the peak load has been shifting to the summer months, as electricity demand for cooling increases due to more frequent heat waves and increasing deployment of space cooling devices.

Table 7.1 Gross electricity generation capacity by source in Italy

(GW)	2016	2022	Change
Hydroelectric	22.4	22.8	+0.4
Wind (onshore)	9.7	11.7	+2.0
Solar	19.7	24.2	+4.5
Geothermal	0.8	0.9	+0.1
Thermal	61.6	58.8	-2.8
Total	**117.1**	**118.4**	**+1.3**

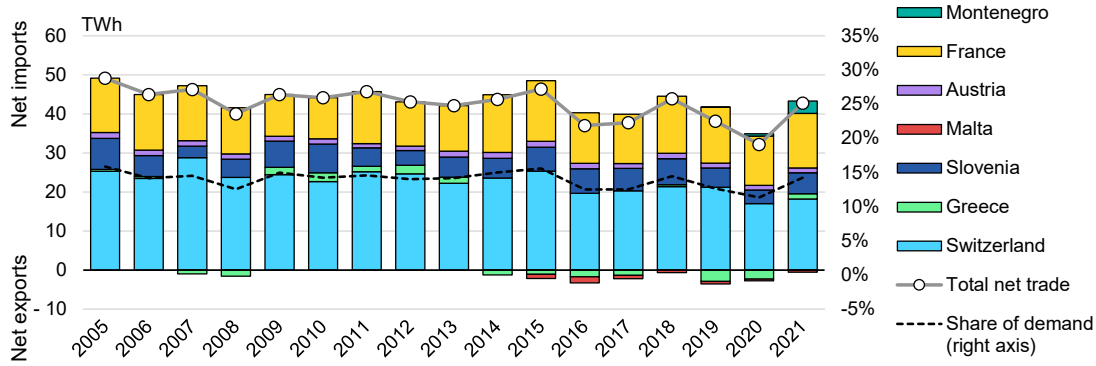
Source: Terna (2022a).

Trade

Between 2010 and 2019, net imports of electricity accounted on average for 14% of Italy's domestic electricity demand (Figure 7.4). The share dropped to 12% in 2020 due to lower

electricity demand linked to the Covid-19 pandemic but rebounded to 14% (43 TWh) in 2021. Electricity imports are mainly from Switzerland (43% of net imports in 2021), France (33%), Slovenia (12.6%) and Montenegro (7.4%). At times, Italy also exports some electricity to neighbouring countries, depending on market conditions.

Figure 7.4 Italy's electricity imports and exports, 2005-2021



Electricity imports come mainly from Switzerland and France and covered on average 14% of demand from 2011 to 2021.

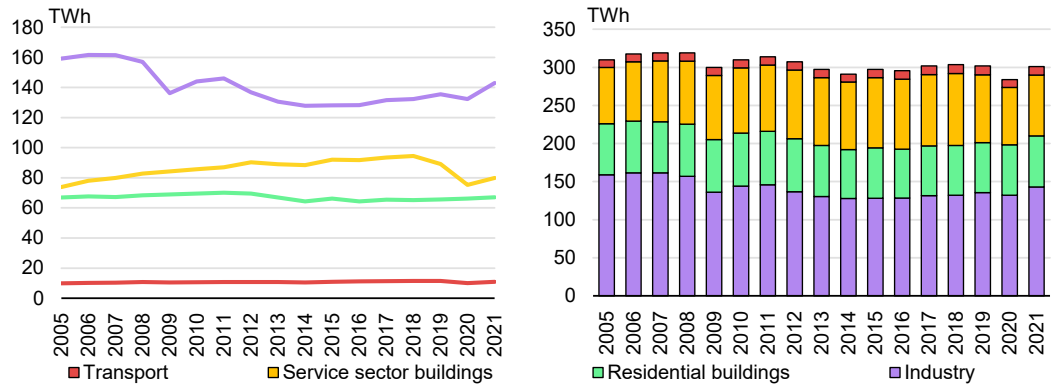
Source: IEA (2022c).

Demand

Electricity demand has followed Italy's economic cycle: it declined in 2009, with the global financial crisis, in 2014 with a second recession, and again in 2020 with the Covid-19 pandemic. It fluctuated around 300 TWh between 2010 and 2019, below the level before 2009 (Figure 7.5). The Covid-19 pandemic mostly impacted the services sector in 2020, which decreased its electricity demand by 16% compared to 2019. Overall, electricity demand dropped by 6% in 2020, leading to a drop in generation compared to 2014 levels. In 2021, electricity demand rebounded strongly and was just 0.3% lower than in 2019. The rebound was especially marked in the industry sector, where demand in 2021 was 6% higher than in 2019.

Electricity covered some 21.5% of TFEC in 2020, below the IEA average (23%). This indicates the scope for electrification of end-uses. In 2021, buildings accounted for half of the electricity demand, 27% from service sector buildings and 22% from residential buildings. In the five years before the Covid-19 crisis, service sector buildings accounted on average for 31% of total electricity demand, but started to decline already in 2019. The other half is almost entirely covered by industry (48%), with only 3.6% of the electricity used in transport (mainly rail). Electricity demand in industry declined until 2014 due to the economic situation and started to increase again as the electrification of the sector increased. The consumption in service sector buildings increased until 2018. Electricity use in residential buildings and transport was stable, reflecting a slight improvement in energy efficiency, but also little advancement in electrification.

Figure 7.5 Electricity demand by sector in Italy, 2005-2021



Half of Italy's electricity demand comes from residential and service sector buildings, while industry covers almost entirely the other half, with a small contribution from rail transport.

Source: IEA (2022c).

Transmission and distribution

The high-voltage alternating current (AC) transmission network in Italy covers the Italian peninsula and the island of Sicily and is interconnected to the network of the island of Sardinia through two high-voltage direct current (DC) links. The Italian transmission network consists of lines and power stations with a voltage of 150 kilovolts (kV), 220 kV and 400 kV for a total length of 74 711 km (Figure 7.6).

The overall transmission network is owned by the TSO Terna[1], which is responsible for the operation, maintenance and development of the grid. The state, through the state-owned investment bank Cassa Depositi e Prestiti and its subsidiaries, is the major shareholder of Terna. It holds nearly 30% of Terna's capital. The remainder is shared by national and international institutional investors (53%) and retail investors (17%).

Italy has 27 interconnection lines to 6 countries, including 7 with France, 12 with Switzerland, 3 with Austria, 2 with Slovenia, 1 with Greece, 1 with Malta and 1 with Montenegro. The most recent interconnector is the "Piedmont-Savoy" interconnector with France, with a total capacity of 1 200 MW, which is expected to be commissioned in 2022. An additional interconnector with Austria ("Glorenza-Nauders") was under construction at the time of writing (Terna, 2022b).

Due to the economic structure and geography of the country and the structural weaknesses of the grid, the Italian electricity system has been based on a zonal approach since the inception of the electricity market in 1999 (see the section on "Market structure" and Figure 7.6). Almost all of Italy's interconnection capacity with other countries is located at the northern border and most load is also concentrated in the north of the country. The long geography of the peninsula results in bottlenecks between different areas of the country, which cause difficulties in optimising electricity flows, particularly towards the islands and between the north and south of Italy. The internal flow of electricity from the

[1] Annex A provides detailed information about institutions and organisations with responsibilities in the energy sector.

south to the centre and the north of Italy is expected to increase as more utility-scale renewable capacity is installed in the southern regions and coal capacity is decommissioned (e.g., in Sardinia).

Figure 7.6 Map of Italy's electricity system

The distribution grid is owned by approximately 140 distribution system operators (DSOs). However, four main DSOs deliver 94% of the electricity. These are e-distribuzione (Enel group, distributing 85% of total volume), Unareti (A2A Group, 3.9%), Areti (Acea Group, 3.6%) and Ireti (Iren Group, 1.3%).

Electricity policy

Italy's electricity policy is guided by the 2019 NECP and the 2021 LTS on Reducing Greenhouse Gas Emissions. It focuses on increasing the share of renewable electricity generation (to 55% of gross electricity consumption by 2030 and to 95% of electricity generation by 2050); phasing out coal-fired generation by 2025; increasing cross-border interconnections and storage capacity; preparing for massive electrification of end-uses (with over half of the energy demand covered by electricity by 2050); increasing the competitiveness of the electricity markets and phasing out regulated prices. The NRRP contributes to these objectives in the medium term (until 2026) by allocating nearly EUR 4 billion to the development of renewable energy (including electricity) and EUR 4.1 billion for investment in smart grids and the climate resilience of the networks. It also foresees the simplification of the authorisation procedures for renewable energy sources.

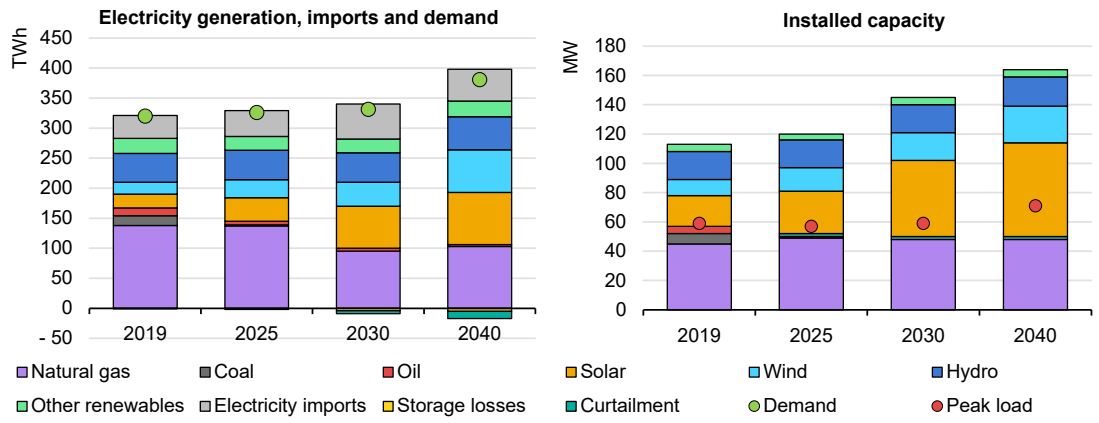
The strategic documents outlining electricity policy were developed before the European Commission proposed its FF55 package, which upgraded the renewable energy and energy efficiency targets in line with the increased climate mitigation ambition. In addition, they do not yet take into account the new global energy context following the Russian invasion of Ukraine in February 2022. In March 2022, the Italian government stated its desire to significantly reduce its reliance on Russian gas imports and to cease importing gas from Russia by 2025. EU energy policy and international developments will have implications for Italy's electricity system. Both call for an acceleration of the transition towards renewable sources of electricity generation.

Future electricity mix

The energy market regulator (ARERA) requires the electricity and gas TSOs to jointly develop scenario analyses to underpin the preparation of the medium- and long-term development plans of the electricity and gas transmission networks. In 2021, Terna and Snam, the natural gas TSO, released the scenario NT Italia (Terna and Snam, 2021).

This scenario updates the scenario used for developing the 2019 NECP and is coherent with its targets. The NT Italia scenario will have to be updated to reflect the increased EU ambition to achieve a 55% reduction of GHG emissions by 2030 for which the EU legislation to implement the new targets is still in the making. According to NT Italia, electricity demand will increase to 331 TWh in 2030, despite overall energy efficiency gains, due to higher electrification of end-use sectors (Figure 7.7). In particular, heat pumps are projected to reach approximately 4 million units in 2030, and EVs are expected to be 6 million in the same year (see Chapter 4). The NT Italia scenario projects electricity generation to be 273 TWh in 2030, slightly lower than in 2020, but with higher net imports (58 TWh).

Figure 7.7 National Trends Italia scenario



The National Trends (NT) Italia scenario, coherent with the National Energy and Climate Plan, foresees relevant gas-fired electricity generation and installed capacity until 2040.

Source: IEA based on data from Terna and Snam (2021).

The role of natural gas

According to NT Italia, natural gas would still be the first single source of electricity generation in 2030, covering about a third of electricity output. Natural gas generation would decrease to 95 TWh from 134 TWh in 2020.[2] Nonetheless, installed gas-fired electricity generation capacity would slightly increase from 46 GW in 2020 to 48 GW in 2030. This is due to the need to compensate for the coal phase-out (see below) and to keep dispatchable capacity available to guarantee flexibility to a generation fleet with a larger share of variable renewables.

After 2030, NT Italia foresees that some gas-fired plants will be converted to renewable gases. This would help extend the economic life of investments in gas-fired capacity if Italy's electricity generation were to transition away from natural gas, as required to meet carbon neutrality by 2050. According to the LTS decarbonisation scenario, in 2050, natural gas would no longer be used to generate electricity and biomethane would have a residual role as an electricity source. However, the NT Italia scenario foresees an increase in gas-fired generation (including renewable gases) to 103 TWh in 2040. This does not appear coherent with the path to carbon neutrality by mid-century and the LTS decarbonisation model. Achieving carbon neutrality requires accelerating the replacement of gas-fired electricity generation with low-carbon sources.

Coal phase-out

Eight coal-fired power plants are still operating in Italy, with a total electric capacity of 7.9 GW. All these plants co-generate electricity and heat, and the total thermal capacity is 18.9 GW.

[2] This is lower than the NECP projection of 113 TWh in 2030.

The goal to phase out electricity generation from coal by 2025 was set in the 2017 National Energy Strategy and confirmed in the NECP. The objective is subordinate to the condition of creating adequate infrastructure:

- New gas capacity of 3 GW, half of which is directly connected to the phase-out of coal, and new storage systems of 3 GW in the central-southern, southern and Sicily areas.
- Investments in the grid: reinforced transmission network in the Brindisi hub, a new Adriatic backbone with at least 1 GW of capacity, installation of 3 000 megavolt ampere of reactive power (MVAR) of new synchronous compensators.
- For the phase-out of coal in Sardinia, a new Sardinia-Sicily-continent electricity interconnection (Tyrrhenian Link), together with a new gas generation or storage capacity of 400 MW located on the island, as well as compensators for at least 250 MVAR.

The Tyrrhenian Link aims to connect the Italian mainland with the islands of Sicily and Sardinia with a double submarine electricity cable. The project includes an east side connecting the peninsula to Sicily (480 km) and a west side connecting Sicily to Sardinia (470 km). In 2022, the MiTE signed a decree authorising the east side, while the decree authorising the west side is expected by mid-2023. According to Terna's 2021 adequacy assessment, the Tyrrhenian Link is expected to be commissioned between late 2025 and 2028. The document also highlights that the construction of the Tyrrhenian Link is necessary to mitigate the island's risks in terms of electricity adequacy when coal is phased out. The connection is also needed to ensure the security of the electricity grid in Sardinia, providing system services such as frequency and voltage control.

A capacity market mechanism is in place in Italy to guarantee the adequacy of electricity supply while coal-fired electricity generation is phased out. It will be essential to install the new capacity contracted through the capacity market auctions swiftly to ensure an orderly exit from coal.

In February 2022, in response to the gas crisis worsened by the Russian invasion of Ukraine, the government tasked Terna with preparing a programme to maximise electricity generation from plants larger than 300 MW using coal or fuel oil. Less restrictive European limits for CO_2 emissions will be used for these plants, instead of national ones. The government pledged that the use of coal will be temporary and will not entail any delay in phasing out coal-fired power generation by 2025.

Electricity from renewable energy sources

The NECP and the NT Italia scenario foresee needing 95 GW of renewable electricity capacity in 2030 to achieve the target of 55% of electricity consumption from renewable energy sources in that year. This implies the installation of 39 GW of additional renewable capacity compared to the 2019 level of 56 GW. This addition would come only from variable sources, reaching 19 GW of wind capacity (an increase of 8 GW, including 900 MW of offshore wind) and 52 GW of solar capacity (an increase of 31 GW). According to the NT Italia scenario, most of the additional solar capacity is expected to be installed in the northern regions, while all the wind capacity will continue to be in the southern regions. At the same time, an additional 10 GW (50 GWh) of electricity storage systems need to be installed by 2030.

As the FF55 package increased the EU ambition of reducing GHG by 55% by 2050 compared to 1990 levels, the Italian government estimates that the total additional installed

capacity of variable renewables needs to reach around 60 GW by 2030, or an additional 5 GW per year. This compares with the average renewable electricity generation additions of 0.8 GW/year from 2013 to 2020 (they were 4.6 GW/year between 2008 and 2013). The new REPowerEU proposals will require even greater installation to 2030 (see Chapters 1, 2 and 4). Looking ahead to 2050, even more variable renewable capacity (estimated at 230-240 GW by Terna) would be necessary to achieve carbon neutrality.

Terna indicates that private companies had submitted connection applications for variable renewables for a total capacity of 168 GW as of the end of 2021. Of these, 50% are solar PV, 31% onshore wind and 19% offshore wind. Contrary to the NT Italia scenario, 90% of applications are located in the southern regions and on the islands. Terna estimates that not all the applications will pass the permitting process, and some could be double counted as projects in the same area can submit multiple applications. However, the high number of applications highlights a considerable potential for increased variable renewable capacity. Private companies and associations stated in February 2022 that the private sector would be ready to invest EUR 85 billion and add 60 GW of renewables in three years, if the permitting procedures were simplified and the requests authorised by June 2022 (see Chapter 5) (Elettricità Futura, 2022).

The government stated that the recent simplification measures for permits had allowed more requests of connections as of May 2022, with 4.2 GW of capacity authorised and ready to be built, 2.5 GW in the advanced authorisation procedure, and 21 GW in the authorisation phase (see Chapter 5). Recent data show that the last trimesters of 2021 and the first trimester of 2022 recorded an average commissioning rate of 500-600 MW/trimester, with an increasing trend. However, the effect of the measures adopted in 2022 will be more visible later on.

Due to the geographical unevenness of the applications for new variable renewable electricity generation, Terna has conducted a sensitivity analysis of the NT Italia scenario, redistributing the 39 GW of new variable renewable capacity expected by 2030 according to the geographical distribution of the new applications, skewed towards the southern regions (NT_{STMG} scenario). In the NT_{STMG} scenario, electricity production from renewables (especially from solar) would increase, as the same amount of capacity is installed in zones with better solar radiation and wind, while the electricity production from thermoelectric plants would decrease. Also, as the expected storage installations (10 GW) are located mainly in the south and on the islands, the overall operation of storage installations would increase. At the same time, the NT_{STMG} scenario foresees an increase of curtailment to 7.1 TWh in 2030, versus 5 TWh in the NT Italia scenario, due to bottlenecks in the electricity grid while transporting electricity from the south to the north of the country. The sensitivity analysis on the amount of storage installed also highlights that if the storage systems installed by 2030 decrease to 4 GW, curtailment would reach 9.6 TWh. This would be 8.4% of forecasted variable renewable electricity generation in 2030 (NT_{STMG} scenario).

Future grid development

The Italian electricity network requires major investments to facilitate the energy transition in the electricity sector, which poses increasing challenges such as higher integration of variable renewable generation (frequently not geographically uniformly distributed), massive electrification of end-uses, multi-directional networks as energy consumers start

to locally produce electricity and an increased need for resilience to climate change. In addition, Italy's zonal electricity market highlights existing limitations and bottlenecks in the grid.

Italian legislation requires Terna to prepare a ten-year development plan for the national transmission grid every two years. The plan should be consistent with the objectives of the NECP related to renewables and decarbonisation, security and adequacy of the electricity system. The last plan, released in 2021, includes a ten-year investment of over EUR 18 billion (a 25% increase from the previous ten-year plan) to strengthen the transmission network and support the transformation of the electricity system toward a future with higher shares of renewables. Every year, Terna submits a document to the MiTE and the regulator (ARERA) detailing the implementation status of the planned interventions and the grid developments to be undertaken in the following three years.

The ten-year grid development plans are approved by the minister responsible for energy policy (since 2021, the MiTE), after an analysis of the costs and benefits by ARERA and the opinions of interested regions. According to legislation, these plans are subject to an SEA. The assessment process includes public consultations and a "reasoned opinion" by the MiTE in agreement with the Ministry of Culture, as the ministry responsible for environmental, landscape and heritage protection. These assessment and consultation procedures have been unduly slow, undermining the realisation of the planned grid investments. At the time of writing, the 2018 plan was the most recent to have been approved (in February 2021), and the MiTE expressed an SEA reasoned opinion on 2019 and 2020 development plans in January 2022. At the same date, Terna had already launched the SEA of the 2021 and 2023 grid development plans (Terna, 2022c).

After the SEA, each grid development project generally needs to undergo an EIA (depending on the specificity of the projects and as required by the EIA legislation). While the SEA should facilitate the EIA of single projects included in the plan, in practice the administrations in charge of the EIAs do not take into account the SEA outcomes. According to Terna, the environmental assessment of the plan and the permitting procedure for each project, including the EIA, last seven to eight years. Three more years after permitting are needed on average to effectively build major lines.

Long permitting procedures are also slowing down the installation of renewable electricity capacity and the related grid interventions (see Chapter 5). Currently, the developer of the generation plant must first request the connection to the grid operator and receive a connection quotation. The developer must then request a "single authorisation procedure", including the EIA of the plant and the grid intervention and all other permits. Then the developer can request that the grid operator develop and implement the grid connection project. The "single authorisation procedure" is the longest part of the process, lasting on average of 7.5 years, while the legislation states that it should last 1-2 years (Elettricità Futura, 2021).

The government has made welcome attempts to simplify and reduce the timelines for the administrative and permitting procedures. Among these, Legislative Decree 199/2021 implementing the RED II Directive (2018/2001) introduced some measures to accelerate the expansion of the electricity grid to integrate increasing shares of renewable electricity and achieve the NECP targets. It requires grid operators to plan grid developments per expected renewables growth. Grid operators are required to anticipate the requests for connection in areas suitable for the installation of renewable electricity facilities, and equip

those areas with the necessary grid infrastructures.[3] In addition, Terna is required to draw up a specific plan of urgent grid works based on the renewable plants that have requested connection and are undergoing the permitting procedure, to achieve the objectives of the NRRP by 2025 and the EU FF55 goals.

However, these simplification measures have not yet delivered the expected results. It is too early to assess their effectiveness. The electricity industry associations claim that these measures are largely insufficient to unlock the necessary investment (Elettricità Futura, 2021; see Chapter 5). Italy would benefit from swiftly identifying grid and capacity developments that are urgently needed to achieve the NECP objectives and accelerate the energy transition, as required by Legislative Decree 199/2021. These works would need to be prioritised or fast tracked, and be subject to an accelerated authorisation procedure, as recommended by the competition authority.[4] Such an accelerated procedure should give adequate consideration to the environmental impacts of the infrastructure developments in a specific area. At the same time, it should not neglect the environmental and economic benefits of renewable energy developments in terms of climate mitigation and energy security. Priority should also be given to increasing/improving the capacity of the public administration for the permitting procedures, as well as to building consensus among local communities and all stakeholders through communication and dialogue.

Where there are areas with good renewables potential requiring grid development, this could be supported with a “renewable development zone” approach adopted in some countries (Box 7.1). In particular, since the current system for transmission charges in Italy does not provide an incentive to place plants in the most cost-effective locations from a grid perspective, this approach could be used to encourage and facilitate more cost-efficient investment accounting for both the transmission and generation costs.

System flexibility

Curtailment of variable renewables was at very low levels in 2020 but is expected to increase to 5 TWh in 2030 (4.5% of the variable renewable generation expected in 2030). An increased share of variable renewables in the future electricity mix will require, in addition to a strengthened electricity grid, higher system flexibility and electricity storage.

Italy is supporting the participation of flexibility systems in the market. In 2017, ARERA developed a regulation dedicated to system flexibility pilot projects. In 2019, Terna promoted several projects to test and enable the participation of demand management, variable and distributed renewable generation, and electricity storage systems to the ancillary services market (see the section on “Market structure”). This enabled around 1.5 GW of new resources to be added to the ancillary services market, with significant benefits in terms of increased competition and reliability of the system. Since 2022, demand management, electricity storage and distributed generation plants are allowed to participate in the provision of secondary frequency/power regulation services and increase the level of competition in this market.

[3] Similarly, grid operators must include in their plans the interventions needed to develop recharging infrastructures for electric vehicles.
[4] AGCOM S4423_segnalazione ex artt 21 e 22.

Following Italy's achievements in the development and deployment of system flexibility and smart grids solutions, including smart meters, the country is spearheading international efforts to ramp up progress on power system modernisation, including through the Digital Demand-Driven Electricity Networks (3DEN) initiative, ISGAN and MI Green Powered Future Mission.

Demand response

Italian regulation defines "virtual units" and "mixed enabled virtual units" that are allowed to participate in the electricity market. A "virtual unit" is an aggregation of different distributed resources acting as a single entity when engaging in power system markets, or selling dispatching services to the system operator. "Mixed enabled virtual units" (UVAM) is an aggregation of consumption and production units and storage systems (including e-mobility charging stations).

Currently, UVAMs can provide services such as congestion management, balancing service and replacement reserve, but the government aims to start experiments for using them for frequency restoration reserve. The regulation foresees a maximum number of four reliability tests per UVAM per year. In the event of failure of three tests in one year, the UVAM is disabled by the ancillary services market and the contract is terminated.

In the first quarter of 2021, UVAM-contracted capacity reached 1 GW. Of this, 30% consists of electricity production capacity, 17% withdrawal capacity, and 53% a mix of production and withdrawal. Focusing on withdrawal capacity, 51% came from the iron and steel industry, 15% from industrial gas, 14% from the services sector, 8% from metallurgy, and 13% from other sectors.

Electricity storage

Energy storage will become more and more important for the stability of the grid and adequacy as dispatchable electricity plants will be phased out and new variable renewable electricity will be added. Italy has a total storage capacity of about 7.5 GW, and most of this capacity consists of utility-scale pumped hydro facilities (7 GW). There is also approximately 60 MW of high-voltage utility-scale electrochemical electricity storage and 396 MW (736 MWh) of distributed electrochemical storage installations. Pumped storage plants participate in the ancillary services market and the cross-border balancing platforms; they are connected to the 400 kV grid and are mostly located in the Alps in the north of the country. For the time being, the contribution of batteries to the dispatching service market is negligible.

The NT Italia scenario foresees an increase in storage capacity of around 10 GW until 2030. Pumped hydro capacity would increase by 4.5 GW, utility-scale electrochemical storage by 1.5 GW and distributed electrochemical storage by 4 GW. There is currently a considerable amount of electrochemical storage (in the order of hundreds of MW) in the pipeline for new installation shortly. However, while the technology is now mature, companies need more clarity on regulations and potential revenues to be able to increase investment.

Terna's sensitivity analysis (NT_{STMG} scenario, see the section on "Electricity from renewable energy sources") has studied the changes with respect to the NT Italia scenario, taking into account the geographical distribution of requests for connection of storage systems. The redistribution of distributed electrochemical storage according to the

geography of the requests of connections, i.e., from north to south, would reduce curtailment by 0.9 TWh, as storage would be closer to the new renewable capacity. However, if a lower amount of storage is added to the grid, curtailment would increase significantly. For example, with the addition of only 600 MW of pumped hydro by 2030 (compared to 4.5 GW in the NT Italia scenario) and 500 MW of utility-scale electrochemical storage (instead of 1.5 GW), curtailment would reach 9.6 TWh (8.4% of forecasted variable renewable electricity generation).

Box 7.1 The renewable development zones approach to grid development

Some countries have adopted a renewable development zones approach to optimise the development of transmission infrastructure in locations with suitable renewable resources. The approach aims to solve a causality dilemma as planning processes for the transmission grid need to examine renewables potential, and renewable developers need certainty of transmission access to secure financing.

Renewable development zones are geographical areas that are characterised by high-quality renewable resources, suitable topology and strong developer interest (IEA, 2018). The planning of transmission projects focuses on these areas because of the potential of higher utilisation of transmission assets.

Creating renewable development zones involves the following steps and a number of stakeholders:

- Assessment of the potential for variable renewables. The government, developers and researchers identify areas with the highest potential for the lowest cost development of variable renewables.
- Selection of candidate zones. The regulator, government and developers select areas with the highest probability of commercial development.
- Development of transmission scenarios. The regulator, government and system operators develop transmission scenarios based on the zones selected.
- Selection of transmission scenario. The regulatory body approves the transmission plan.

For example, Australia and South Africa have adopted a renewable development zones approach with successful results. In South Africa, the state-owned utility Eskom now considers renewable resources potential in its transmission planning exercises, which incorporate stakeholders' input in the process, optimising the development of the transmission grid in areas with high potential for renewables. Eight renewable development zones were approved in South Africa in 2016, and real data from the zones is helping to model and develop new zones. In 2019, three new renewable development zones were announced, as the country is reducing its reliance on coal. In Australia, five renewable development zones have been identified in New South Wales, six in the state of Victoria and other states are in the process of developing their zones. Some of these also include electricity storage infrastructure to optimise the use of variable renewable energy sources.

Sources: ERCOT (2017); IEA (2018); New Zealand, NSW Government (2022).

Smart meters

The campaign for the installation of smart meters started in Italy in 2001, and covered almost all low-voltage consumers, as since 2011 the installation of a smart meter is mandatory in Italy. First generation (1G) smart meters allow remote actions such as readings, activation and deactivation, and power modulation (reduction or increase). Italy was the second country in Europe to achieve 80% coverage with smart meters in 2011 after Sweden. The cost of installation of 1G smart meters is also among the lowest in Europe.

In 2016, ARERA set requirements for second-generation (2G) smart meters. 2G smart meters have improved functionalities, such as increased efficiency of readings and the possibility of switching at any time (instead of the first day of the month with 1G). Also, 2G smart meters allow consumers to access 15-minute frequency readings directly from other devices (e.g., smartphones), with the potential to increase their consumption awareness and access dynamic electricity offers. In addition, 2G smart meters are ready to manage demand-side response with the possibility to remotely control the load and in perspective provide ancillary services to the network. Starting from January 2022, only 2G smart meters can be installed. By 2025, at least 90% of points of delivery should be equipped with 2G meters and 96% by 2026. At the end of 2021, about half of 1G smart meters had already been replaced with 2G ones.

Energy communities and self-consumption

The Directive on Common Rules for the Internal Electricity Market ((EU) 2019/944) introduced rules to enable active consumer participation, individually or through citizen energy communities, in all markets, either by generating, consuming, sharing or selling electricity or by providing flexibility services through demand response and storage. Energy communities can help increase public acceptance of renewable energy projects and make it easier to attract private investments. Self-consumption and energy communities encourage energy efficiency and can help citizens lower their electricity bills. Italy first introduced rules and incentives for energy communities in 2020 and updated their regulation in 2021, to foster their development. As of mid-2021, there were about 20 energy communities in Italy, which were coherent with the regulations. Italy is lagging compared to other countries. For example, there were 70 energy communities in France, 500 in the Netherlands and 1 750 in Germany (Utilitatis and RSE, 2022). See Chapter 5 for a broader discussion on energy communities.

Market structure and reforms

Generation

Italy has fully unbundled transmission and generation ownership. The number of industrial groups operating either in electricity generation or in electricity supply is over 14 000. Enel is the major player, controlling about 16% of the national production and 36% of total sales in 2020. The following five groups (Edison, A2, Hera, Axpo Group and Eni) combined account for 24% of generation and 25% of total sales. Nonetheless, concentration in the

market has decreased over time. The Herfindahal-Hirschman Index (HHI)[5] for gross electricity generation was 493 in 2020, lower than in 2019 when it was 538. However, there are marked differences across regions.

Capacity market

In June 2019, after ARERA's favourable opinion, the then Ministry of Economic Development signed a decree approving the capacity market rules to allow Terna to procure capacity through long-term procurement contracts. Terna prepares medium- to long-term adequacy assessments every other year, which are used as the basis for contract volumes on the capacity market. The 2021 assessment highlighted that the Italian electricity system was not adequate to comply with the maximum of three hours of loss of load expectation set by the government (Terna, 2021). The main issues identified in the assessment were: a strong dependence of northern regions on imports from neighbouring countries; the age of the conventional generation fleet, especially in some areas; and the inadequacy of transmission capacity between the two largest islands and the mainland. In the future, the European Resource Adequacy Assessment will become an important component of justifying capacity market requirements, but the first assessment, undertaken in 2021, was not endorsed by the EU Agency for the Cooperation of Energy Regulators.

The Italian capacity remuneration mechanism is based on a technology-neutral capacity market scheme where generators (including distributed generation and foreign capacity) and demand-side operators are allowed to participate. Terna carries out specific auctions to guarantee the generation adequacy target and signs a contract with successful bidders based on reliability options. Generators are granted a capacity price, but if reference prices in the market are above a strike price calculated by ARERA, they are required to pay the price difference back to Terna. Since 4 July 2019, fossil fuel power plants are authorised to participate in the capacity market only if they do not exceed the emission limit of 550 g CO_2/kWh, as recommended by the European Commission's Clean Energy Package (Council of the European Union, 2019). Power plants that were authorised to participate in the market before 4 July 2019 are allowed to have emissions per unit of energy delivered higher than 550 g CO_2/kWh if they respect the limit on the unit of power of 350 kg CO_2/kW. This compares with the current average intensity of natural gas-fired power plants in Italy of 357 g CO_2/kWh.

The first two auctions took place in November 2021 for deliveries in 2022 and 2023, and the auction for 2024 took place in February 2022. The auction for 2022 awarded 41 GW of capacity (of which 1.8 GW of new capacity in Italy and 4.4 GW of capacity abroad), the auction for 2023 awarded 43.4 GW (of which 4 GW of new domestic capacity and 4.4 GW of capacity abroad) and the auction for 2024 awarded 41.5 GW of capacity (of which 3.8 GW of new domestic capacity and 3.6 GW of capacity abroad) (Terna, 2022d). For all auctions, most awarded capacity is existing capacity within the country. Most of the new plants consisted of fuel combustion plants (mostly gas-fired co-generation[6]). In total, only 49 MW were allocated to solar and 22 MW to hydro. The auction for 2024 allocated 1.12 GW to battery storage, 528 MW of which is in Sardinia. Existing capacity was

[5] The HHI is calculated by squaring the market share of each firm competing in the market then summing the resulting numbers. Regulators generally consider markets in which the HHI is between 1 500 and 2 500 points to be moderately concentrated. Conversely, markets in which the HHI is in excess of 2 500 points are considered to be highly concentrated.

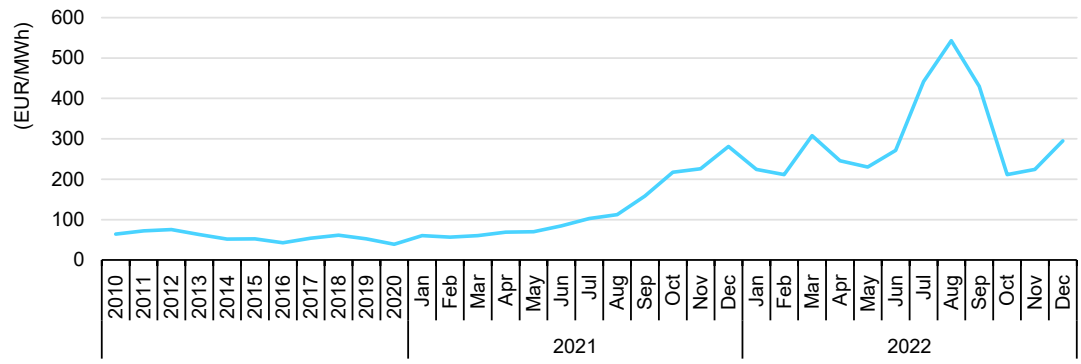
[6] Co-generation refers to the combined production of heat and power.

awarded EUR 33 000/MW/year in all auctions and new capacity EUR 75 000/MW/year for plants winning the auctions for 2022 and 2023, and EUR 70 000/MW/year for those awarded for 2024. The annual cost is EUR 1.3 billion for the auction for 2022, EUR 1.5 billion for the auction for 2023 and EUR 1.5 billion for the auction for 2024.

Wholesale market

The Italian spot electricity market consists of a day-ahead market and an intraday market. Both are managed by the electricity market operator, GME. The day-ahead market and the intraday market are based on a zonal approach, with seven market zones, as a consequence of the system topology and sensitivity, and due to transmission constraints between the zones (as mentioned above). The transmission network is represented in a simplified way, and network nodes are grouped into bidding zones. Producers and consumers submit hourly energy offers and bids. The clearing price is where the demand and supply curve meet, for each hour of each market zone, taking into account cross-zonal transmission capacity between the zones. This way, most of the internal network congestions are managed through energy markets thanks to the bidding zones configuration. Sale offers are settled at the hourly zonal price and buy offers are settled at the single national price (PUN), computed as the average of zonal prices, weighted according to the consumption in each zone. Sale prices are usually slightly higher in the northern zones than in the south. The PUN price has been increasing since the start of 2021 following the European gas crisis, it peaked in August 2022 to then decrease again, but still at much higher values than the period from 2010 to 2020 (Figure 7.8).

Figure 7.8 Single national price of the Italian wholesale market, 2010-December 2022



Source: IEA based on data from GME (2022).

The day-ahead market closes at noon of the day before the delivery day. The intraday market allows operators to update their bids in a combination of continuous trading and complementary regional auctions. The intraday market closes one hour before delivery.

There is also an ancillary services market to ensure the reliability of the electricity grid. Terna acts as the central counterpart. Some plants (programmable plants larger than 10 MW) must participate on a mandatory basis in the ancillary services market and the balancing market. In addition, GME operates a forward electricity market, where specific volumes of electricity are sold for specific time frames.

Retail markets

There are three retail markets in Italy: 1) the open or free market; 2) the enhanced protection market (*mercato di maggior tutela*); and 3) the safeguard market. Customers must actively choose to move to the open market. Those who do not move are served by the enhanced protection market. The safeguarded market (last resort service) is aimed at all final customers who do not qualify for the enhanced protection market and who may temporarily find themselves without an electricity supplier (including if the retailer goes bankrupt).

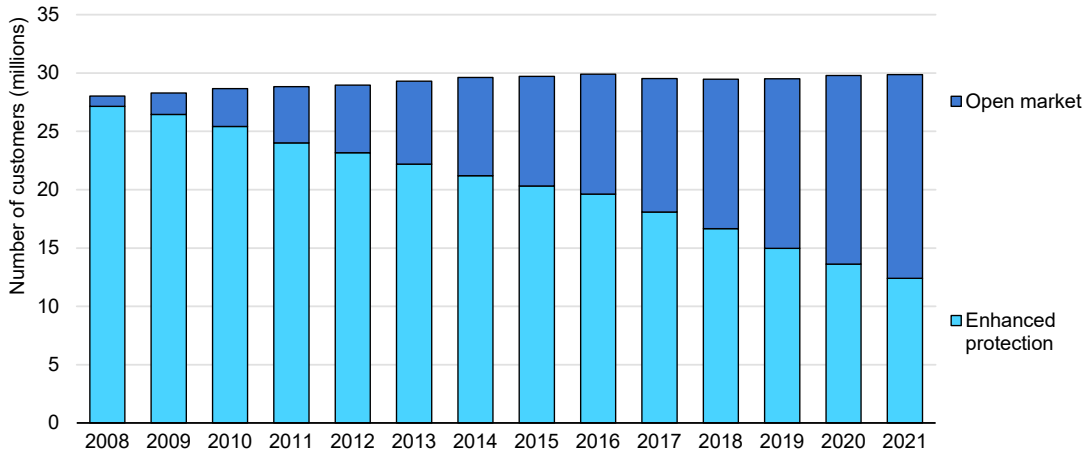
Italy opened the electricity retail market in July 2007, and introduced the enhanced protection market with regulated tariffs, on a transitional basis, to support households and small businesses that were not yet in a position to choose a supplier on the free market. The share of residential customers in the free market has been growing in the last decade, reaching 58% in 2021. The open market represented 84% of total electricity consumption in 2020, as commercial and industrial loads have moved almost completely to the open market. However, 14 years after the opening of the electricity market, nearly 42% of about 30 million domestic customers were still served in the enhanced protection market (Figure 7.9). The share of domestic customers and electricity sales in the enhanced protection market is even higher in the southern regions.

The deadline for the full liberalisation of the market has been postponed several times, which has created uncertainty for both operators and customers. This has also prolonged conditions of market power. Suppliers operating in the regulated segment can encourage their customers to keep their contracts with them under free market conditions. Indeed, more than half of customers that exited the protected market in 2020 and 2021 chose to stay with the same company or a retailer of the same group. The Enel Group is the largest retailer, serving 36% of consumers in the overall retail market. Half of domestic customers and enterprises connected to the low-voltage grid purchase electricity from Enel. Enel's sale quota has been slightly declining in recent years, but the retail market remains relatively concentrated. The top three retailers combined served about 46% of the market in 2019 and 2020.

While the free market has a low level of concentration, the enhanced protection market is heavily concentrated. The Enel Group is by far the dominant of the 119 retailers, supplying 86% of customers remaining in the regulated market. On the contrary, the Enel Group serves 27% of customers in the free market, which counts 739 suppliers. The number of resellers on the free market has increased steadily (+16 from 2019 to 2020; it was 336 in 2013).

All electricity consumers are free to choose their supplier at any time without fees. The process of switching to the new retail electricity provider takes one to two months, even though EU regulation requires it to take less than 21 days. The Integrated Information System established by the single buyer (Acquirente Unico, AU; see next paragraph) in 2010 should guarantee that the 21-day timeline is respected. The switching rate between retail providers has been increasing from a very low level in 2008 (1.1%) to 15.7% in 2021. As of the end of 2021, nearly all domestic customers in the free market (98.6%) had a contract with a price fixed for one year.

Figure 7.9 Household clients in the enhanced protection and free market, and switching rate for changing supplier in Italy, 2008-2021



The number of customers joining the open market is increasing, but as of 2021, more than 12 million households were still served by the enhanced protection market, set to close in 2024.

Source: IEA based on data from ARERA (2021).

The transition from the protected market to the free market

The enhanced protection market ensures continuity of supply and regulated contractual conditions at reasonable prices. At the centre of the enhanced protection market is the AU, a state-owned company with a legislative mandate to ensure adequate service to those consumers who have not chosen to switch to an alternative supplier. AU purchases electricity on the wholesale market and sells it to standard offer retailers, who in turn resell it at a regulated rate. So as to not distort the market, enhanced protection prices are identified by the regulator consistently with wholesale market conditions.

At the end of 2020, the enhanced protection market included 13.6 million households and 2.3 million very small enterprises, representing 14.7% of total electricity consumption (see Figure 7.9). These numbers further declined in 2021, to 11.9 million households and 1.8 million micro-enterprises.

On 1 January 2021, the enhanced protection market was closed to SMEs. The regulator ARERA organised an auction for allocating the SME customers remaining in the enhanced protection market retailers. The number of customers allowed to be assigned to Enel was capped at 35%. The enhanced protection market will be closed to very small enterprises as of January 2023, and to all customers as of 2024. Accordingly, ARERA is planning to organise auctions for those consumers that are still in the enhanced protection market once it is closed. The retailers that are selected through these auctions must offer specific conditions established by the regulator, under a regime called “gradual protection” (*servizio a tutele graduali*). This is a transitory regime to smooth the transition to the free market for customers that are reluctant to do so.

In addition, the legislation introduced a category of “vulnerable customers” that can benefit from regulated supply conditions and tariffs even after 2024. “Vulnerable clients” include all customers above 75 years old and other categories of financially disadvantaged customers. According to estimates, there will be approximately 4.5 million such clients.

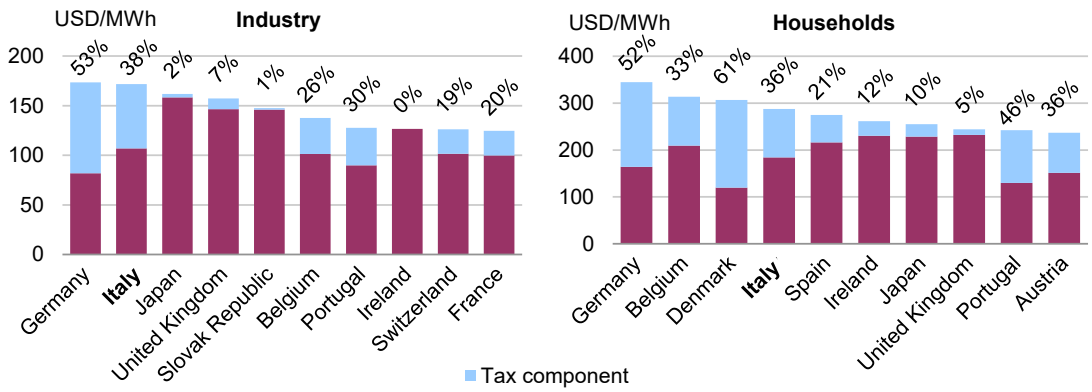
However, this adds another category of potentially protected customers to those that will enter the "gradual protection" regime. There is still a lack of clarity about the process to identify the suppliers of the vulnerable customers and the related regulated contractual conditions. As the competition authority noted, the "gradual protection" regime and the service for vulnerable customers risk extending in practice the regulated protected market and continuing to give a competitive advantage to retailers that operate in the enhanced protection market.

There is a need to raise customers' awareness of the opportunity offered by switching to the free market. Several contracts are available on the free market offering lower electricity prices than in the enhanced protection market, thereby providing substantial potential savings on electricity bills. However, many Italian customers, especially in the southern regions, decide to remain regulated and/or not to switch suppliers, feeling safer with the incumbent supplier services. An indication of this is the limited number of electricity contracts subscribed for on line (7.4% of new domestic contracts in 2020). The AU manages a web platform to compare retail offers for electricity and gas supplies on the open market (ilportaleofferte.it). For each offer, the website provides potential savings compared to the regulated tariffs of the enhanced protection market. The AU also manages a web tool that allows customers to monitor their electricity and gas consumption over the last three years (consumienergia.it). However, these web tools are generally not used much by the mass of potential customers.

Electricity prices

Italy has one of the highest electricity prices among IEA countries. Industry prices were the second highest in 2020, at 171.7 USD/MWh, and well above the IEA average of 109.9 USD/MWh. Household electricity prices were the fourth highest, at 287.4 USD/MWh, compared to an IEA average of 204.5 USD/MWh, due to a large tax component and other fixed fees ("general system charges", see below). The tax component (38% and 36% for industry and households, respectively) is among the highest among IEA countries, especially for industry prices (Figure 7.10).

Figure 7.10 IEA countries with the ten highest industry and household electricity prices, 2021



In 2020, Italy had the second-highest electricity price for industry and the fourth-highest for households among IEA countries.

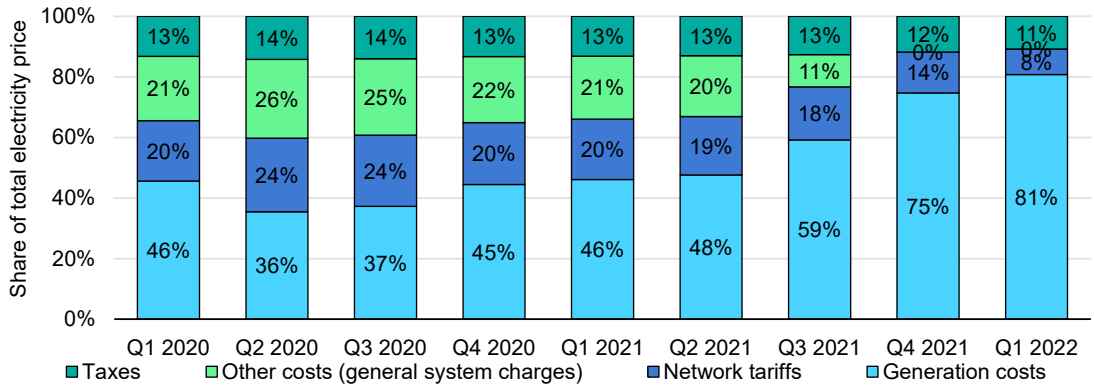
Source: IEA (2022d).

Figure 7.11 shows the shares of retail prices from generation costs, taxes, network tariffs and other costs from the first quarter of 2020 to the first quarter of 2022, for a typical consumer in the enhanced protection market. The so-called "general system charges" mainly cover the costs of incentives for renewables and the cost of the reduced rates for high-consuming manufacturing companies. They made up 21% of the retail price in the first half of 2021.

These charges were temporarily reduced in the third quarter of 2021 and successively set to zero in the fourth quarter of 2021 and first two quarters of 2022 to reduce the total prices for consumers, as the generation costs were surging due to high gas prices (Figure 7.11). An advantage of this approach is that it does not prevent wholesale costs from being passed on to customers. This measure affected 29 million families and 6 million small and very small enterprises. It is estimated to have reduced the increase in households' electricity bills to 9.9% in the third quarter of 2021 (from the previous quarter), compared to a potential increase of 20% (Italy, MEF, 2021). The government extended the cancellation of the general system charges until March 2023. As this is an emergency measure introduced to address the impact of the pandemic, it has to be renewed every three months.

The cost of cancelling the general system charges was about EUR 2 billion in 2021 and EUR 4.2 billion in 2022, covered by revenue from auctioning CO_2 emissions allowances and from the extraordinary taxation on "extra profits" of energy companies. In addition, businesses can claim a tax credit to partially compensate for the extra costs due to high electricity prices (the cost for the state budget is EUR 2.3 billion in 2022).

Figure 7.11 Breakdown of electricity prices for a typical consumer in Italy, 2020-2022



The Italian government temporarily completely cancelled the "general system charges" from electricity bills from Q4 2021 to the first half of 2022 in response to high electricity prices.

Source: IEA based on data from Italy, MiTE (2022).

Social bonus

Low-income customers and those with a serious illness can receive a discount directly on their electricity and gas bills ("social bonuses"). The electricity bonus is determined by ARERA and corresponds to about a 30% discount of the expenses incurred by an average household user for electricity. The bonus is financed through the electricity tariff as part of the general system charges.

Low-income customers are identified by an economic condition index (ISEE). In response to the rising energy prices, the ISEE threshold for receiving the social bonus was increased in 2021 from EUR 8 265 to EUR 12 000, thereby extending the eligibility for the social bonuses from 4 million to 5.2 million households. The cost of this extension for the state budget is estimated around EUR 1 billion in 2021-2022 for both the electricity and gas bonuses for vulnerable households. This compares to the more than EUR 6 billion spent to reduce electricity prices for all residential customers (and small businesses), irrespective of their income (see Table 2.3 in Chapter 2). Italy should consider better targeting social support for electricity costs to households in need.

Until 2021, customers had to apply to receive the electricity bonus, which hampered access to it. Since July 2021, however, customers need to make a unique generic application for welfare benefits. The Integrated Information System developed by AU allows automatically delivering the bonus to applicants that have obtained an eligible ISEE. Around 2.4 million households received the social bonus for electricity in 2021, up from 855 000 in 2020. Still, this is only about half of the potentially eligible population.

Electricity emergency response

The details of Italy's electricity emergency response procedures, and the requirements placed on the TSO and DSOs, are outlined in Chapter 10 of the Italian Grid Code, known as the Defence Plan. Under the Defence Plan, the TSO can implement a variety of response measures after activating a state of "alert", "alarm" or "emergency" in the electricity system.

A state of "alert" can be activated if the TSO deems that there is a risk of potential supply disruptions resulting from weather reports or concerns raised by DSOs. Under a state of "alert", the TSO would regularly co-ordinate with DSOs to monitor the situation, potentially postpone maintenance works, and seek to deploy additional personnel and resources to areas viewed to be the most at risk.

A state of "alarm" can be activated if the "alert" level has already been activated and the situation deteriorates, or if there is a high potential for a sizeable supply disruption. Under a state of "alarm", all non-essential works would be suspended and efforts would begin to secure additional electricity imports.

The TSO would declare a state of "emergency" of the electricity system if it views the situation to be "critical" with imminent or ongoing load interruptions. When an "emergency" level has been activated, the TSO must immediately inform the regional security co-ordinator, composed of representatives of electricity TSOs from neighbouring countries, and attempt to find a solution by increasing imports. If this is unsuccessful in resolving the (potential) disruption, the TSO can implement rolling blackouts and load shedding to reduce electricity consumption.

Electricity emergency preparedness

In addition to the general emergency response measures outlined in Italy's Grid Code, Italy has developed a list of procedures to be implemented in response to specific emergency scenarios. These emergency scenarios were developed in conjunction with the TSO, ARERA and DSOs. The scenarios and corresponding response measures are outlined in Italy's Risk Preparedness Plan. The emergency scenarios outlined in the Risk

Preparedness Plan include cyberattacks, weather and climate-related events, and physical attacks on electricity infrastructure.

At the regional level, the MiTE participates in the European Commission's Electricity Co-ordination Group, a platform for the exchange of information and the co-ordination of electricity policy measures with a cross-border impact.

Regional co-ordination between Italy and its northern neighbours (Austria, France, Slovenia and Switzerland) is strong. Terna is a member of Coreso, a regional security co-ordinator for electricity in continental Europe.

Assessment

Electricity generation in Italy is dominated by natural gas, covering half of total generation in 2021, the second-highest share among IEA countries. The second source of electricity is hydro, providing 16% of the total. Electricity from variable renewables has significantly increased in the last decade. An exceptional increase in installed solar PV between 2010 and 2014 led to a peak in generation from renewables, which later stabilised at around 40% of total electricity output. Between 2011 and 2021, net imports of electricity accounted on average for 14% of Italy's electricity demand.

The Italian electricity system faces several challenges. The energy transition goals require the electricity mix to quickly shift towards higher shares of renewables and decrease the use of coal, oil and natural gas. In the short term, current plans imply a continued reliance on natural gas as coal will be phased out by 2025 and to support variable renewables. However, the Russian invasion of Ukraine has highlighted Italy's high dependence on imports of natural gas. The government should intensify its efforts to increase the share of renewables and lower the use of natural gas. This means also focusing on increasing investment in electricity storage options to be used in combination with variable renewables, thereby lowering the need to use gas-fired power plants during peaks of electricity demand.

Coal-fired electricity generation has significantly decreased to less than 6% in 2021, as the government plans to close its coal electricity generation plants by 2025. The objective is conditional on the creation of adequate alternative infrastructure, such as new gas capacity of 3 GW, new electricity storage capacity of 3 GW in the south of Italy and on the islands, alternative generation capacity in Sardinia, and investments in the electricity grid. While the new generation and storage capacity is taken into account in the capacity market, the construction of the Tyrrhenian Link between Sardinia, Sicily and the mainland is not expected to be completed until between late-2025 and 2028, potentially delaying the coal phase-out on Sardinia.

In February 2022, in response to the gas crisis worsened by the Russian invasion of Ukraine, the government tasked Terna to prepare a programme to maximise electricity generation from plants larger than 300 MW using coal or fuel oil. Less restrictive European limits for CO_2 emissions will be used for these plants instead of national ones. The government should carefully consider the impact of this measure on GHG emissions mitigation plans. It should maintain its pledge that the increased electricity generation from coal and oil is an emergency measure and will not jeopardise the coal phase-out.

Currently, the time to build major transmission lines is on average 11 years (8 for SEA and permitting and 3 for construction). It will be critical to accelerate this process and ensure

that transmission projects can be realised more rapidly. The government has made welcome attempts to simplify and reduce the timelines for the administrative and permitting procedures. In particular, since late 2021, grid operators are required to anticipate the requests for connection in areas suitable for the installation of renewable electricity facilities and equip those areas with the necessary grid infrastructures. However, it is too early to assess the effectiveness of these simplification measures.

The Italian government estimates that additional renewable capacity additions of 6-7 GW per year would be needed until 2030 to comply with the EU FF55 package. This compares with average renewable capacity additions of 0.8 GW/year from 2014 to 2020. At the end of 2021 and the beginning of 2022, the pace of installation of renewables has increased to 500-600 MW/trimester, but a higher rate will be required to achieve the targets. Since the beginning of 2022, the government has introduced welcome simplifications to the permitting procedure to allow faster deployment of renewables, but the scale of the challenge requires continued monitoring and swift interventions if the deployment does not scale up significantly.

Under the current system for transmission charges, the costs of transmission reinforcement associated with new generation are borne by all network users, which means there is a lack of incentive to place plants in the most cost-effective locations from a grid perspective. The Italian government should consider mechanisms to ensure that new renewables deployment accounts for the efficiency of grid investment. One tool that could facilitate more cost-effective investment in the coming years is the creation of renewable energy development zones, which identify areas where multiple renewable installations can be connected with shared grid capacity, and where permitting for plants within a zone is fast tracked.

The TSO prepares a medium- to long-term adequacy assessment every other year which is used as the basis for determining the contract volumes on the capacity market. The 2021 assessment highlighted that the Italian electricity system was not adequate to comply with the government's maximum of three hours of loss of load expectation. Given the importance of its role, this assessment would benefit from increased transparency in reporting the methodology and inputs employed. With the rapid increase in renewables generation expected in the coming years, it would also be beneficial to complement existing studies with an integrated exercise covering the resilience and flexibility of the system and taking into account different development scenarios.

In response to the adequacy assessment, Italy developed a capacity remuneration mechanism. Terna carries out specific auctions to guarantee the generation adequacy target. Successful bidders are granted a capacity price, but if reference prices in the market are above a strike price calculated by ARERA, they are required to pay back the price difference to Terna. Plants have to meet the emissions limit of 550 g CO_2/kWh, which is below the current average CO_2 emissions intensity of natural gas-fired power plants in Italy. The auctions conducted between 2021 and February 2022 for the years 2022, 2023 and 2024 awarded mostly gas-fired combined heat and power plants, with less than 100 MW allocated to renewables (hydro and solar) and 1.12 GW to electricity storage. While the award of a considerable amount of storage (including more than 500 MW instrumental for the coal phase-out in Sardinia) is welcome, a higher share of renewables and demand response would help with the energy transition and flexibility of the network.

According to the TSO, the current storage capacity of 7.5 GW would need to more than double by 2030, to reach 17.5 GW with significant contributions from pumped hydro and distributed electrochemical storage. A sensitivity analysis from Terna on the scenarios for the future electricity mix highlights that a lower additional storage capacity would result in

increased curtailment in 2030 of up to 8.4% of variable generation. To increase the flexibility of the system, recent regulation allows demand response from “virtual units” (including EV charging stations) to participate in the electricity market. In the first quarter of 2021, “virtual units” contracted capacity reached 1 GW. The government should ensure that flexibility options, including storage and demand response, are increasingly involved in the electricity markets, as these can help to increase the stability of a system with a rising share of variable renewables.

According to the energy scenario developed by the Italian electricity TSO based on the NECP, electricity demand will increase by about 10% through 2030, as end-use sectors are further electrified. However, total domestic electricity generation is not expected to increase significantly, with a significant increase in net imports as a result. The exchange of electricity with interconnected countries is expected to increase in both directions, as there is expected to be more frequent export to neighbouring countries with increased renewable electricity generation. Interconnection capacity has recently increased, with new interconnection lines commissioned or under construction with Austria, France and Montenegro. The government should continuously monitor the need for additional interconnection capacity to support electricity exchanges with neighbouring countries and an increasingly coupled European electricity system.

There are three retail markets in Italy: 1) the open market; 2) the enhanced protection market; and 3) the safeguard market. Customers must actively choose to move to the open market; the share of customers in the open market increased from 11% in 2010 to 58% in 2021. The rate of switching suppliers in the free market has significantly increased, from 4% in 2010 to 15% in 2021. However, 13 years after the opening of the electricity market, nearly 46% of domestic customers were still served in the enhanced protection market, with even higher shares in southern regions.

The deadline for the full liberalisation of the market has been postponed several times, which has created uncertainty for both operators and customers. This has also prolonged conditions of market power. Italy plans to phase out the enhanced protection market by 2024. The government is considering holding auctions to select service providers for customers who do not enter the open market before the end of the enhanced protection market. It will be important to avoid exacerbating the existing concentration of the market, for example by ensuring that the customers currently remaining in the enhanced protection market are awarded to multiple service providers.

In parallel, a new category of vulnerable consumers will be introduced, proposed to include financially vulnerable customers as well as customers over the age of 75, who will be eligible to receive a regulated tariff. This is in part aimed to address the current situation where customers have relatively low awareness for comparing retailer offers. Since this is a separate issue from financial vulnerability, it would be more appropriate to address the issue of reluctance to leave regulated tariffs with increased customer awareness campaigns, and separately provide social support mechanisms for financially vulnerable customers only.

Italy has one of the highest electricity prices among IEA countries. Industry prices were the second highest in 2020, and household electricity prices the fourth -highest in the same year. The tax component in Italy is significant and includes general system charges, such as the cost of incentives for renewables and the cost of reduced rates for high-consuming manufacturing companies. The energy system charges accounted for 21% of the retail price for a typical domestic consumer in the first half of 2021. In response to exceptionally high energy prices, the government temporarily completely cancelled the system charges in the last quarter of 2021 until at least March 2023, with costs now covered by the state

budget. An advantage of this approach is that it does not prevent wholesale costs from being passed on to customers. However, it reduces prices for all consumers and fails to channel support to financially vulnerable consumers only.

Italy has developed a clear and logical set of emergency response procedures, outlined in both the Defence Plan and the Risk Preparedness Plan. The TSO generally has a high level of preparedness for emergency situations and pays strong attention to cross-border co-ordination. The Risk Preparedness Plan details numerous risk scenarios that the TSO has considered. However, while individual risks to electricity security have been identified, electricity security could be further enhanced by developing risk scenarios and contingency plans that take into consideration the potential of several risk events occurring simultaneously as well as risk events that have impacts across different geographical regions, various generation sources and infrastructure. This would include extreme weather scenarios that impact both renewables generation and gas supply and distribution.

Recommendations

The government of Italy should:

- Accelerate the deployment of low-carbon generation and related network infrastructure to ensure that policies to reduce the dependency on imports of natural gas from Russia do not compromise the phase-out of coal-fired generation by 2025, which is one of Italy's key commitments towards the clean energy transition.
- Significantly reduce permitting times to allow timely grid development, which will be needed to integrate new renewables and meet decarbonisation targets.
- Account for the efficiency of grid investment in mechanisms to accelerate renewables deployment. Consider implementing a renewables development zones approach to facilitate rapid and more cost-effective deployment.
- Undertake transparent integrated medium- to long-term planning studies for transmission, generation and gas supply, including resilience and flexibility scenarios, to increase preparedness for challenges arising from an increasing import dependence, a changing power mix and climate change.
- Ensure that the concentration of the retail market is not worsened with the closing of the enhanced protection market.
- Consider targeted support schemes for vulnerable electricity consumers to help them dealing with sharply increased prices due to the ongoing conflict; those could be limiting the amount of monthly electricity consumption per household that benefits from tax reduction, or a government cash transfer to poorer households.

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8. Natural gas

Key data

(2021)

Domestic production: 3.2 bcm of natural gas, 0.1 bcm of biomethane, -62% since 2011

Net imports: 71.5 bcm, +1.7% since 2011

Share of gas: 42% of total energy supply, 50% of electricity generation, 30% of TFC, 8% of energy production

Inland demand: 76.4 bcm (production + net imports + 1.6 bcm stock changes), -2% since 2010

Demand by sector: electricity and heat generation 41%, residential buildings 27%, industry 18%, service sector buildings 11%, transport 3%

Overview

Natural gas is the most significant fuel in Italy's energy mix, accounting for 42% of TES and 30% of TFC in 2021. The share of natural gas in both TES and TFC has been trending mildly upwards since the mid-2010s. The Italian power sector is particularly reliant on natural gas, which accounted for half of the electricity generation in 2021.

Italy is a small producer of natural gas, leaving it heavily reliant on imports. The country has a strong dependency on Russian gas, which accounted for 41% of its gas imports in 2021. However, the Italian government has expressed a determination to reduce the country's reliance on Russian gas.

Italy has access to multiple sources of natural gas, with six pipeline interconnection points and three LNG terminals. Italy plans to install at least two floating storage regasification units (FSRUs) to facilitate increased LNG imports, at least one of which will be operational by 2023. The government is supporting efforts to secure alternative sources of natural gas and to expand existing import infrastructure (see Chapter 2).

Natural gas will likely remain a major part of Italy's energy mix in the longer term, particularly in electricity generation, as the country seeks to retire coal-fired capacity by 2025 and use natural gas as the principal source of dispatchable power. The government is aiming to curtail natural gas consumption to some extent by increasing the share of biomethane, synthetic methane and hydrogen in the gas network; however, these efforts are in the early stages and Italy lacks a clear strategy on the promotion of hydrogen and renewable gases.

Italy faces a significant future challenge to ensure that appropriate incentives are in place to support the construction of adequate infrastructure for the import and distribution of natural gas while simultaneously ensuring that new infrastructure projects do not become "stranded assets" in the long term when natural gas consumption eventually begins to materially decline.

Gas supply, demand and trade

Production

Domestic production of natural gas was 3.2 bcm in 2021, which together with 0.1 bcm of domestically produced biomethane accounts for 4.2% of consumption. Natural gas production has progressively declined for many years; the 2021 production level was 62% lower than in 2011 and 81% lower than in 2000.

In the early 2010s, offshore production accounted for the vast majority of Italy's natural gas production. However, offshore production has declined dramatically and accounted for around 55% of total production in 2020. Most proven reserves are now onshore, almost entirely in the south of the country.

In the past decade, the government has implemented several measures which contributed to the decline in upstream activity, including prohibiting offshore upstream activity within a 12-mile distance of the coast and increasing permitting fees.

Since 2021, however, the government has indicated a willingness to support increased natural gas production in Italy in response to higher prices and supply concerns. In 2022, the government announced a plan to boost domestic gas production by cutting red tape and simplifying permitting in prescribed areas. In July 2022, the government invited companies to apply for gas production allowances.

In 2021, there were 172 active hydrocarbon concessions in Italy: 111 onshore and 61 offshore. However, almost all natural gas production comes from a relatively small number of concessions.

Demand

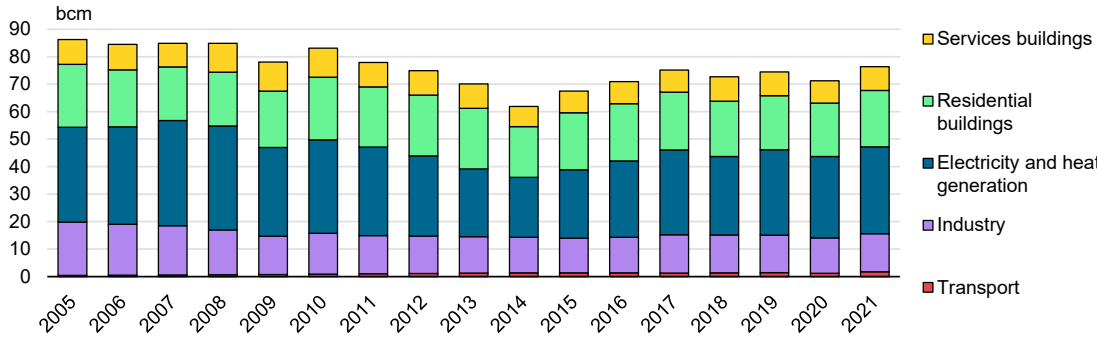
Natural gas demand was 71.3 bcm in 2020 and 76.4 bcm in 2021 (Figure 8.1). Demand has been relatively stable since 2015, hovering around 70 bcm. Before 2015, demand trended downwards for several years, dropping from 83.1 bcm in 2010 to 61.9 bcm in 2014, as the use of gas for electricity generation decreased in these years, before rising again since 2014 (see Chapter 7). Peak demand levels can vary significantly from year to year and are largely dependent on average winter temperatures. In 2020, peak demand reached 366 million cubic metres per day (mcm/d) while the historical peak demand level was recorded in 2012 at 463 mcm/d.

The electricity and heat generation sector is the largest consumer of natural gas in Italy, accounting for 41% of total consumption in 2021. Gas demand from electricity and heat generation remains below the 2010 level but has increased since the mid-2010s, particularly due to the substitution of coal-fired power generation capacity with combined-cycle gas turbine power plants. Gas demand from electricity is expected to increase further in the short term as new gas-fired electricity generation plants that were awarded in the

capacity market for 2022 and 2023 come online (see Chapter 7). In the longer term, gas demand from electricity and heat generation is expected to remain strong.

Residential and service sector buildings respectively accounted for 27% and 11% of natural gas demand in 2020; demand from both residential and services buildings has slightly decreased over the past decade due to efficiency improvements. Industry accounted for 18% of total gas demand in 2021; gas demand from industry has been largely stable in the past decade.

Figure 8.1 Natural gas demand by sector in Italy, 2005-2021



Natural gas demand has risen considerably since it fell to a low in 2014, largely as a result of increased demand from the power sector following the closure of coal-fired generation capacity.

Source: IEA (2022a).

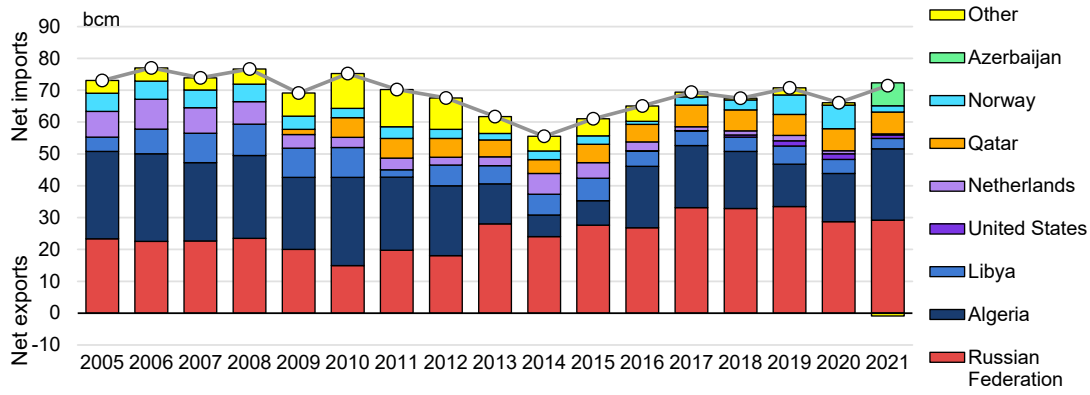
Trade

Italy is a large net importer of natural gas, with total net imports amounting to 71.5 bcm in 2021 (Figure 8.2), making it the second most significant importer of gas among European OECD countries after Germany. Before falling in 2020 due to reduced demand, net gas imports had been rising since 2014 due to a combination of increasing demand and declining domestic production. Natural gas imports to Italy can be received through six pipeline interconnection points and three LNG terminals though the Gorizia pipeline interconnection is not often used for imports. (Figure 8.3). More than 90% of imports arrive by pipeline, although the volume of imports through Italy's LNG terminals has increased notably in 2022.

Italy is heavily dependent on Russian natural gas, which accounted for 41% of its total gas imports in 2021. Italy also imports significant quantities of natural gas by pipeline from North Africa, with Algeria and Libya respectively accounting for 34% and 5% of total Italian natural gas imports in 2021. In 2019 and 2020, increased quantities of North Sea gas were imported into Italy, with Norway accounting for 11% of total imports in 2020, compared to just 1% in 2015. However, imports from Norway decreased to 3% in 2021 as the Trans Adriatic Pipeline (TAP) came into operation in late 2020. Qatar has been a significant supplier of natural gas to Italy (10%) since the early 2010s following the construction of LNG import infrastructure. The United States has been a significant supplier of natural gas to Italy since 2019; US LNG accounted for 2% of total gas imports in 2021. Since late 2020,

Italy has also been importing quantities of natural gas from Azerbaijan via the TAP pipeline, accounting for 10% of Italy's gas imports in 2021.

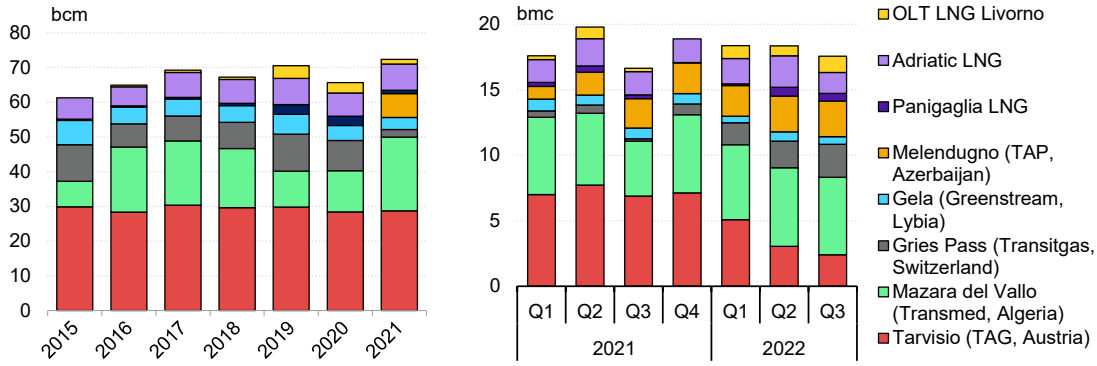
Figure 8.2 Italy's natural gas net trade by country, 2005-2021



Italy is a large natural gas net importer with a heavy reliance on Russian gas imports.

Source: IEA (2022a).

Figure 8.3 Italy's natural gas imports by interconnection, 2015-2022



Natural gas can be imported through multiple pipelines and three LNG terminals. In 2022, the share coming from Tarvisio decreased to reach 14% in Q3 2022.

Source: IEA based on data from Snam (2022).

Infrastructure

Pipelines

Italy's six pipeline entry points are: Tarvisio, Mazara del Vallo, Gries Pass, Gela, Melendugno and Gorizia. The combined import capacity of the six pipeline entry points is 360 mcm/d or 131 bcm/y.

The Tarvisio and Mazara del Vallo interconnections are by far the most significant import points by capacity; Russian gas is imported through Tarvisio from Austria via the Trans Austria Gas (TAG) pipeline while Algerian gas is imported through Mazara del Vallo via the sub-sea Transmed pipeline. The Gries Pass interconnection can be used to import gas originating in north-west Europe from Switzerland while the Gela interconnection can be used to import gas from Libya via the sub-sea Greenstream pipeline. The Gorizia interconnection with Slovenia is rarely used for imports.

Since late 2020, Italy has been able to import natural gas through the Melendugno interconnection in the south-east which facilitates Azeri gas imports via the TAP. In 2022, the utilisation rate of the Melendugno interconnection was at full capacity. The Italian government is open to a doubling of the capacity of the TAP connection between Albania and Italy if new upstream investments are planned.

Figure 8.4 Map of Italy's gas infrastructure

In the past decade, Italy has invested in infrastructure facilitating the reverse flow of gas from Italy into northern Europe. In 2018, Snam, the gas TSO,[1] completed upgrades at several northern compression stations to allow reverse flow into Switzerland. All of Italy's northern gas interconnectors now have reverse flow capacity for exports.

Table 8.1 Italy's natural gas import points by pipeline, winter 2021-2022

Entry/exit points	Supply source	Maximum daily technical entry capacity (mcm/d)
Tarvisio	Trans Austria Gas pipeline (Russia via Austria)	108.9
Mazara del Vallo	Transmed pipeline (Algeria via Tunisia)	102.6
Gries Pass	Transitgas pipeline (Northern Europe via Switzerland)	59
Gela	Greenstream pipeline (Libya)	43.6
Melendugno	Trans Adriatic Pipeline (Azerbaijan via Albania)	44
Gorizia	Slovenia (reverse flow)	39

Source: Information provided by the Government of Italy.

LNG terminals

In addition to the six pipeline entry points, natural gas can be imported through three LNG regasification terminals: the Adriatic (or Cavarzere) terminal off the Veneto coast in the north-east; the Panigaglia terminal near Liguria in the north-west; and the Offshore LNG Toscana (OLT) terminal near Livorno on the western coast in Tuscany. The three LNG terminals have a combined technical entry capacity of around 54 mcm/d.

The Adriatic LNG terminal is Italy's most significant LNG terminal by import capacity. Its import capacity stands at 26.4 mcm/d and it has an annual regasification capacity of 8 bcm. There is 250 000 cubic metres (m^3) of storage capacity at the terminal. Eighty per cent of the regasification capacity at the Adriatic LNG terminal (6.4 bcm) is reserved for the import of Qatari gas in accordance with a long-term supply contract. The terminal is owned by Adriatic LNG, in which ExxonMobil Italiana Gas has a 71% share, Qatar Terminal Company Limited a 22% share and the Snam Group the remaining 7%.

The Panigaglia LNG terminal has an import capacity of 13 mcm/d and an annual regasification capacity of 3.5 bcm. The terminal's storage capacity is 100 000 m^3. The terminal is limited by an inability to receive the largest LNG tankers and mostly receives loads from smaller ships operating in the Mediterranean. It is operated by GNL Italia, which is owned by the Snam Group.

The OLT LNG terminal has a 15 mcm/d import capacity and an annual regasification capacity of 3.75 bcm. The terminal's storage capacity is 155 000 m^3. It is owned by Offshore LNG Toscana, in which the Snam Group has a 49% shareholding. The remaining shares are owned by an asset management group, First Sentier Investors.

Under EU Third-Party Access rules and the requirements of Italy's energy regulator, ARERA, Italy's three LNG terminals must offer 20% of their nominal capacity to the open

[1] Annex A provides detailed information about institutions and organisations with responsibilities in the energy sector.

market through a regular subscription process. However, before 2022, demand for access to LNG import capacity was limited and Italy's LNG import terminals were generally underutilised.

Table 8.2 Italy's LNG import terminals, 2022

LNG terminal	Maximum daily technical entry capacity (mcm/d)
Adriatic (Cavarzere)	26.4
Panigaglia	15
OLT (Livorno)	13

Source: Information provided by the Government.

Domestic pipeline network

Snam Rete Gas (SRG), part of the Snam Group, is Italy's main gas TSO. SRG operates a nationwide pipeline network 32 000 km long and supplies around 95% of the Italian market. All SRG pipelines have reverse flow capability. Società Gasdotti Italia (SGI) is the second-largest transporter of natural gas in Italy, operating a pipeline network of around 1 300 km long, mainly in southern Italy. Infrastrutture Trasporto Gas, also controlled by Snam, operates the 84-kilometre long Cavarzere-Minerbio pipeline, transporting gas from the Rovigo regasification terminal at the Adriatic LNG terminal to a national distribution network hub near Minerbio (Bologna).

The natural gas distribution sector operates under service concessions granted by local governments; only one network operator is allowed to distribute natural gas in each concession area. The most significant distribution company is Italgas (owned by the Snam Group), which owns 28% of the distribution networks. Other significant DSOs include 2i Rete Gas (19% of the networks) and A2A (9% of the networks). Beyond the three largest operators, the Italian gas distribution sector is highly fragmented.

Storage

Total natural gas storage capacity in Italy stood at 19.04 bcm in 2021. About 4.6 bcm of this capacity is dedicated to the storage of strategic stocks. The vast majority of natural gas storage capacity in Italy is located in underground storage sites in depleted gas fields. There are 13 underground storage sites in total. These sites are the property of the state; the state allocates operational control of storage capacity to industry players through concession agreements. The maximum nominal withdrawal rate from the natural gas storage system is 329 mcm/d, equivalent to 1.7 days of average daily demand in 2020.

Stogit, controlled by Snam, is by far the most significant operator of natural gas storage in Italy, with a capacity of 17.2 bcm (90% of total storage capacity). The MiTE has tasked Stogit with storing 97% of Italy's strategic storage reserves, equating to 4.48 bcm. The remaining storage capacity is controlled by Edison Stoccaggio (865 mcm, including 140 mcm of strategic reserves) and Ital Gas Storage (1 bcm).

Storage operators are required to make all their commercial capacity available via auctions. Access to storage facilities is based on a Third-Party Access System approved by the regulator, ARERA. Tariffs are established by ARERA in line with criteria established by the government. Tariffs include a commodity charge; a strategic storage fee; and charges for volume, injection and withdrawal capacity.

Table 8.3 Italy's natural gas storage capacity by location, 2020/21

Location	Capacity (bcm)	Withdrawal rate (mcm/d)
Brugherio	0.3	8
Bordolano	1.2	20
Cortemaggiore	1	15
Fiume Treste	4	66
Minerbio	3.1	57
Ripalta	1.7	12
Sabbioncello	0.9	20
Sergnano	2.2	55.5
Settala	1.8	37.5
Cellino	0.1	0.8
Collalto	0.4	2.8
San Potito e Cotignola	0.9	7.2
Cornegliano	1.3	27
Total	**19**	**328.8**

Source: Information provided by the Government.

Gas supply diversification projects

In 2022, the Italian government began investigating the potential of numerous projects aimed at facilitating a phase-out of the dependency of gas supply from Russia. In March 2022, the government mandated the Snam Group to make efforts to secure FSRUs; at least one FSRU is set to be operational by 2023, while two additional ones have been secured for installation by the end of 2024; the FSRUs would have a combined capacity of at least 10 bcm.

In March 2022, Enel, Italy's biggest energy utility, began to investigate the potential for a previously discarded plan to construct a new LNG terminal in southern Italy. The proposed Porto Empedocle LNG project would have a capacity of 8 bcm/y. The government has yet to take a decision on the project. A lengthy authorisation process and the lack of a government guarantee to cover costs in the event of low utilisation levels have been cited by industry as major impediments to the construction of additional new LNG import capacity.

The Adriatic pipeline project, which involves the construction of new pipeline infrastructure from Puglia in southern Italy, aims to facilitate increased imports from the TAP pipeline; the project has an estimated cost of EUR 2.4 billion and is projected to be commissioned in 2024.

The Italian government has also backed the construction of the proposed EastMed pipeline, which would transport gas to southern Europe from the Eastern Mediterranean; however, the status of this project remains uncertain.

Domestic gas infrastructure projects

Construction of an FSRU at the port of Oristano in western Sardinia is expected to be completed by 2023. To facilitate the distribution of gas in Sardinia, which is not connected

to the Italian gas network, Enura, a joint venture between Snam and SGI, has proposed a project for a 600 km pipeline across the island. In addition to the gas pipeline, a network of regasification plants, coastal storage depots and distribution networks would support the distribution of gas across Sardinia. The project aims to help end coal-fired power generation on the island. While the new LNG terminal is scheduled for completion in 2023, the pipeline network will be developed through 2030.

The main TSO, SRG, is also planning to upgrade its network through a EUR 400 million project to install electro-compressors to replace seven existing turbo-compressors aimed to increase efficiency and reduce emissions. The project is set to be completed by 2029.

Gas policy

The Italian government believes that natural gas will remain a major part of Italy's energy mix in the long term. In the base PEC scenario of Italy's 2019 NECP, natural gas consumption is marginally higher than the 2020 level in 2040; the scenario forecasts that natural gas will still account for around 40% of PEC in Italy by 2040. The next iteration of Italy's NECP, due for release in 2023, will detail how Italy can meet its obligations under the EU FF55 package and its own ambitions for carbon neutrality by 2050, while natural gas maintains a fundamental role in the energy mix.

Supply diversification and phasing out of dependency from Russian gas

To ensure the long-term security of natural gas supply, the NECP states an objective to further increase the diversification of gas supply sources and expand the potential for LNG imports. In March 2022, the Italian government also stated a goal to significantly reduce its reliance on Russian gas imports within one year and potentially to cease importing gas from Russia by 2025, in response to Russia's invasion of Ukraine. This is to be achieved by optimising existing LNG infrastructure, adding FSRUs, potentially adding new LNG import capacity, and increasing imports from the TAP and through the Transmed pipeline from Algeria (see "Infrastructure" section). In April 2022, Eni and Sonatrach reached an agreement to increase exports of Algerian gas to Italy by up to 9 bcm/y (+40% on the 2021 level) by 2023.

Hydrogen and biomethane

The NECP states an objective to focus on the production of renewable gases and increase the share of biomethane, synthetic methane and eventually hydrogen in the gas network. In 2021, the Italian government released a preliminary National Hydrogen Strategy which envisions that, through a series of initiatives, Italy can produce enough low-carbon hydrogen to cover 2% of PEC by 2030 (see Chapters 3 and 6). However, while the preliminary National Hydrogen Strategy provides broad guidelines and objectives for increasing hydrogen penetration, a more detailed and concrete strategy will be necessary to ensure significant uptake of hydrogen. Similarly, a detailed strategy for the promotion of renewable gases will be required to ensure significant penetration.

Market structure

Italy's natural gas industry consists of transport companies (transmission and distribution), storage companies, LNG regasification facility operators, upstream companies, and wholesale and retail suppliers.

The Snam Group is dominant in the transport and storage of natural gas and has significant interests in Italy's LNG regasification terminals. After an unbundling process, the Snam Group was separated into individual transport, storage and LNG regasification companies in 2012. In the upstream, wholesale and retail sectors, Eni is the most significant player.

Italy's natural gas market has historically been characterised by a small number of large players, long-term supply contracts and limited supply sources. This contributed to prices being high relative to northern European markets. While the market remains concentrated, competition has increased in recent years alongside an increase in the diversity of import sources. This has contributed to the convergence of Italian wholesale gas prices with those in northern European markets (see below, "Prices and taxation").

ARERA, an independent body, carries out regulatory and supervisory activities across the natural gas sector.

Upstream

In 2020, 17 companies were directly involved in the production of natural gas in Italy. However, Eni dominates the upstream gas sector, accounting for 72% of total gas production in 2020. Royal Dutch Shell was the second largest, accounting for 16% of production, while Edison (through Energean PLC) and Gas Plus accounted for 8% and 2% of production respectively. A variety of other producers accounted for a combined 2% of natural gas production in 2020.

Wholesale market and trading

In 2020, 199 companies were registered as sellers in the Italian natural gas wholesale market. Eni is the largest player, with a market share of 21% in 2020 (including sales from its subsidiary Eni Trading & Shipping). Engie, through various subsidiaries, had a wholesale market share of around 16%, while Alpiq and Enel had market shares of 9% and 6%, respectively. Companies with wholesale market shares of 2-5% include Edison, Shell Energy Europe, Gazprom, DXT Commodities, A2A, MET International and EDF Trading.

In the past decade, Eni's market share has remained generally steady while the combined market shares of other companies considered by the regulator as "large suppliers" has grown. The combined market share of companies considered "smaller suppliers" has not grown substantially, even though the total number of smaller players has increased.

Wholesalers can directly sell their products through bilateral over-the-counter contracts or Italy's gas exchange. The gas exchange is managed by GME, which plays the role of central counterparty. GME is wholly owned by the Ministry of Economy and Finance. GME oversees the gas spot market (MP-GAS), which includes the day-ahead market

(MGP-GAS), intraday market (MI-GAS), locational products market (MPL) and the regulated market for the trading of stored gas (MGS). It also oversees the forward gas market (MT-GAS).

Parties may also enter into spot bilateral contracts through the virtual trading point, Punto di Scambio Virtuale (PSV), operated by the gas TSO, SRG. Since 2015, PSV has progressively developed into a gas trading hub of regional significance; the Italian government is keen to develop PSV and facilitate its role as an emerging reference hub for southern Europe.

Retail market

In 2020, 468 companies were registered as suppliers of natural gas to the Italian retail market. Eni is the most significant player, with an 18% market share in 2020, followed by Edison and Enel, which held market shares of 14% and 12%, respectively. Medium-sized players include Hera, Iren, EPH and A2A, all of which held market shares of 4-5% in 2020. In the past decade, the number of small suppliers in the retail market has grown considerably. This has resulted in a substantial drop in the average annual sales volume per company.

Since 2007, household consumers have had the option to purchase natural gas from the supplier of their choice at market prices. However, many household consumers have chosen to retain the status of “protected consumer” under the so-called Maggior Tutela (“enhanced protection”) scheme. For customers receiving gas under this scheme, the energy regulator, ARERA, determines the contractual conditions of gas supply provided by the DSO, including the regulated price that households pay.

The Maggior Tutela scheme was scheduled to be scrapped in 2020, but this was postponed. Around 38% of total consumers in Italy remained on the Maggior Tutela scheme in 2020. The scheme for gas is now set to end in 2023, at which point most protected customers will be forced to move to the open market. To facilitate a smooth transition of the remaining “protected customers” to the open market, ARERA will organise auctions of lots of customers to suppliers; the share of customers that each supplier can obtain will be capped to avoid increasing market concentration. However, even after the Maggior Tutela scheme ends, the government will retain regulated tariffs for consumers designated as “vulnerable”; this includes those in energy poverty and all consumers over 75 years old.

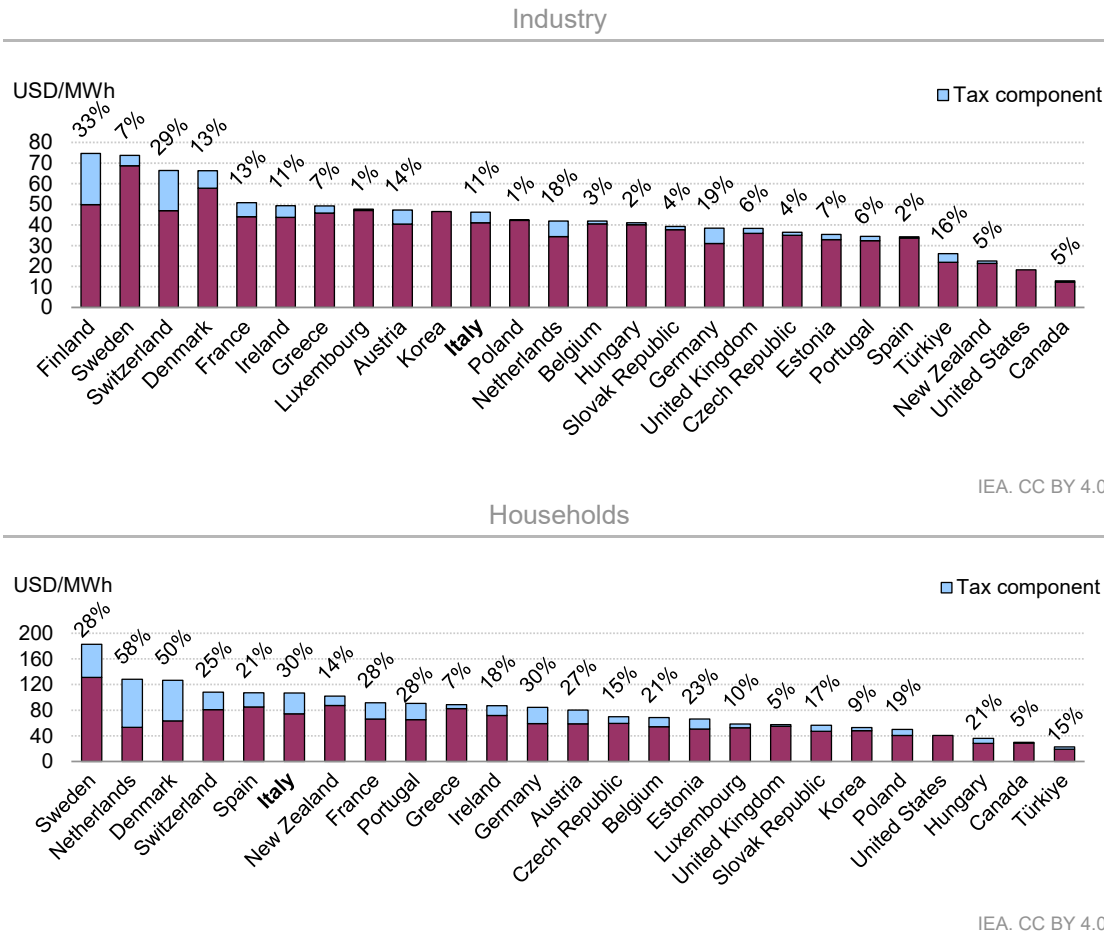
Prices and taxation

Natural gas prices in Italy have traditionally been among the highest in Europe due to market illiquidity, the dominance of long-term contracts and a lack of competition. These conditions have improved somewhat in recent years, but Italian natural gas prices are still among the highest in Europe. In 2021, the IEA average natural gas price for industry was 43.1 USD/MWh while the average household price was 79.8 USD/MWh (Figure 8.5).

Thirty-eight per cent of households still avail of regulated prices set by the energy regulator. In Q1 2022, ARERA raised the regulated gas price for households substantially, by 42%, due to the significant rise in wholesale gas prices. In 2021, the average household price for natural gas included a 39.7% tax component (excise duty, regional surtax and VAT).

The government has taken measures to alleviate the price burden for end users, including reducing the VAT on natural gas sales for both household and industrial consumers from 22% to 5%; this measure was introduced in October 2021 for an initial period of three months but has since been rolled until at least end-Q3 2022. The government has also provided subsidy payments (*bonus sociale energia elettrica e gas*) to low-income households to assist with paying gas and electricity bills.

Figure 8.5 Natural gas prices, industry and households in IEA countries, 2021



Italy's natural gas prices remain higher than the IEA average.

Notes: 2021 prices are not available for Australia, Japan, Mexico or Norway. The United States' tax rate is unavailable. Household prices are inclusive of a supplier margin, transmission costs, storage costs and distribution.

Source: IEA (2022b).

Gas emergency policy

The MiTE maintains an Emergency Plan, which specifies the roles and responsibilities of various stakeholders in the event of a gas supply emergency, as well as the measures that can be taken in response to a supply disruption.

Italy's Emergency Plan details three levels of natural gas supply emergency: "early warning", "alert" and "crisis", based on the emergency levels established by EU regulation

(2017/1938). Various emergency response measures can be taken to avert or reduce the impact of a natural gas supply disruption, depending on the level of the natural gas emergency at hand.

Under both the early warning and alert levels, market participants act to resolve the situation without the need for government intervention. Suppliers should increase imports and use interruptible contracts, while major consumers in the power and industrial sectors would enact fuel switching, if necessary.

If the crisis level is activated, under the Emergency Plan the MiTE can enforce limits on the consumption of natural gas in power generation and the industrial sector, release strategic stocks, make use of LNG storage capacity as "peak shaving" devices, and suspend the obligation to supply all unprotected customers.

After consulting the Technical Gas System Emergency and Monitoring Committee, two emergency measures were prepared for the gas year 2021-2022: 1) the use of underutilised LNG storage capacity as "peak shaving" devices; and 2) the interruption of natural gas supply to industrial consumers.

Each year, the MiTE sets minimum gas stockholding levels for the winter period. The government enacted a decree in March 2022 mandating that Italy's total gas storage capacity must be filled to at least 90% of total capacity in advance of the 2022-2023 winter period, in alignment with the IEA 10-Point Plan to Reduce the European Union's Reliance on Russian Natural Gas. About 4.6 bcm of Italy's 19 bcm total natural gas storage capacity is dedicated to the storage of strategic gas reserves. However, there are restrictions concerning the release of Italy's strategic gas reserves; strategic storage volumes can only be released if gas import capacity is used to the maximum and all commercial storage volumes are first released. Italy's strategic gas stocks have never been released.

Assessment

Natural gas is a critical energy source in Italy, accounting for 41% of the total energy supply and half of the electricity generation in 2021. In the coming decade, natural gas will continue to play a central role in power generation, particularly as coal-fired capacity is phased out. In the longer term, natural gas will retain an important role as the principal source of dispatchable power and will also likely remain a key energy source in the buildings and industry sectors, even if the role of biomethane and hydrogen grows. It is therefore unlikely that natural gas consumption will decrease significantly in the long term and, with little prospect of a substantial increase in domestic production, Italy will remain heavily dependent on natural gas imports.

In the short term, reducing dependence on Russian gas is arguably the biggest challenge facing the Italian energy sector. In March 2022, the Italian government announced that it aims to significantly reduce Russian gas imports in the next year and cease importing gas from Russia by 2025. The scale of this challenge is evidenced by the fact that Russia has accounted for over 40% of Italy's considerable volume of gas imports until 2021. However, the government has already made commendable efforts to secure alternative sources of pipeline gas, increase imports through Italy's existing LNG infrastructure and secure FSRUs.

In the longer term, the government should continue to focus on diversifying its gas supply sources. It should facilitate supply diversification by minimising regulatory impediments to the construction of necessary import infrastructure. However, the government should simultaneously support and encourage those companies developing new natural infrastructure projects to "future proof" their investments by ensuring that they can also be used for importing and distributing hydrogen and renewable gases.

Given the strong likelihood that natural gas will continue to play a fundamental role in Italy's energy mix in the coming decades, minimising emissions from natural gas use will be essential if Italy is to meet its ambition to achieve carbon-neutrality ambition by 2050 (see Chapter 3). It is imperative, therefore, that the government makes significant efforts to limit the future use of unabated natural gas by considering where CCUS can be implemented as well as strengthening efforts to substitute natural gas with biomethane and green hydrogen in all relevant sectors.

In recent years, the government has taken measures to support gas market competition and liberalise the retail sector. The cancellation of the Maggior Tutela ("enhanced protection") scheme has been delayed from its original date of 2020, but will now be implemented in 2023, at which point most protected customers will move to the open market. However, the government will retain regulated tariffs for consumers designated as "vulnerable", which includes those in energy poverty and all consumers over 75, irrespective of their economic status. The government has also made significant efforts to shield end users from the impact of higher wholesale gas prices as of the fall of 2021 and exacerbated by Russia's invasion of Ukraine in February 2022, by reducing the VAT on natural gas sales for all household and industrial consumers and providing subsidy payments to some groups of consumers.

Government policy to protect the most vulnerable consumers from high tariffs can be understandable under some circumstances and the reduced gas tariffs only partially absorb the recent prices increases. Yet, reduced tariffs provide assistance to all consumers without full taking into account their economic position. Moreover, there is also a risk that they weaken incentives to invest in more efficiency and delay the penetration of low-emission fuels.

Recommendations

The government of Italy should:

- Continue to pursue efforts to phase out Russian gas imports and diversify gas supply sources.
- Minimise regulatory impediments to the construction of necessary gas import and distribution infrastructure, where possible, while ensuring that all new infrastructure can also be used for importing and distributing hydrogen and renewable gases.
- Introduce clear milestones for the gradual substitution of natural gas with biomethane and low carbon hydrogen in all relevant sectors and an explicit objective for the use of carbon capture, utilisation and storage, where appropriate within the next iteration of the National Energy and Climate Plan.
- Focus support measures to address high gas prices to those defined as energy poor and provide assistance to "protected customers" when making the transition to the open market.

References

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Snam (2022) Transported Gas Balances, https://www.snam.it/en/transportation/operational-data-business/2-Trends-since-2005

9. Oil

Key data

(2021)

Production of crude oil: 111 kb/d, -5.7% since 2011

Net imports of crude oil:* 1 176 kb/d, -25% since 2011

Domestic production of oil products: 1 401 kb/d, -22% since 2011

Net exports of oil products: 267 kb/d, -10% since 2011

Share of oil: 32% of TES,** 37% of TFC ,16% of domestic energy production and 3.1% of electricity generation

Oil products consumption: 1 184 kb/d (domestic transport 60%, industry including non-energy consumption 22%, international bunkering 7%, buildings 6%, electricity and heat generation 5%)

* Production and imports of crude oil includes crude oil, natural gas liquids and feedstock.

** Total energy supply does not include oil used for international bunkering.

Overview

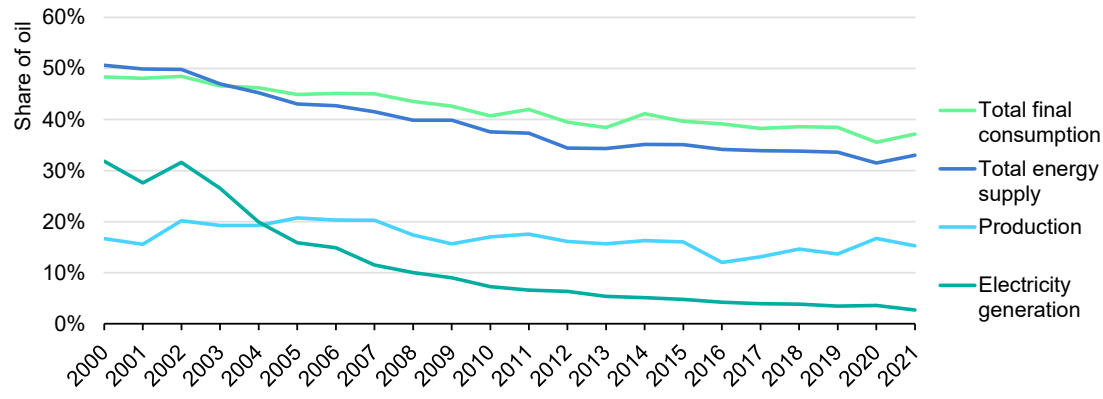
The share of oil in TFC and TES in Italy has been slowly trending downwards for more than a decade (Figure 9.1). However, oil remains the most significant energy source in TFC (37% in 2021) and the second most significant energy source in TES (32%).

While Italy has a small upstream oil industry, it is heavily reliant on crude oil imports. Reliance on Russian crude oil remains substantial, although crude imports from Russia have decreased in the past decade, and will likely cease by the end of 2022 once the EU ban on the import of seaborne imports of Russian crude oil enters into force in December 2022.

Italy has a large refining industry and is a significant net exporter of oil products. However, there has been a substantial rationalisation of refining capacity since the late 2000s, resulting in a reduction of Italy's net export position. Further rationalisation of refining capacity is likely in the coming years.

Oil demand remained relatively stable from 2015 to 2019 before falling significantly in 2020 due to the Covid-19 pandemic. Demand has rebounded strongly since mid-2021 and, in the short term, there is little to suggest that it will reduce significantly. However, in the medium to long term, the government expects a sizeable reduction in oil demand, largely as a result of the uptake of EVs and alternative fuels in the transport sector. Italy does not have any specific targets for reducing oil consumption, however.

Figure 9.1 Share of oil in the Italian energy sector, 2000-2021



Oil remains a critical energy source in Italy. In 2021, it was the most significant energy source in TFC (37%) and the second most significant energy source in TES (32%).

Source: IEA (2022a).

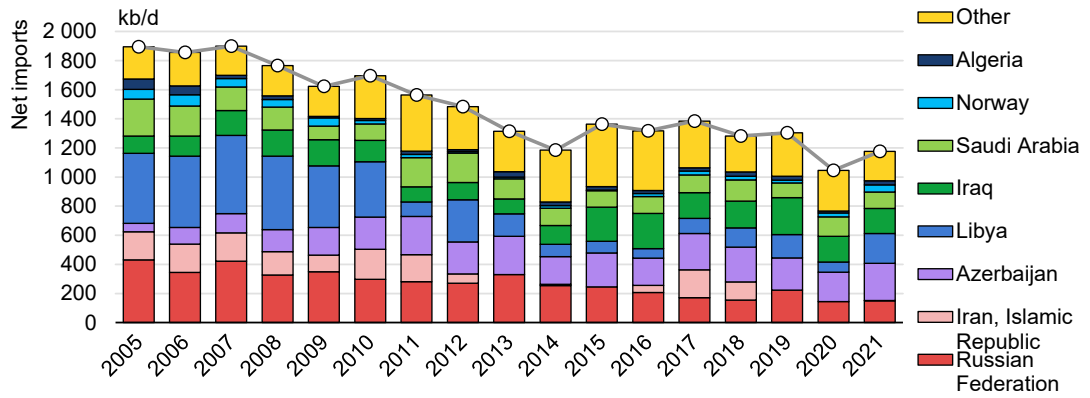
Supply and demand

Crude oil production and trade

Crude oil production in Italy amounted to 111 thousand barrels per day (kb/d) in 2021, a 15% increase on the 2019 production level. The increased production was a result of the commissioning of the Tempa Rossa oil field in the Basilicata region of southern Italy in late 2019. In 2021, domestic crude oil production met just 11% of the total demand. Italy's NECP projects crude oil production to decline considerably going forward, with forecasted production in 2030 being 30% below the 2020 level.

Italy is heavily reliant on crude oil imports, with net imports totalling 1 176 kb/d in 2021 (Figure 9.2). Net imports in 2020 were 19% lower than in 2019 due to lower refinery runs in response to reduced demand resulting from the impacts of Covid-19. However, before 2020, net crude oil imports had already been trending downwards for over a decade as a consequence of refining capacity rationalisation and reduced refinery utilisation levels. In 2021, net crude oil imports increased by 12% from the previous year.

Figure 9.2 Italy's crude oil, natural gas liquids and refinery feedstock net imports by country, 2005-2021



Crude oil imports have trended downwards as a result of refining capacity rationalisation; Russia remains a major supplier, but Russian crude imports have been decreasing.

Source: IEA (2022a).

In 2021, Azerbaijan was the largest supplier of crude oil to Italy, accounting for 22% of total net imports. Seventeen per cent of Italy's net crude oil imports were sourced from Libya in 2021, but this share has been limited over the past decade as a result of a significant reduction in Libyan export capacity. Iraq has been a constant supplier of crude oil to Italy for many years, accounting for 15% of total imports in 2021. Saudi Arabia accounted for 10% of Italy's crude oil imports in 2021.

Italy's reliance on Russian crude oil remains substantial, but has declined significantly over the past decade; 12% of Italy's net crude oil imports were supplied by Russia in 2021, compared to a peak of 25% in 2013. In March 2022, Italy's largest refiner, Eni, announced that it will no longer import Russian oil in response to Russia's invasion of Ukraine. Imports of Russian crude ceased by the end of 2022 after the implementation of the EU ban on the import of seaborne imports of Russian crude oil which entered into force in December 2022. The 320 kb/d Priolo/ISAB refinery that is indirectly owned by Russian oil firm Lukoil continued to rely on Russian crude oil for a portion of its feedstock needs during 2022 which caused the share of crude oil imports from Russia to grow to 25% in Q3 2022.

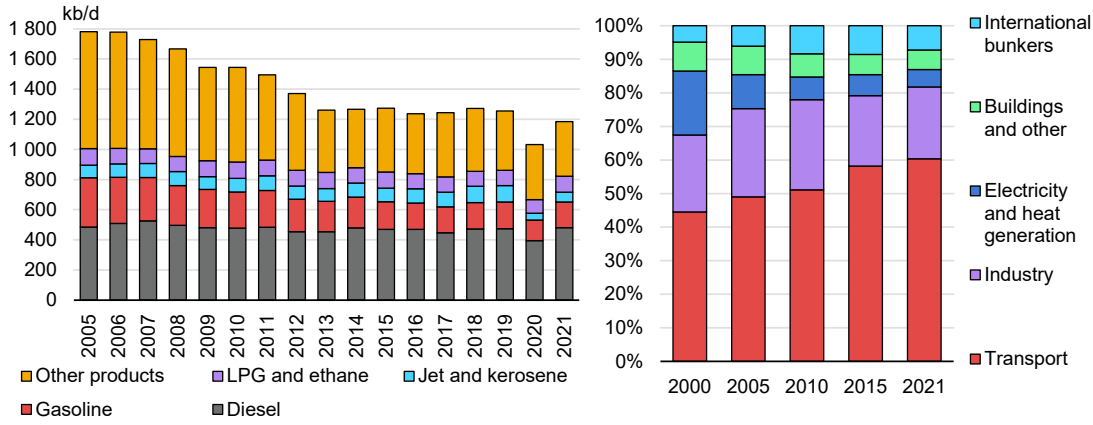
Oil products demand

Total demand for oil products stood at 1 184 kb/d in 2021 (Figure 9.3), Oil demand had decreased by 16% in 2020 as a result of the impact of restrictions on mobility and reduced economic activity caused by the Covid-19 pandemic, and rebounded by 15% from 2020 to 2021. Earlier, oil product demand trended sharply downwards from 2005 to 2013, before plateauing until 2019.

Demand for oil products is heavily concentrated in the transport sector, which accounted for 60% of total consumption in 2021. Diesel is the most consumed oil product in Italy, representing 41% of total oil products demand in 2021. Diesel demand showed a particularly strong rebound with 2021 demand even slightly higher than 2019.

In 2021, industry was the second most significant oil-consuming sector, accounting for 22% of demand, a large proportion of which relates to the demand for petrochemicals feedstocks. Buildings accounted for 6% of total demand, followed by electricity and heat generation (5%). Seven per cent of oil products demand derives from international bunkers, down from 12% in 2019 due to the particularly sharp drop in jet fuel demand during the pandemic.

Figure 9.3 Oil products demand by fuel and sector in Italy, 2005-2021



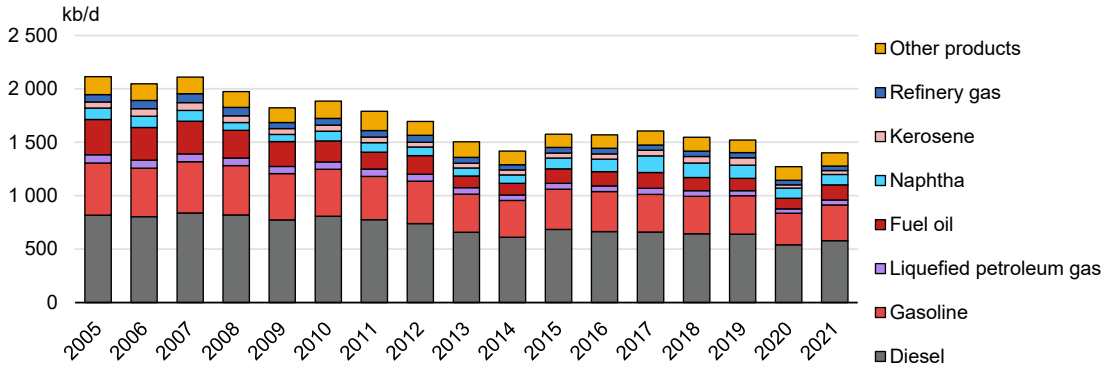
Oil products demand is substantially lower than in 2005; however, aside from 2020, total demand has been largely flat for around a decade.

Note: The share by sector is not available for 2021.
Source: IEA (2022b).

Oil products production and trade

Italy's total oil products production amounted to 1.40 mb/d in 2021 (Figure 9.4), 10% lower than 2019, as the rebound in refining production lagged behind demand growth. In 2020, oil product production fell sharply after refinery utilisation rates approached historical lows in response to reduced demand. Before 2020, oil products production had already fallen well below the peak in 2005 at 2.1 mb/d as a result of significant rationalisation of refining capacity. Refining production is heavily oriented towards middle distillates; diesel accounted for 41% of production in 2021. Gasoline represented 24% of production, while fuel oil accounted for 10% and naphtha 7%. Refinery yields have changed little in percentage terms over the past decade.

Figure 9.4 Oil products production by product in Italy, 2005-2021



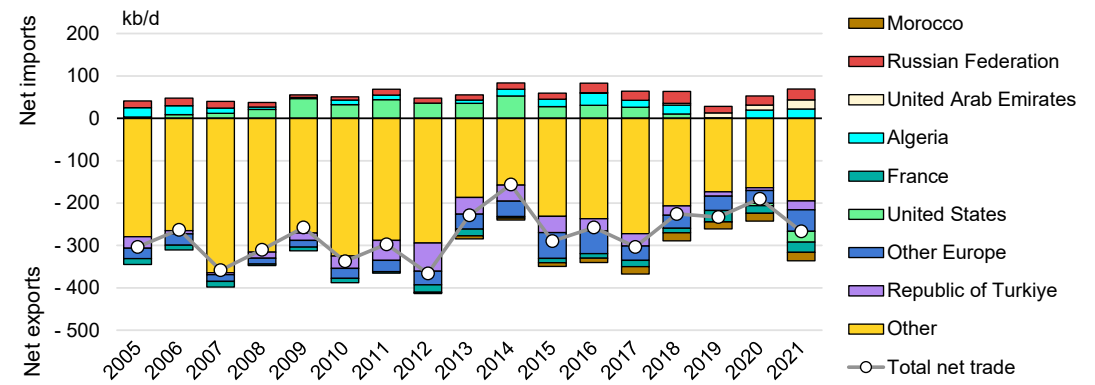
Refining capacity rationalisation and lower utilisation rates have resulted in reduced levels of oil product production compared to 2005.

Source: IEA (2022b).

Italy is a net exporter of oil products, with net exports standing at 267 kb/d in 2021. Net exports are lower than a decade ago due to refining capacity rationalisation; in 2011, net exports totalled 297 kb/d, 10% higher than in 2021. Italy is a significant net exporter of gasoline, a marginal net exporter of middle distillates and a net importer of petrochemicals feedstocks. As a result of the high probability of further refining capacity rationalisation in the longer term, Italy's net export position in gasoline will likely contract in the short term, while it could become a net importer of middle distillates.

In 2021, Spain was the most significant destination for Italian oil product exports (28 kb/d) followed by the United States (26 kb/d), France (24 kb/d) and the Republic of Türkiye (21 kb/d). Italy was a notable net importer of oil products from Russia (25 kb/d), Algeria (22 kb/d) and the United Arab Emirates (21 kb/d).

Figure 9.5 Oil products trade by country in Italy, 2005-2021



Italy is a net exporter of oil products, mainly to Europe but also to the United States and Türkiye. Net imports came in 2021 from Russia, Algeria and United Arab Emirates.

Source: IEA (2022b).

Oil policy

Italy's NECP foresees oil consumption declining over the medium and long term, largely as a result of government policies to promote renewable energies and electrify the transport sector. However, Italy does not have specific targets for reducing oil consumption.

In addition to various measures aimed at incentivising the uptake of electric passenger vehicles, the Italian government is promoting a greater role for both natural gas and hydrogen in the heavy-duty vehicle segment, and potentially marine transport. Nonetheless, oil will undoubtedly remain the dominant fuel for both sectors in the next decade, and likely beyond.

Biofuels

The government has provided significant support for the penetration of biofuels in the transport sector, with a focus on advanced biofuels. Both the government and major fuel suppliers view biofuels as a key component of Italy's efforts to reduce oil consumption and decarbonise the transport sector.

As of 2022, the biofuel blending mandate for gasoline and diesel stands at 10% with an advanced biofuels component of 2.5%, of which advanced biomethane must account for 75%. Under Italy's NECP, the biofuels blending mandate will rise to 11% by 2030, with a minimum share of 8% for advanced biofuels and a maximum of 3% share for first generation biofuels. As Italy currently imports 90% of biofuel feedstocks, the government is assessing numerous projects to increase domestic production of advanced biofuels to facilitate its ambitions for higher consumption.

Italy's NECP highlights the need for policy measures to support the evolution of the refining industry. It calls for the conversion of existing oil refining capacity into biofuels production facilities in line with a projected increase in demand for advanced biofuels.

Market structure

The Italian oil market is fully liberalised with imports, exports and pricing determined by market participants.

Wholesale and retail

Eni[1] is the largest player in the wholesale sector, followed by Saras and Kuwait Petroleum International (KPI). Eni also has the largest retail market share in Italy, with a 27% share in 2020; the company operates over 4 000 service stations in Italy. The next most significant players in the Italian retail market are Esso (11%, 2020), KPI (9%, 2020), Italiana Petroli (7-8%; 2020); Tamoil (6%, 2020) and Saras (3%, 2020).

The Italian retail sector is characterised by a large number of small, independent stations, which account for a significant portion of total sales volumes. There were more than 20 000 retail stations in Italy in 2020, compared to just over 11 000 in France; the rate of retail

[1] Annex A provides detailed information about institutions and organisations with responsibilities in the energy sector.

sites per capita in Italy is almost double that of France. A large number of retail sites will likely close in the future, due to both falling demand in the long term and potential government intervention to reduce the number of small, independent sites.

Prices and taxation

In the first quarter of 2022, the cost of automotive diesel in Italy was the eighth-highest among IEA countries at 1.99 USD/L, with a tax rate of 51%, compared to the IEA average of 1.75 USD/L and a tax rate of 40% (Figure 9.6). The price for premium unleaded gasoline (95 RON) in Italy was the seventh highest among IEA countries at 2.10 USD/L, with a tax rate of 55%, compared to the IEA average of 1.84 USD/L and a tax rate of 46% (Figure 9.7).

Figure 9.6 Price comparison for automotive diesel in the IEA, Q1 2022

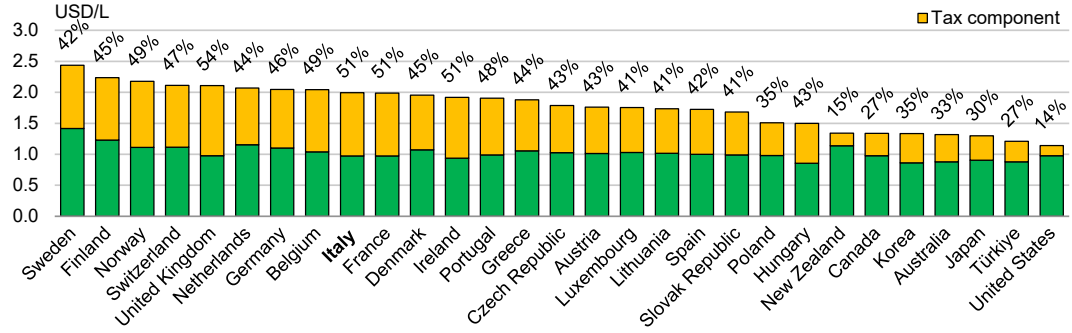
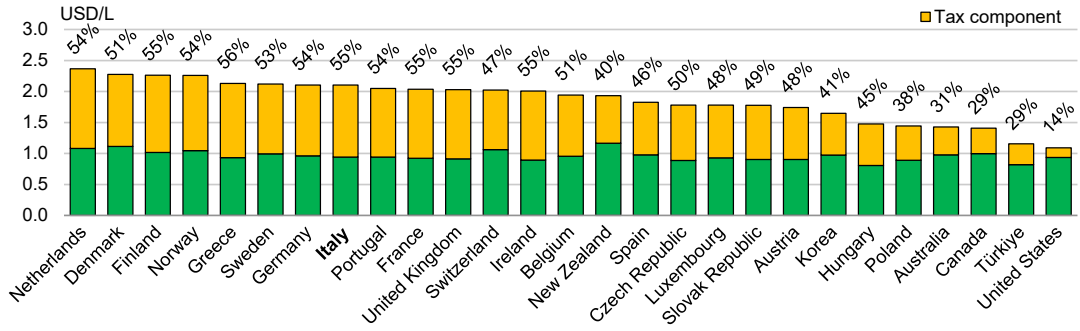


Figure 9.7 Price comparison for unleaded gasoline (95 RON) in the IEA, Q1 2022



Automotive diesel and unleaded gasoline prices in Italy are among the highest of IEA countries.

Notes: Automotive diesel data are unavailable for Mexico, Estonia for 1Q 2022; premium unleaded gasoline (95 RON) data are unavailable for Estonia, Japan and Mexico, and Lithuania for Q1 2022; data for Italy are not available for Q2 2022.

Source: IEA (2022c).

In March 2022, the government introduced a 0.25 EUR/L discount on the excise duty of gasoline and diesel, equivalent to 0.31 EUR/L when including VAT. This was aimed to mitigate the impact of rising motor fuel prices on consumers, particularly following Russia's invasion of Ukraine. The discount was removed as of 1st January 2023.

Infrastructure

Refineries

There are 11 operational oil refineries in Italy, with a total atmospheric distillation capacity of around 1.7 mb/d (Table 9.1). The average utilisation rate of Italy's refineries has hovered around 80% for most of the past decade. However, the utilisation rate dropped to just 68% in 2020 as demand fell sharply.

There has been a significant rationalisation of refining capacity in Italy over the past decade with the closure of four refineries; the Gela refinery in Sicily was transformed into a biofuels processing facility while three other shuttered refineries were converted into storage facilities. Another refinery, the 84 kb/d Livorno plant, was supposed to stop processing crude in 2022, although the refinery's closure has been delayed; Eni is considering converting the site into a biofuels refinery.

Figure 9.8 Map of Italy's oil infrastructure

Additional rationalisation of refining capacity is highly likely in the future, given long-term projections of declining demand for oil products in the European Mediterranean and increased competition to supply European product markets from new, large-scale refineries in the Middle East and Asia.

Eni is the most significant operator in the Italian refining sector with ownership of 4 of Italy's 11 operational refineries (Sannazzaro, Taranto, Livorno and Porto Marghera). Eni also jointly owns the 200 kb/d Milazzo refinery in Sicily in partnership with KPI.

Italy's largest refinery by operating capacity, the 320 kb/d Priolo/ISAB refinery, also in Sicily, was until recently owned by a Swiss-based trader Litasco which is controlled by the Russian oil firm Lukoil. In January 2023, an agreement was reached to sell the refinery to a group led by the Cypriot private equity firm G.O.I. Energy, backed by Geneva-based Trafigura. The deal is expected to be closed in March 2023, and requires final approval by the Italian government.

Other notable players in the refining sector include Saras, which owns the 300 kb/d Sarroch refinery, and the Algerian national oil company, Sonatrach, which owns the 190 kb/d Augusta refinery.

Table 9.1 Oil refineries in Italy

Refinery	Owner	Capacity (kb/d)
Priolo/ISAB	Litasco/Lukoil	320
Sarroch	Saras	300
Milazzo	Eni/KPI	200
Augusta	Sonatrach	190
Sannazzaro	Eni	180
Trecante	SARPOM	160
Taranto	Eni	110
Livorno	Eni	84
Falconara	API	78
Porto Marghera	Eni	70
Busalla	Iplom	40
TOTAL		**1 732**

Source: Information provided by the government.

Transport

The domestic pipeline network (for both crude and products) is largely concentrated in northern Italy. Two pipelines that emanate in Italy deliver crude oil to Italian refineries and other refineries in central Europe; the Central European Line from Genoa (1 mb/d capacity) supplies inland refineries in northern Italy while the Transalpine Pipeline (TAL) from Trieste (850 kb/d capacity) supplies refineries in Austria, the Czech Republic and Germany. However, most refineries in Italy are located along the Mediterranean coast and receive crude oil directly by ship.

Italy has 16 crude oil tanker ports, 4 of which (Taranto, Milazzo, Falconara [Ancona] and Augusta [Santa Panagia]) can receive cargo ships of up to 300 000 dead weight tonnes.

Storage

There are approximately 405 oil storage terminals across Italy, with a total storage capacity of around 26 mcm or 163 mb. Storage capacity is roughly divided into 25% crude oil and 75% refined products. There are no plans for significant additions or reductions to Italy's oil storage capacity, although this may change if there is additional refining capacity rationalisation.

Oil emergency policy and stockholding

Oil emergency organisation and decision making

The MiTE has overall responsibility for oil emergency policy in Italy. A body known as the Conference of Services would be convened to act as Italy's National Emergency Sharing Organisation (NESO) in the event of an oil supply disruption. The Conference of Services would be chaired by a representative from the MiTE and include representatives from several other government ministries, representatives from the oil industry as well as the Central Energy Stockholding Agency (OCSIT, Organismo Centrale di Stoccaggio Italiano).

In the event of an oil supply disruption, the MiTE would convene the Conference of Services to discuss whether emergency response measures should be taken. After deciding on how to react to a supply disruption, the Conference of Services would submit its recommendations to the MiTE. The final decision on the implementation of emergency measures would rest with the Minister of Ecological Transition.

A stock release is the principal means by which Italy would participate in an IEA collective action or respond to a serious localised supply disruption. In addition to a stock release, other emergency measures include a range of demand restraint measures and a limited amount of fuel switching.

Stockholding

Emergency oil stocks are held by both industry and the national stockholding agency, OCSIT.

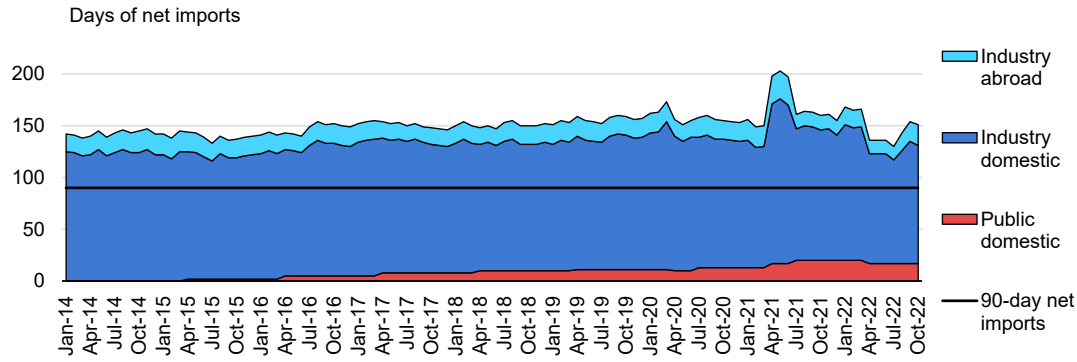
In accordance with the 2012 Legislative Decree on Minimum Stocks of Oil, the total level of emergency oil stocks in Italy must be equivalent to 90 days of net oil imports in the previous calendar year. The equivalent of 30 days of net oil imports must be held in the form of gasoline, diesel, fuel oil or jet fuel (known as "specific stocks").

OCSIT came into operation in 2014 with a mandate to hold Italy's "specific stocks". Since its foundation, OCSIT has gradually increased its total stockholding level and aims to increase its stockholding level to 30 days of net imports of "specific stocks" by 2024. As of July 2022, the volume of stocks held by OCSIT equated to 19 days of Italy's net oil imports in 2021 (Figure 9.9). To reach a total emergency stockholding level of at least 90 days of net oil imports, Italy also maintains a compulsory stockholding obligation on industry.

In March and April 2022, Italy participated in two separate IEA collective actions implemented in response to tight oil market circumstances following Russia's invasion of Ukraine (62.7 mb and 120 mb, respectively). In the March 2022 collective action, Italy contributed 2.04 mb, while in April 2022 it contributed 5 mb. Italy's contributions were made

by lowering its industry stockholding obligation and consisted of a mix of crude oil and oil products (around 60% crude oil).

Figure 9.9 Emergency oil stocks by type in Italy, January 2014 - October 2022



Italy has been consistently compliant with its IEA stockholding obligation; as of October 2022, it held 132 days of stocks in total.

Source: IEA (2022b).

Assessment

Demand for oil products has rebounded strongly in Italy since 2020 and, in the short term, there is little to suggest that it will fall significantly, if at all. The government has also conceded that oil will remain the dominant fuel in the freight, aviation and maritime sectors for at least a decade, and most likely beyond. As a consequence, the security of oil supply will remain a priority for Italy.

In the long term, the government expects that oil demand will fall significantly, primarily as a result of the uptake of alternative fuels for passenger cars. The uptake of biofuels in the transport sector is particularly strongly promoted, while there are plans to expand charging infrastructure for EVs. However, the government has not accompanied these initiatives with a long-term target of reducing oil consumption. The introduction of an ambitious target to reduce oil consumption to a specified level could solidify and provide direction to the various initiatives currently underway aimed at curtailing oil consumption while providing a clear signal of the government's ambition to decarbonise transport.

On the supply side, Italy retains a significant refining industry, which is largely dependent on imported crude oil. Reliance on Russian crude oil remains substantial, but crude imports from Russia have decreased in the past decade and will likely end once the EU ban on the import of seaborne imports of Russian crude oil enters into force by December 2022.

The Italian refining sector has struggled with reduced demand and increased competition in the past decade, resulting in significant capacity rationalisation with the closure of four refineries. Another refinery, the 84 kb/d Livorno plant, will likely stop processing crude shortly. Additional rationalisation of refining capacity is highly probable in the long term given the challenging environment facing refiners across the Mediterranean, resulting from increased competition to supply European product markets from new, large-scale

refineries in the Middle East and Asia. Although suppliers will inevitably adapt, some attention may be required to ensure that adequate import capacity and storage infrastructure are in place in the long term. The government should continue to promote the repurposing of surplus refining infrastructure for the production of low-carbon fuels and the storage of oil products, to support both decarbonisation efforts and energy security.

Recent oil market tightness, and the consequent rise in fuel prices, promoted the government to discount the excise duty on gasoline and diesel in March 2022. The discount was removed as of 1st January 2023. Untargeted measures to shield consumers from price rises should be used sparingly, and for very limited periods, if at all. Such measures should also be used only as a last resort, and after efforts have been made to encourage consumers to reduce consumption. In the future, the government should consider whether light-handed demand restraint measures could be implemented before resorting to measures to curtail retail prices.

Recommendations

The government of Italy should:

- Set targets to reduce oil consumption in transport to complement and provide direction to the government's ambitions to promote the use of alternative fuels and vehicles, and reduce carbon emissions from the transport sector.
- Ensure that infrastructure is in place for product imports and storage, given the likelihood of further rationalisation of refining capacity.
- Assess whether additional measures are needed to encourage the use of existing oil infrastructure for the supply of alternative fuels, including the conversion of traditional oil refineries into bio-refineries, as well as additional charging infrastructure and hydrogen refuelling at retail stations.
- Consider whether light-handed demand restraint measures to encourage reduced oil consumption can be implemented in the short term to alleviate market tightness.

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IEA (2022b), Monthly Oil Data Service (database), https://www.iea.org/data-and-statistics/data-product/monthly-oil-data-service-mods-complete (accessed 5 July 2022)

IEA (2022c), OECD Energy Prices and Taxes Quarterly (database) https://www.iea.org/data-and-statistics/data-product/oecd-energy-prices-and-taxes-quarterly (accessed in March 2022)

ANNEX A. Key organisations involved in energy-related policies in Italy

The **central government** and the **regions** and **autonomous provinces** of Italy share legislative competences on the production, transport and distribution of energy but the regional legislative power is limited by the fundamental principles established by national legislation. The **State-Region Conference** is the institutional body for co-ordinating national and regional policies in all matters of shared responsibility. **Municipalities** also have relevant functions in implementing climate policy, for instance in terms of urban planning, public transport, building regulations and waste management.

At the central level, the Ministry of Ecological Transition (**MiTE**, Ministero della Transizione Ecologica) was established in 2021 by merging responsibilities for energy, climate and environmental policies under one roof and renaming the Ministry for the Environment, Land and Sea. The **MiTE** was also charged with implementing environmental policy. Previously, national energy policy was the remit of the Ministry of Economic Development (**MiSE,** Ministerio dello Sviluppo Economico), while the **Ministry for the Environment, Land and Sea** was in charge of national climate and environmental policies. The name of the **MiTe** was changed to "**Ministry of the Environment and of Energy Security**" in October 2022 when a new government came into office but its responsibilities remained unchanged.

It promotes good environmental practices, sustainable mobility and urban regeneration dealing also with the promotion of environmental education in schools. At the international level, it has a central role in the management of EU funds. Its establishment aimed to increase the coherence of energy and climate policies and integrate the objective of the transition to a low-carbon and green economy in all the ministry's activities. The Government sworn in on October 22, 2022, changed the name of the Ministry to "Ministry of the Environment and of Energy Security". Several other ministries have energy- or climate-related competences, such as the ministries responsible for transport and infrastructure; agriculture; and education, university and research (**MIUR**).

The Inter-ministerial Committee for Economic Planning and Sustainable Development (**CIPESS**) is a collective governmental body chaired by the Prime Minister. It is responsible for the co-ordination and horizontal integration of national policies to achieve the Sustainable Development Goals. **CIPESS** provides high-level political governance for overall research and innovation, approves the National Research Programme, and allocates overall financial resources to public research institutions. The **Ministry of Education, University and Research** and the **Ministry of the Environment and of Energy Security** channel funds for energy research and development.

The National Agency for New Technologies, Energy and Sustainable Economic Development (**ENEA**) is a public body aimed at research, technological innovation and the provision of advanced services in the energy sector, the environment and sustainable economic development. ENEA and tthe Research on Energy Systems (**RSE,** Ricerca sul Sistema Energetico) are the key public energy research, development and innovation institutions.

The Inter-ministerial Committee for Ecological Transition (**CITE**, Comitato Interministeriale per la Transizione Ecologica), established in 2022, co-ordinates the policies of the various ministries to bring

them in line with the long-term goal of the ecological transition. It approves the Ecological Transition Plan and reviews its implementation.

The Higher Institute for Environmental Protection and Research (**ISPRA**) and **ENEA** provide statistical, technical and scientific support.

The state-owned Manager of Energy Systems (**GSE**, Gestore dei Sistemi Energetici) promotes and supports renewable energy sources in Italy. It provides financial support for renewable electricity, manages some energy efficiency incentives and promotes energy efficiency awareness. With the support of **ENEA** and the **Ministry of the Environment and of Energy Security**, **GSE** manages, evaluates and certifies the energy savings generated under the white certificate scheme. **GSE** is the parent company of three subsidiaries: Single Buyer (**AU**, Acquirente Unico), Manager of Energy Markets (**GME**, Gestore dei Mercati Energetici) and **RSE**.

The **AU** ensures adequate electricity services to customers in the protected market, where electricity is sold at regulated prices. **GME** operates power, gas and environmental markets. **RSE** develops research activities in the energy sector and is responsible for national energy scenarios.

The Regulatory Authority for Energy, Networks and Environment (**ARERA**, Autorità di Regolazione per Energia Reti e Ambiente) carries out regulatory and supervisory activities in the sectors of electricity, natural gas, water services, waste cycle and district heating. It sets electricity and gas tariffs and defines service quality standards, as well as the conditions for connection to networks. **ARERA** also provides advisory services to the government and the parliament in matters within its competence, as well as to define, transpose and implement EU legislation. **ARERA's** resources come from contributions calculated on the revenues of regulated operators, not from the state budget.

The Competition Authority (**AGCM**, Autorità Garante della Concorrenza e del Mercato) enforces rules against business anticompetitive behaviours, including in energy markets.

The Italian state holds around a 30% stake in four important players in the oil, gas and electricity markets: **Snam** S.p.A, the gas transmission system operator (TSO); **Terna** S.p.A., the electricity TSO; **Eni**, which is the largest player upstream, wholesale and retail sector; and **Enel**, which accounts for the largest individual share of electricity production and over one-third of electricity sales. **Terna** is engaged in driving and enabling the ecological transition to create a new development model based on renewable energy sources and respect for the environment. It manages Italy's high-voltage electricity transmission grid, optimising the management of grid planning, development and maintenance activities, and ensuring the stability, security and quality of the electricity service. **Snam** operates three separate business activities: the gas transmission system, gas storage and has significant interests in regassification terminals.

ARERA requires **Snam** and **Terna** to develop scenario analysis to underpin the preparation of the medium- and long-term development plans of the electricity and gas transmission networks.

The Central Energy Stockholding Agency, (**OCSIT**, Organismo Centrale di Stoccaggio Italiano) was created in 2014 with the mandate to hold Italy's specific public emergency stocks.

ANNEX B: Organisations visited

Review criteria

The Shared Goals, which were adopted by the International Energy Agency (IEA) Ministers at their 4 June 1993 meeting in Paris, provide the evaluation criteria for the in-depth reviews conducted by the IEA. The Shared Goals are presented in Annex D.

Review team

The in-depth review team visit took place in Rome from 4 to 11 April 2022. The review team met with government officials, energy suppliers, market participants, interest groups in the public and private sectors, consumer representative associations, research institutions, and other organisations and stakeholders.

The report was drafted based on the information obtained during these meetings, the team's preliminary assessment of Italy's energy policy, the Italian government's response to the IEA energy policy questionnaire, and information on subsequent policy developments from the government and private sector sources. The members of the team were:

IEA member countries

Mr Doug Hengel, United States (team leader)

Ms Isabella Plimon, Austria

Mr Mehment Kürkçü, Türkiye

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International Energy Agency

Ms Ivana Capozza, Senior Energy Policy Analyst (IDR co-ordination)

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Mr Alessio Scanziani, Research Assistant

Mr Aad van Bohemen, Consultant, Energy Policy and Security Division

The team is grateful for the co-operation and assistance of the many people it met during the visit. Thanks to their kind hospitality, openness and willingness to share information, the visit was highly informative, productive and enjoyable.

The team wishes to express its gratitude to Director-General for Energy Infrastructure and Safety, Marilena Barbaro, Ministry of Ecological Transition, for taking the time to share her views with the team, which helped frame all discussions during the review visit.

The team also wishes to thank Mr Giovanni Perrella, Technical Secretary, Mr Stefano Raimondi, Director, and Mr. Wolfgang d'Innocenzo, Director, from the Ministry of Ecological Transition, and their many colleagues for sharing their views and answering the team's questions during the review week; for their time, encouragement, and tireless efforts and professionalism in planning and organising the review visit; and for their patience and diligence in supporting the team throughout the review process.

The review was prepared under the guidance of Mr Keisuke Sadamori, Director, Energy Markets Directorate, IEA. Ms Ivana Capozza is the main author of the report. Ms Dagmar Graczyk managed the preparation of the report and authored the executive summary and Chapter 6 (Energy Research, Development and Innovation). Mr Ronan Graham wrote Chapters 8 and 9 (Natural Gas and Oil). Mr Alessio Scanziani wrote Chapter 7 (Electricity) and jointly with Ms Clémence Lizé, Mr Anders Caratozzolo, Mr Gregoire Ladouce and Ms Jiyul Shin prepared and drafted the sections relating to energy data contained in each chapter. Mr Aad van Bohemen, consultant to the Energy Policy and Security Division, IEA, provided advice throughout the review process.

Helpful comments, chapter reviews and updates were provided by the following IEA staff: Mr Heymi Bahar, Mr Simon Bennett, Ms Emi Bertoli, Ms Toril Bosoni, Ms Chiara D'Adamo, Mr Paolo Frankl, Ms Zoe Hungerford, Mr Kevin Lane, Ms Suzy Leprince, Mr Luca Lo Re, Mr Gergely Molnar and Ms Kristine Petrosyan.

Special thanks to the IEA secretariat with regard to the data, publication and editing. Mr Alessio Scanziani, Ms Clémence Lizé, Mr Anders Caratozzolo, Ms Eléonore Carré and Ms Su Min Park ensured the preparation of the design of the report with figures, tables and maps. Mr Steve Gervais, Ms Roberta Quadrelli and Ms Erica Robin from the Energy Data Centre participated in the data and statistics discussions during the visit. Ms Suzy Leprince, Mr Domenico Lattanzio, Mr Arnau Risquez Martin and Mr Jungyu Park provided support on statistics and data. Ms Isabelle Nonain-Semelin managed the editing process and finalised the production, Ms Astrid Dumond managed the production process and support for the maps was provided by Ms Tanya Dyhin, Ms Lucile Wall and Ms Charner Ramsey. The report was edited by Ms. Jennifer Allain.

Organisations visited

Acquirente Unico (AU)

Anigas

Assocostieri

AssoEnergia

Assogasliquidi

Assopetroli

A2A

Banca d'Italia

Central Energy Stockholding Agency (OCSIT)

Cisambiente

Competition Authority (AGCM)

Confindustria Energia

ECCO

Edison

Elettricità Futura

Energy Strategy Group

ENEL

Energy Services Manager (GSE)

Energy System Research (RSE)

Eni

Federesco

Fondazione Eni Enrico Mattei

Foundation for Sustainable Development

Friends of the Earth

GME

Institute for Environmental Protection and Research (ISPRA)

Invitalia

Italia Nostra

Kyoto Club

Legambiente

Ministry of Infrastructure and Sustainable Mobility (MIMS)

Ministry of Ecological Transition (MiTE)

Ministry of Economy and Finance (MEF)

Ministry of Education, Universities and Research (MIUR)

Motus-E

National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA)

NGV Italia

Politecnico di Milano

Politecnico di Torino

Regulatory Authority for Energy, Networks and Environment (ARERA)

Sardinien Regional Government

SNAM

SOGIN

TERNA

UNEM

Utilitalia

WWF Italy

ANNEX C: Energy balances and statistical notes

Unit: PJ

SUPPLY		1973	1990	2000	2010	2019	2020	2021
TOTAL PRODUCTION		**853.6**	**1060.0**	**1179.6**	**1381.8**	**1440.7**	**1465.4**	**1430.6**
Coal		12.5	11.5	0.1	2.7	-	-	-
Peat		-	-	-	-	-	-	-
Oil		44.0	187.1	196.4	235.3	197.1	245.1	218.6
Natural gas		528.3	587.4	570.3	288.2	164.6	137.6	109.2
Biofuels and waste[1]		10.2	35.6	72.7	426.3	518.8	520.6	543.8
Nuclear		34.3	-	-	-	-	-	-
Hydro		135.1	113.9	159.1	184.0	166.7	171.2	163.4
Wind		-	0.0	2.0	32.9	72.7	67.5	75.3
Geothermal		89.3	124.4	178.3	200.0	225.9	223.7	219.9
Solar/other		-	0.2	0.5	12.5	94.8	99.7	100.5
TOTAL NET IMPORTS[2]		**4166.9**	**5149.9**	**6173.6**	**5854.9**	**4748.6**	**4169.5**	**4544.1**
Coal	Exports	18.4	5.9	3.7	8.9	8.4	8.8	7.6
	Imports	341.9	581.3	553.8	586.2	275.8	207.2	232.6
	Net imports	323.5	575.4	550.2	577.2	267.4	198.4	225.0
Oil	Exports	1214.1	823.8	911.4	1259.8	1178.8	993.0	1124.4
	Imports	5331.6	4388.6	4594.3	4056.6	3374.3	2747.1	3007.1
	Int'l marine and aviation bunker	-346.1	-174.8	-187.3	-257.2	-277.3	-164.7	-167.8
	Net imports	3771.4	3390.0	3495.6	2539.6	1918.2	1589.4	1714.9
Natural gas	Exports	-	0.6	1.7	4.8	11.2	10.8	52.9
	Imports	68.9	1060.3	1969.9	2583.9	2436.8	2276.6	2503.0
	Net imports	68.9	1059.7	1968.1	2579.1	2425.7	2265.8	2450.1
Electricity	Exports	8.5	3.3	1.7	6.6	21.0	27.3	13.6
	Imports	11.7	128.1	161.4	165.6	158.3	143.2	167.7
	Net imports	3.2	124.8	159.6	159.0	137.3	115.9	154.0
TOTAL STOCK CHANGES		**-33.2**	**-77.3**	**-192.8**	**-67.2**	**-55.0**	**30.8**	**194.8**
TOTAL SUPPLY (TES)[3]		**4987.3**	**6136.5**	**7181.9**	**7274.0**	**6236.9**	**5756.3**	**6259.8**
Coal		338.9	612.6	525.8	572.5	271.3	213.4	232.0
Peat		-	-	-	-	-	-	-
Oil		3780.7	3488.4	3636.4	2734.1	2095.9	1812.0	2065.6
Natural gas		595.7	1632.9	2425.8	2849.4	2551.8	2440.3	2613.8
Biofuels and waste[1]		10.2	39.4	94.3	529.7	620.3	612.7	635.2
Nuclear		34.3	-	-	-	-	-	-
Hydro		135.1	113.9	159.1	184.0	166.7	171.2	163.4
Wind		-	0.0	2.0	32.9	72.7	67.5	75.3
Geothermal		89.3	124.4	178.3	200.0	225.9	223.7	219.9
Solar/other		-	0.2	0.5	12.5	94.8	99.7	100.5
Electricity trade[4]		3.2	124.8	159.6	159.0	137.3	115.9	154.0
Shares in TES (%)								
Coal		*6.8*	*10.0*	*7.3*	*7.9*	*4.4*	*3.7*	*3.7*
Peat		-	-	-	-	-	-	-
Oil		*75.8*	*56.8*	*50.6*	*37.6*	*33.6*	*31.5*	*33.0*
Natural gas		*11.9*	*26.6*	*33.8*	*39.2*	*40.9*	*42.4*	*41.8*
Biofuels and waste[1]		*0.2*	*0.6*	*1.3*	*7.3*	*9.9*	*10.6*	*10.1*
Nuclear		*0.7*	-	-	-	-	-	-
Hydro		*2.7*	*1.9*	*2.2*	*2.5*	*2.7*	*3.0*	*2.6*
Wind		-	-	-	*0.5*	*1.2*	*1.2*	*1.2*
Geothermal		*1.8*	*2.0*	*2.5*	*2.7*	*3.6*	*3.9*	*3.5*
Solar/other		-	*0.0*	*0.0*	*0.2*	*1.5*	*1.7*	*1.6*
Electricity trade[4]		*0.1*	*2.0*	*2.2*	*2.2*	*2.2*	*2.0*	*2.5*

0 is negligible, - is nil, .. is not available, x is not applicable. Please note: rounding may cause totals to differ from the sum of the elements.

Unit: PJ

DEMAND							
FINAL CONSUMPTION	**1973**	**1990**	**2000**	**2010**	**2019**	**2020**	**2021**
TFC	**4042.7**	**4812.6**	**5394.2**	**5599.6**	**4928.6**	**4498.1**	**4894.4**
Coal	154.1	149.5	112.3	79.0	33.6	30.3	38.2
Peat	-	-	-	-	-	-	-
Oil	2928.2	2572.8	2608.2	2278.9	1895.6	1599.9	1818.8
Natural gas	517.4	1272.9	1615.6	1635.6	1410.3	1359.1	1468.4
Biofuels and waste[1]	-	36.1	66.1	378.3	349.1	340.9	371.4
Geothermal	-	8.4	8.9	5.2	5.5	5.0	4.8
Solar/other	-	0.2	0.5	5.6	9.5	9.9	10.3
Electricity	443.0	772.7	982.7	1077.5	1051.0	990.7	1051.9
Heat	-	-	-	139.5	174.0	162.4	130.6
Shares in TFC (%)							
Coal	*3.8*	*3.1*	*2.1*	*1.4*	*0.7*	*0.7*	*0.8*
Peat	-	-	-	-	-	-	-
Oil	*72.4*	*53.5*	*48.4*	*40.7*	*38.5*	*35.6*	*37.2*
Natural gas	*12.8*	*26.4*	*30.0*	*29.2*	*28.6*	*30.2*	*30.0*
Biofuels and waste[1]	-	*0.8*	*1.2*	*6.8*	*7.1*	*7.6*	*7.6*
Geothermal	-	*0.2*	*0.2*	*0.1*	*0.1*	*0.1*	*0.1*
Solar/other	-	*0.0*	*0.0*	*0.1*	*0.2*	*0.2*	*0.2*
Electricity	*11.0*	*16.1*	*18.2*	*19.2*	*21.3*	*22.0*	*21.5*
Heat	-	-	-	*2.5*	*3.5*	*3.6*	*2.7*
TOTAL INDUSTRY[5]	**1981.9**	**1863.8**	**1954.5**	**1662.5**	**1340.8**	**1286.0**	**1317.7**
Coal	111.5	137.7	109.4	78.8	33.6	30.3	38.2
Peat	-	-	-	-	-	-	-
Oil	1231.0	704.4	585.4	516.8	339.6	323.9	303.2
Natural gas	361.7	613.3	737.0	457.0	384.5	365.7	398.8
Biofuels and waste[1]	-	9.2	12.1	18.0	29.1	30.8	32.1
Geothermal	-	-	-	0.1	0.1	0.1	0.1
Solar/other	-	-	-	0.3	0.5	0.4	0.4
Electricity	277.7	399.3	510.6	460.3	430.3	422.3	459.4
Heat	-	-	-	131.0	123.2	112.5	85.5
Shares in total industry (%)							
Coal	*5.6*	*7.4*	*5.6*	*4.7*	*2.5*	*2.4*	*2.9*
Peat	-	-	-	-	-	-	-
Oil	*62.1*	*37.8*	*30.0*	*31.1*	*25.3*	*25.2*	*23.0*
Natural gas	*18.3*	*32.9*	*37.7*	*27.5*	*28.7*	*28.4*	*30.3*
Biofuels and waste[1]	-	*0.5*	*0.6*	*1.1*	*2.2*	*2.4*	*2.4*
Geothermal	-	-	-	-	-	-	-
Solar/other	-	-	-	-	-	-	-
Electricity	*14.0*	*21.4*	*26.1*	*27.7*	*32.1*	*32.8*	*34.9*
Heat	-	-	-	*7.9*	*9.2*	*8.7*	*6.5*
TRANSPORT[3]	**793.9**	**1369.4**	**1661.8**	**1614.7**	**1501.4**	**1213.2**	**1477.5**
OTHER[6]	**1267.0**	**1579.4**	**1777.9**	**2322.5**	**2086.3**	**1999.0**	**2099.1**
Coal	36.6	11.8	2.9	0.2	-	-	-
Peat	-	-	-	-	-	-	-
Oil	928.2	532.0	405.3	274.3	197.6	192.7	196.2
Natural gas	150.5	650.9	865.0	1149.4	977.8	952.9	1009.8
Biofuels and waste[1]	-	26.9	53.9	300.9	266.6	257.1	280.0
Geothermal	-	8.4	8.9	5.1	5.4	5.0	4.8
Solar/other	-	0.2	0.5	5.3	9.1	9.5	9.9
Electricity	151.6	349.1	441.4	578.8	579.1	532.0	553.3
Heat	-	-	-	8.5	50.8	49.9	45.1
Shares in other (%)							
Coal	*2.9*	*0.7*	*0.2*	-	-	-	-
Peat	-	-	-	-	-	-	-
Oil	*73.3*	*33.7*	*22.8*	*11.8*	*9.5*	*9.6*	*9.3*
Natural gas	*11.9*	*41.2*	*48.7*	*49.5*	*46.9*	*47.7*	*48.1*
Biofuels and waste[1]	-	*1.7*	*3.0*	*13.0*	*12.8*	*12.9*	*13.3*
Geothermal	-	*0.5*	*0.5*	*0.2*	*0.3*	*0.2*	*0.2*
Solar/other	-	*0.0*	*0.0*	*0.2*	*0.4*	*0.5*	*0.5*
Electricity	*12.0*	*22.1*	*24.8*	*24.9*	*27.8*	*26.6*	*26.4*
Heat	-	-	-	*0.4*	*2.4*	*2.5*	*2.1*

0 is negligible, - is nil, .. is not available, x is not applicable. Please note: rounding may cause totals to differ from the sum of the elements.

Unit: PJ

DEMAND							
ENERGY TRANSFORMATION AND LOSSES	**1973**	**1990**	**2000**	**2010**	**2019**	**2020**	**2021**
ELECTRICITY GENERATION[7]							
Input (PJ)	1168.0	1806.3	2206.0	2469.1	2243.4	2127.6	2209.0
Output (PJ)	518.2	767.5	972.0	1075.8	1051.5	1003.1	1033.3
Output (TWh)	143.9	213.1	269.9	298.8	292.0	278.6	287.0
Output shares (%)							
Coal	*3.6*	*16.8*	*11.3*	*14.9*	*7.3*	*5.4*	*5.6*
Peat	-	-	-	-	-	-	-
Oil	*62.4*	*48.2*	*31.8*	*7.3*	*3.5*	*3.6*	*2.7*
Natural gas	*3.1*	*18.6*	*37.5*	*51.1*	*48.5*	*48.0*	*50.2*
Biofuels and waste[1]	*0.9*	-	*0.7*	*3.9*	*7.5*	*7.9*	*7.5*
Nuclear	*2.2*	-	-	-	-	-	-
Hydro	*26.1*	*14.8*	*16.4*	*17.1*	*15.9*	*17.1*	*15.8*
Wind	-	-	*0.2*	*3.1*	*6.9*	*6.7*	*7.3*
Geothermal	*1.7*	*1.5*	*1.7*	*1.8*	*2.1*	*2.2*	*2.1*
Solar/other	-	-	*0.3*	*0.9*	*8.3*	*9.1*	*8.9*
TOTAL LOSSES	**933.2**	**1322.3**	**1749.8**	**1709.1**	**1369.6**	**1273.5**	**1373.6**
of which:							
Electricity and heat generation[8]	649.9	1039.0	1234.2	1188.2	960.8	895.8	952.1
Other transformation	-66.1	-102.4	122.2	27.1	6.3	4.0	2.2
Own use and transmission/distribution losses	349.3	385.7	393.4	493.8	402.6	373.7	419.2
Statistical differences	**11.4**	**1.6**	**37.9**	**-34.8**	**-61.3**	**-15.3**	**-8.2**
INDICATORS	**1973**	**1990**	**2000**	**2010**	**2019**	**2020**	**2021**
GDP (billion 2015 USD)	978.93	1566.24	1841.82	1900.01	1918.16	1745.03	1860.97
Population (millions)	54.75	56.72	56.94	59.82	59.73	59.44	59.11
TES/GDP (MJ per 2015 USD)[9]	5.10	3.92	3.90	3.83	3.25	3.30	3.36
Energy production/TES	0.17	0.17	0.16	0.19	0.23	0.25	0.23
Per capita TES (GJ per capita)	91.09	108.19	126.13	121.60	104.42	96.84	105.90
Oil supply/GDP (MJ per 2015 USD)[9]	3.86	2.23	1.98	1.44	1.09	1.04	1.11
TFC/GDP (MJ per 2015 USD)[9]	4.13	3.07	2.93	2.95	2.57	2.58	2.63
Per capita TFC (GJ per capita)	73.84	84.85	94.73	93.61	82.52	75.68	82.80
CO_2 emissions from fuel combustion ($MtCO_2$)[10]	328.1	389.4	420.4	392.0	309.3	274.2	307.6
CO_2 emissions from bunkers ($MtCO_2$)[10]	22.8	8.5	5.3	9.6	8.5	7.8	8.1
GROWTH RATES (% per year)	**73-90**	**90-00**	**00-10**	**10-18**	**18-19**	**19-20**	**20-21**
TES	1.2	1.6	0.1	-1.8	-1.1	-7.7	8.7
Coal	3.5	-1.5	0.9	-5.7	-24.2	-21.4	8.7
Peat	-	-	-	-	-	-	-
Oil	-0.5	0.4	-2.8	-3.1	-1.7	-13.5	14.0
Natural gas	6.1	4.0	1.6	-1.7	2.4	-4.4	7.1
Biofuels and waste[1]	8.3	9.1	18.8	1.7	2.1	-1.2	3.7
Nuclear	-100.0	-	-	-	-	-	-
Hydro	-1.0	3.4	1.5	-0.6	-5.1	2.7	-4.6
Wind	-	75.8	32.1	8.6	14.0	-7.1	11.5
Geothermal	2.0	3.7	1.2	1.6	-0.4	-1.0	-1.7
Solar/other	-	9.2	37.4	28.1	4.5	5.1	0.8
TFC	1.0	1.1	0.4	-1.5	-1.0	-8.7	8.8
Electricity consumption	3.3	2.4	0.9	-0.3	-0.4	-5.7	6.2
Energy production	1.3	1.1	1.6	0.6	-1.0	1.7	-2.4
Net oil imports	-0.6	0.3	-3.1	-3.6	1.6	-17.1	7.9
GDP	2.8	1.6	0.3	0.1	0.5	-9.0	6.6
TES/GDP	-1.5	-0.1	-0.2	-1.8	-1.5	1.4	1.9
TFC/GDP	-1.7	-0.5	0.1	-1.5	-1.4	0.3	1.9

0 is negligible, - is nil, .. is not available, x is not applicable. Please note: rounding may cause totals to differ from the sum of the elements.

Footnotes to energy balances and key statistical data

[1] Biofuels and waste comprise solid biofuels, liquid biofuels, biogases, industrial waste and municipal waste. Data are often based on partial surveys and may not be comparable between countries.

[2] In addition to coal, oil, natural gas and electricity, total net imports also include biofuels.

[3] Excludes international marine bunkers and international aviation bunkers.

[4] Total supply of electricity represents net trade. A negative number in the share of TES indicates that exports are greater than imports.

[5] Industry includes non-energy use.

[6] Other includes residential, commercial and public services, agriculture/forestry, fishing, and other non-specified.

[7] Inputs to electricity generation include inputs to electricity, co-generation and heat plants. Output refers only to electricity generation.

[8] Losses arising in the production of electricity and heat at main activity producer utilities and autoproducers. For non-fossil-fuel electricity generation, theoretical losses are shown based on plant efficiencies of approximately 33% for nuclear; 10% for geothermal; and 100% for hydro, wind and solar photovoltaic.

[9] MJ per USD at 2015 prices and exchange rates.

[10] "CO_2 emissions from fuel combustion" have been estimated using the IPCC Tier I Sectoral Approach methodology from the *2006 IPCC Guidelines.* Emissions from international marine and aviation bunkers are not included in national totals.

ANNEX D: Glossary and list of abbreviations

In this report, abbreviations and acronyms are substituted for a number of terms used within the International Energy Agency. While these terms generally have been written out on first mention, this glossary provides a quick and central reference for the abbreviations used.

Acronyms and abbreviations

AC	alternating current
BEV	battery-electric vehicle
CCS	carbon, capture and storage
CCUS	carbon capture, utilisation and storage
CEM	Clean Energy Ministerial
CIC	biofuel certificate (*certificate immissione in consumo*)
CNR	National Research Council
CO_2	carbon dioxide
DC	direct current
DSO	district system operator
EC	European Commission
EED	Energy Efficiency Directive
EET	energy efficiency title
EIA	environmental impact assessment
ENEA	National Energy Efficiency Agency
EPC	energy performance certificate
ETP	Ecological Transition Plan
ETS	Emissions Trading System
EU	European Union
EV	electric vehicle
FEC	final energy consumption
FF55	Fit-for-55
FiP	feed-in premium
FiT	feed-in tariff
FSRU	floating storage regasification unit
GDP	gross domestic product
GHG	greenhouse gas
HHI	Herfindahl-Hirschman Index
ICE	internal combustion engine
IEA	International Energy Agency
IP	intellectual property
KPI	Kuwait Petroleum International

LNG	liquefied natural gas
LPG	liquefied petroleum gas
LTS	Long-term Strategy
LULUCF	land use, land-use change, and forestry
MI	Mission Innovation
MVAR	Megavolt ampere of reactive power
NECP	National Energy and Climate Plan
NEEAP	National Energy Efficiency Action Plan
NPACC	National Plan on Adaptation to Climate Change
NREAP	National Renewable Energy Action Plan
NRP	National Research Programme
NRRP	National Resilience and Recovery Plan
NT Italia	National Trend Italia
nZEB	nearly zero energy building
OECD	Organisation for Economic Co-operation and Development
OLT	Offshore LNG Toscana
PEC	Primary energy consumption
PHEV	plug-in hybrid electric vehicle
PPP	purchasing power parity
PSV	Punto di Scambio Virtuale
PUN	single national price
PV	photovoltaics
R&D	research and development
RDI	research, development and innovation
RED	Renewables Energy Directive
RRF	Recovery and resilience facility
SEA	strategic environmental assessment
SME	small and medium-sized enterprise
SRG	Snam Rete Gas
TAG	Trans Austria Gas
TAL	Trans Alpine Pipeline
TAP	Trans Adriatic Pipeline
TCP	technology collaboration programme
TES	total energy supply
TFC	total final consumption
TFEC	total final energy consumption
TSO	transmission system operator
UNFCCC	United Nations Framework Convention on Climate Change
UVAM	mixed enabled virtual unit
VAT	value-added tax

Units of measure

bcm	billion cubic metres
CO_2-eq	carbon dioxide-equivalent
GJ	gigajoule
GW	gigawatt
GWh	gigawatt hour
L	litre
kb/d	thousand barrels per day
kg	kilogramme
km	kilometre
ktoe	thousand tonne of oil equivalent
kV	kilovolt
kWh	kilowatt hour
m^3	cubic metre
mcm	million cubic metres
MJ	megajoule
$MtCO_2$-eq	million tonnes of carbon dioxide-equivalent
Mtoe	million tonnes of oil equivalent
MW	megawatt
PJ	petajoule
TJ	terajoule
toe	tonne of oil equivalent
TWh	terawatt hour

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Energy Policy Review

The International Energy Agency (IEA) regularly conducts in-depth peer reviews of the energy policies of its member countries. This process supports energy policy development and encourages the exchange of international best practices and experiences.

Since the last review in 2016, Italy has raised its climate ambitions by aiming for carbon neutrality by 2050, and the country is on track to reach its 2030 targets for emissions reductions and energy efficiency. The government has taken encouraging initial steps to overcome the long permitting procedures, administrative burdens and increasing local opposition that have delayed new renewable installations.

Italy in 2022 successfully reduced its reliance on Russian natural gas imports, by signing new contracts with alternative suppliers, making use of the pipeline and LNG infrastructure that it has built up over the last decade. Reducing overall demand for natural gas through an accelerated shift to alternative energy sources and a stronger focus on energy efficiency, especially in the building sector, will not only further strengthen energy security, but also help the country meet its climate targets.

In this report, the IEA provides energy policy recommendations to help Italy effectively transform its energy sector in line with its goals.