



Hungary 2022

Energy Policy Review

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.

Since the last IEA review of Hungary in 2017, the country has increased its climate ambition by legislating a carbon neutrality goal for 2050 and adopted a long-term vision informed by the National Clean Development Strategy, which offers a scenario approach for energy policy decision-making. Several other IEA member countries are looking at it to inform their own efforts towards carbon neutrality.

In the near term, Hungary needs to prioritise efforts to reduce its high reliance on Russia for gas, oil and nuclear fuel. Concrete actions are needed to diversify energy sources and expand policies that lower fossil fuel consumption, increase energy savings and promote investments in clean energy technologies and in human resources to deliver a just and inclusive transition.

Over recent years, Hungary has achieved remarkable growth in solar photovoltaic (PV). To meet its ambitious target of 90% clean electricity by 2030, including through an early phase-out of coal use in power generation by 2025, Hungary will need to further increase its low-carbon sources of generation. However, this will not be straight forward: the country's existing nuclear fleet is currently due to retire around the mid-2030s and its plans to expand the fleet were premised on Russian investment. In response, the government may need to evaluate the option of lifetime extensions beyond the current limit of 50 years. The power system also needs to be prepared for the integration of a further 12 GW of solar PV by investing in storage and a more diverse renewables portfolio.

By leveraging its low-carbon electricity system, Hungary can support sectoral transitions through electrification and reduce gas demand quickly, notably in heating, which today is almost 60% reliant on natural gas. This will help reduce dependency on fossil fuel imports, notably from Russia, and will lessen the country's exposure to price volatility.

I am grateful to Hungary for its leadership on energy and climate issues and its support for key IEA initiatives. In particular, as recommended in this review, Hungary is now raising its ambition for the deployment of low-emission hydrogen. This review offers recommendations on how Hungary can tap into opportunities in this area.

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

Dr Fatih Birol

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International Energy Agency

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1. Executive summary

Since the last IEA review, Hungary increased its climate ambitions by legislating a carbon neutrality goal for 2050, adopting a long-term strategy, advancing the phase-out of coal by 2025, promoting a remarkable growth in the deployment of solar PV and upgrading its existing nuclear reactors.

The major priorities for Hungary's climate and energy policies relate to energy security, reducing fossil fuel use and keeping energy prices affordable. This new review presents a range of recommendations to the government of Hungary to help address its key energy policy challenges, notably the low levels of energy efficiency progress (buildings, transport), high vulnerability and reliance on Russia for gas, oil and nuclear fuel, regulated energy prices which may act as a barrier to clean energy investments, as well as the need for increased resources to deliver the transition.

Energy transition towards net zero

Hungary was among the first countries globally to turn its 2050 emissions target into a legal commitment with the adoption of the Climate Protection Law in 2020. Hungary's medium- and long-term energy and climate policy is guided by the National Energy and Climate Plan (NECP) of 2020 and the National Clean Development Strategy (NCDS) of 2021.

The NCDS supports energy policy making with early or late action scenarios running up from 2030, 2040 to 2050. Reaching the 2050 target is possible, but will require developing clear policy road maps with key milestones set per sector, which will need to be monitored closely to allow early corrective actions to be taken, as needed.

Hungary's Climate Protection Law also sets out medium-term energy targets: after 2030, increases in final energy consumption above the 2005 level need to be provided exclusively from carbon-neutral energy sources, and renewable energy sources should reach at least a 21% share of gross final energy consumption by 2030.

Hungary merged the governance responsibilities for energy and climate policies within the Ministry of Technology and Industry. Bringing the two policies under one ministry facilitates the integration of climate and energy policy planning. The creation of a dedicated Deputy State Secretary for Climate Policy reflects the growing importance of climate policy within the government.

In the context of the REPowerEU plan, reflecting Europe's determined actions to end energy dependency from the Russian Federation (hereafter, "Russia") by 2027, existing strategies and targets need to be reviewed. Moreover, the EU Climate Law and related measures proposed under the Fit for 55 package require almost all EU member states, including Hungary, to step up efforts to reduce CO₂ emissions on a faster trajectory and boost energy efficiency and renewable energy.

In 2022, Hungary's energy policy strategy focuses on strengthening the country's energy independence. Russia's invasion of Ukraine in February 2022 has created a new set of energy security challenges in Europe. In response, Hungary declared a state of energy emergency on 13 July 2022. To address the emergency, the government aims to increase domestic gas and coal production, secure additional gas imports and increase the output of the country's lignite-fired power plant. A possible lifetime extension of the Paks Nuclear Power Plant is also under discussion while a potential ban on exports of energy carriers and firewood is considered.

Placing energy efficiency at the centre of policy making

Hungary has seen rising energy demand reaching 753 PJ in 2020. Efficiency efforts have not been able to decouple energy demand from economic growth, notably in transport and industry.

Under Hungary's NCDS, energy efficiency needs to increase strongly. By 2030, final energy consumption should be reduced to 734 PJ, assuming early action on energy efficiency, and ultimately to around 500 PJ by 2050. However, Hungary's NECP of 2021 has less ambitious energy efficiency targets for 2030, capping the country's final energy consumption to 785 PJ, which is the 2005 level.

In its NECP, the Hungarian government acknowledges the importance of energy efficiency to reach climate targets and ensure energy security. However, the energy efficiency first principle is not specifically recognised, neither in the NECP nor in the National Energy Strategy (NES), which has an outlook for 2040.

Experiences in other IEA countries show that energy efficiency not only brings substantial resource savings and security benefits, but also contributes to other targets such as improving health indicators and overall quality of life, creating employment opportunities, and supporting innovation.

The government has divided responsibilities for energy efficiency policy design, funding, implementation, and monitoring and evaluation among different government institutions and other responsible entities. Across ministries, governmental institutions and non-governmental organisations, as implementing authorities, the key challenge is often the lack of skilled professionals. To bridge this gap, the government should support the administrative realignment of energy efficiency responsibilities through, for example, the creation of a dedicated energy efficiency agency that would bundle the available technical skills and financial measures and facilitate access to energy efficiency programmes. Such an agency could work with local authorities to support them in the technically complex implementation of multi-year deep renovation projects.

Household retail prices for electricity and natural gas have long been capped in Hungary, with the objective to keep prices for households affordable and to avoid exposing households to price volatility. However, such regulated energy prices are available to all household consumers and small businesses, not only vulnerable ones, and as such hamper decarbonisation efforts, consumer choice and retail competition. The electricity and gas price regulations are planned to be reviewed, taking into account the tools published in the European Commission's Communication of 23 March 2022.

The regulatory framework needs to be revised to reach the highest possible retail market liberalisation in gas and electricity, including the elimination of administratively determined

end-user prices. Protection measures should focus on vulnerable customers and less well-off households as part of social policy rather than energy policy. In July 2022, the government decided to deregulate gas and electricity retail prices for households with consumption above average levels and increase them towards market prices.

Maintaining and boosting low-carbon power generation

Renewable energy has seen remarkable growth thanks to the introduction of the new renewable energy tenders (METÁR), with strong performance of solar photovoltaic (PV). The share of renewable energy sources in gross final energy consumption increased rapidly since 2017 to reach 12.6% in 2019 and 13.9% at the end of 2020, exceeding the 13% target that Hungary had for 2020, but below Hungary's 2030 ambition of 21%.

In line with net zero ambitions, Hungary targets a low-carbon electricity mix of 90% by 2030, with new nuclear and renewables to play a major role.

Hungary has focused on maintaining its nuclear generation capacity. Between 2012 and 2017, all four units of the Paks Nuclear Power Plant (NPP) were granted 20-year lifetime extension licences, on top of the 30-year original design lifetime, bringing their scheduled closure dates to 2032-37. A new build project Paks II is under preparation with Russia and was granted construction licence by the Hungarian Atomic Energy Authority.

Going forward, efforts are needed to boost the share of renewables in gross final consumption. In light of higher EU-wide ambitions, Hungary is also considering raising its 2030 target for renewables in final consumption to a higher level of 23% or even 25%, banking on strong solar PV.

Hungary still has untapped potential in developing geothermal and wind power. A faster progress in renewable energy deployment may allow Hungary to close its last coal-fired power plant ahead of time by 2025. It would also mitigate possible delays at the new NPP project Paks II and support an alternative strategy for Hungary in the coming years.

Hungary plans to phase out coal use for electricity generation by 2030, or if possible by 2025 if the government can timely facilitate the “just transition” by shifting direct and indirect jobs in lignite mining and lignite-fired power generation at Hungary's last coal station, the Mátra plant, to other energy supplies. The government also supports efforts to replace imported coking coal with low-carbon fuels in the future.

Hungary's NCDS expects technologies, such as carbon capture, utilisation and storage (CCUS) and hydrogen, to become available after 2030 but before 2040. Up to 2030, Hungary plans to produce 20 000 tonnes (t) per year of hydrogen via steam methane reforming of fossil fuels and 16 000 t per year of hydrogen produced from solar PV, with some pilot projects under way, such as the Aquamarine project. Hungary has a modest ambition to install 240 megawatts (MW) of electrolyser capacity by 2030, whereas EU countries on average target capacity at gigawatt (GW) scale. Building on the IEA review and in the context of the REPowerEU, Hungary has shifted gear in 2022 and is advancing its hydrogen ambitions by one decade to develop hydrogen for its transport and hard-to-abate sectors.

In 2020, Hungary had 17.3% of electricity in its total final consumption, below the IEA average of 23%. Hungary's energy policy anticipates a significant increase of electrification in many sectors of its economy to reach 50% by 2050, initially driven by the transport

sector. Looking forward, electricity security will require sufficient and diverse sources of flexibility to accommodate the increasing share of variable renewable electricity that is envisaged under the NECP.

In 2021, nuclear energy accounted for almost half of electricity generation in Hungary, followed by strong contributions from natural gas (28%), coal (11%) and solar (5%). Among IEA countries, Hungary has the third-highest share of nuclear, after France and the Slovak Republic. Thanks to the recently completed lifetime extension of the existing units at the Paks NPP beyond the initial 30 years for another 20 years (between 2032 and 2037), nuclear power can maintain its role in the mix. The planned construction of two additional units at the Paks site based on Russian investment may face significant delays. Hungary needs to increase its efforts to avoid an increase in power sector emissions after 2030 and ensure reliable dispatchable capacity. Lifetime extensions of existing reactors should be considered.

The next iteration of Hungary's NECP is an opportunity to update these actions, including by:

- reinforcing energy efficiency measures
- accelerating deployment of diverse renewable energy sources and examining lifetime extensions of existing nuclear reactors
- considering early action on CCUS and hydrogen during the 2030s with dedicated investment schemes.

Maintaining energy security during the transition

Under Hungary's energy strategy, the government's stated policy objective is to reduce import dependency.

Hungary's dependency on energy imports has increased over the last decade as demand for fossil fuels has increased. Despite greater diversification of oil supply, the country remains heavily dependent on Russian oil and gas. With little domestic production, Hungary's import dependency stood at 87% in 2020. Russia accounted for 64% of crude oil imports and 95% of gas imports.

However, with current government policies, oil will remain a significant part of Hungary's energy mix through 2030, and well beyond. The Hungarian government does not have a target to reduce oil consumption, but only to limit consumption growth. This growth is unlikely to be met by increased domestic production, meaning that Hungary's already substantial reliance on oil imports will likely grow.

On the whole, Hungary has a solid oil stockholding system exemplified by a competent national stockholding agency that is legally obligated to hold oil stocks within the Hungarian territory at a level equivalent to at least 90 days of net imports. Hungary has been consistently compliant with its IEA's minimum oil stockholding obligation, with total oil stocks covering well beyond the 90-day net import level. As of June 2022, total oil stocks in Hungary equated to 199 days of net imports, 84 days of which is publicly held emergency stocks. Hungary took part in the two IEA Collective Actions agreed to in March and April 2022 as part of a co-ordinated effort to respond to tight oil market conditions following Russia's invasion of Ukraine, contributing a total of 796 thousand barrels of crude oil from its public stockpiles.

Hungary is heavily dependent on the southern branch of the Druzhba pipeline for its crude oil imports. The government cited this reliance as a reason for requesting an exemption from the EU embargo on Russian oil imports, as decided by the European Council on 30-31 May 2022 and to be implemented by the end of 2022. Therefore, the EU embargo includes a temporary exemption for crude oil imports by pipeline, allowing Hungary to import crude oil via the Druzhba pipeline. In the light of Russia's invasion of Ukraine and uncertainties of future transit of Russian crude to Europe, the Hungarian government needs to urgently review options to reduce this dependency of pipeline imports from Russia and strengthen the diversification of its oil imports, together with its regional neighbours.

Natural gas is the most significant source in total energy supply (TES), accounting for 34% in 2020 and almost 60% of residential heating. Natural gas consumption is expected to increase towards 2030, when the last Mátra lignite-fired power plant will be closed and replaced with, among other sources, a 500 MW gas-fired plant.

Hungary has made significant progress since the last IEA in-depth review in diversifying its supply routes and now has six gas interconnection points. Another major development to strengthen gas security is the import of liquefied natural gas (LNG) from the Krk terminal in Croatia since the beginning of 2021. Hungary's N-1 indicator, an industry metric used to gauge the security of natural gas supply, has been above 100% for several years and reached 157% in 2021. However, it should be kept in mind that most of the new interconnections supply natural gas from Russia, so this is mainly a diversification of supply routes, not of natural gas supply sources. Hungary also holds strategic gas reserves at an underground storage facility owned by the Hungarian oil and gas stockholding agency. In September 2021, the level of strategic stocks held was 1.45 billion cubic metres (bcm), around 13% of annual consumption in 2020.

Electricity demand in Hungary has increased and will likely grow further given the government's plans for electrification of the transportation system and the wider economy. While Hungary's electricity generation capacity will likely remain sufficient in the short term, the installation of a significant quantity of additional generation capacity will be required in the longer term given both increased electricity demand and the planned phase-out of existing nuclear and coal-fired capacity.

Hungary's electricity interconnectivity reached 55% in 2020, close to the targeted increase of cross-border capacity of 60% of gross installed capacity and substantially above the EU target of 15% by 2030. Hungary has strongly invested in regional interconnections and will soon be linked to Slovenia and reinforce connections with the Slovak Republic, supporting regional power trade.

Preparing the electricity networks for the challenges posed by decentralised generation and variable capacity is the future challenge, requiring significant investment in the grid, balancing and storage capacities. The government has plans to increase energy storage capacity to at least 1 000 MW by 2026 and to add 100 MW capacity of demand-side response by 2030. However, Hungary's existing legislative framework for regulating energy storage is inadequate to facilitate significant market-based commercial storage investments.

Under its new emergency legislation, Hungary seeks to increase gas production (to 2 bcm/y), secure additional gas imports from Russia, potentially ban exports of energy carriers and firewood, increase coal production and power output at Hungary's lignite-fired power plant and extend the lifetime of the Paks Nuclear Power Plant.

Key recommendations

- In line with the REPowerEU, the net zero target and Fit for 55 package, adopt increased ambitions on energy efficiency, renewables and low-carbon technologies and strengthen the 2030 greenhouse gas and sectoral emissions targets. Update the National Energy and Climate Plan and the policies and measures required.
- Place energy efficiency at the centre of energy policy making by creating a dedicated body for the implementation of efficiency policies. Design a programme to reduce energy poverty with a focus on energy efficiency and social policy measures, reducing the scope of regulated end-user prices.
- To strengthen security of supply, prioritise investments in energy efficiency and domestic low-carbon energy sources by removing all barriers to the roll-out of renewable electricity and its system integration through increased energy storage and demand response. Further reduce demand for and consistently diversify supply sources of crude oil and natural gas.
- Review the regulatory framework to increase energy market competition, ensure a level playing field for market participants, strengthen the position of consumers, and open markets for new investors and services.

2. General energy policy

Key data (2020)

TES: 26.3 Mtoe (natural gas 33.4%, oil 27.1%, nuclear 16.0%, bioenergy 10.3%, coal 7.1%, electricity 3.8%, solar 0.9%, wind 0.2%, hydro 0.1%), +1% in 2010-19, -2% in 2019-2020

TES per capita: 2.68 toe per capita (IEA average: 3.84 toe per capita)

TES per GDP: 89 toe per USD million (IEA average: 91 toe per USD million)

Production: 10.8 Mtoe (nuclear 38.9%, bioenergy 25.8%, natural gas 12.2%, oil 9.6%, coal 8.6%, solar 2.1%, geothermal 1.4%, wind 0.5%, hydro 0.2%), -9% since 2010

TFC: 19.9 Mtoe (buildings 40.0%, industry 37.7%, transport 22.3%)

Country overview

Hungary is a Central European country that borders Austria, Croatia, Romania, Serbia, the Slovak Republic, Slovenia and Ukraine. Hungary has a population of 9.75 million. Budapest is Hungary's capital and its largest city, with almost 1.77 million inhabitants in 2020.

Hungary is a parliamentary democracy with a unicameral system. Parliamentary elections take place every four years, the latest of which were held on 3 April 2022, electing the country's parliament, the National Assembly. The head of the executive is the prime minister, who is elected by the National Assembly. The parliament also elects the president for a five-year term. The president is the official Head of State and can only be re-elected once. In 2022, Katalin Novák serves as president and Viktor Orbán as prime minister. Hungary joined the Organisation for Economic Co-operation and Development (OECD) in 1996, the IEA in 1997 and the European Union in 2004.

Hungary had solid economic growth from 2014 until the Covid-19 pandemic commenced in 2020. While Hungary's gross domestic product (GDP) contracted by 5.1% in 2020 as a result of the Covid-19 lockdowns, economic growth started to recover already in the third quarter of 2020 (EC, 2021a).

The OECD projects Hungary's GDP to grow at around 5% in both 2021 and 2022, implying that it will reach its pre-Covid level in early 2022 (OECD, 2021). The strong growth prior to 2020 had seen unemployment drop to its lowest level in 30 years to just under 3.6% in the first quarter of 2020; it then rose to 4.2% in 2020 (OECD, 2021). Since then, employment has been recovering quickly and labour shortages are already felt in some economic sectors, especially in engineering, the digital economy and services; unemployment is set to fall to 3.4% in 2022 (OECD, 2021).

Hungary has a diversified economy with car manufacturing and vehicle automotive parts production, electronics, and, information and communications technology forming an important part of the industry sector. Those sectors are vulnerable to supply chain shortages, especially of semiconductors. Moreover, the automotive industry is also set to undergo a transformation as part of the energy transitions in Europe, Hungary's dominant export destination, with a shift to electric mobility, which is not yet a key focus of Hungary's vehicle industry (OECD, 2021).

Figure 2.1 Map of Hungary



Impact of Covid-19 on the energy sector

The Covid-19 crisis impacted the Hungary's export-oriented economy and also its energy sector. In 2020, Hungary's TES was 26 million tonnes of oil equivalent (Mtoe), a 2% decrease relative to 2019. The energy sector suffered the most notable impact of the Covid-19 pandemic on the demand for transport fuels, which dropped by 8% from 2019 to 2020 due to restrictions on mobility. Demand for motor fuels was lower in 2020 than in 2018.

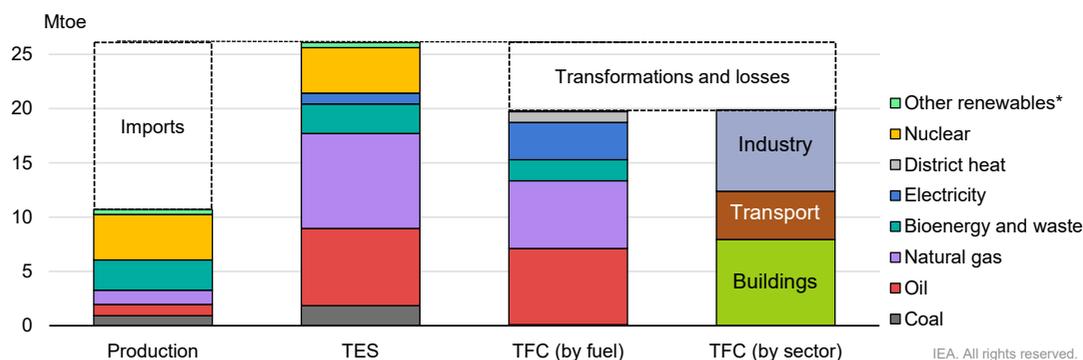
The impact of the Covid-19 pandemic on electricity demand was only temporary for the months of April to June 2020. Although demand recovered from July to September 2020, it remained below the level in 2019. Since October 2020, electricity demand in Hungary has grown to such a degree that it almost broke the historic peak in December 2020 before eventually setting a new peak in February 2021.

Similarly, the pandemic did not have a major effect on annual total gas consumption, which decreased by only 0.5% between 2019 and 2020. Some sectors were, however, more affected than others, as gas consumption decreased by 5% in industry and 22% in service sector buildings while it increased by 3% in electricity and heat generation and by 7% in residential buildings.

In 2020, total energy-related CO₂ emissions decreased by 5% to 43.8 million tonnes of carbon dioxide (Mt CO₂) in the wake of the Covid-19 pandemic and lower energy supply. In 2020, emissions from the transport sector dropped by 14% year-on-year due to the restrictions caused by the Covid-19 pandemic, reaching 12 Mt CO₂. The Covid-19 pandemic did not have a major impact on emissions from industry, as these remained stable from 2019 to 2020. The buildings sector was the only sector with increasing emissions (by 5%) from 2019 to 2020. These changes are not structural, as the report shows emissions went up again after the end of lockdowns.

Supply and demand

Fossil fuels accounted for 68% of Hungary's TES in 2020, of which 33% was natural gas, 27% oil and 7% coal. The main non-fossil energy source is nuclear (16% of TES), followed by bioenergy and waste (10%); electricity imports (4%); and other renewables (2%), including hydro, wind, geothermal and solar.

Figure 2.2 Overview of Hungary's energy system by fuel and sector, 2020

Hungary relies on imports for more than half of its TES, dominated by fossil fuels and nuclear. As such, oil and gas cover two-thirds of TFC, mainly in buildings and industry.

* *Other renewables* include small shares of hydro, wind, geothermal and solar.

Source: IEA (2022).

In 2020, Hungary produced 41% of its TES domestically, which indicates a high dependency on energy imports due mainly to the limited fossil fuel resources (Figure 2.2). Oil and natural gas together covered two-thirds of total final consumption (TFC), while the share of electricity in TFC was the third-lowest among IEA countries (17%) and below the IEA average of 23%. In terms of sectors in TFC, buildings accounted for 40% of TFC, followed by industry (38%) and transport (22%).

Energy production and self-sufficiency

Hungary's total domestic energy production was 11 Mtoe in 2020, 9% lower than in 2010. The main source of domestic energy is nuclear, covering 39% of production in 2020, followed by bioenergy and waste (26%), natural gas (12%), oil (10%), coal (9%), and other renewables (4%). Hungary's share of domestic production in TES (self-sufficiency) remained around 40% between 2010 and 2020. In 2020, domestic coal production accounted for 54% of coal supply. As Hungary has limited sources of natural gas and oil, it showed only 16% and 15% of self-sufficiency for gas and oil, respectively.

Energy supply

In 2020, Hungary's TES was 26 Mtoe. After fluctuations around 26 Mtoe between 2010 and 2020, it reached a minimum of 24 Mtoe in 2014 and a maximum of 27 Mtoe in 2019 (Figure 2.3).

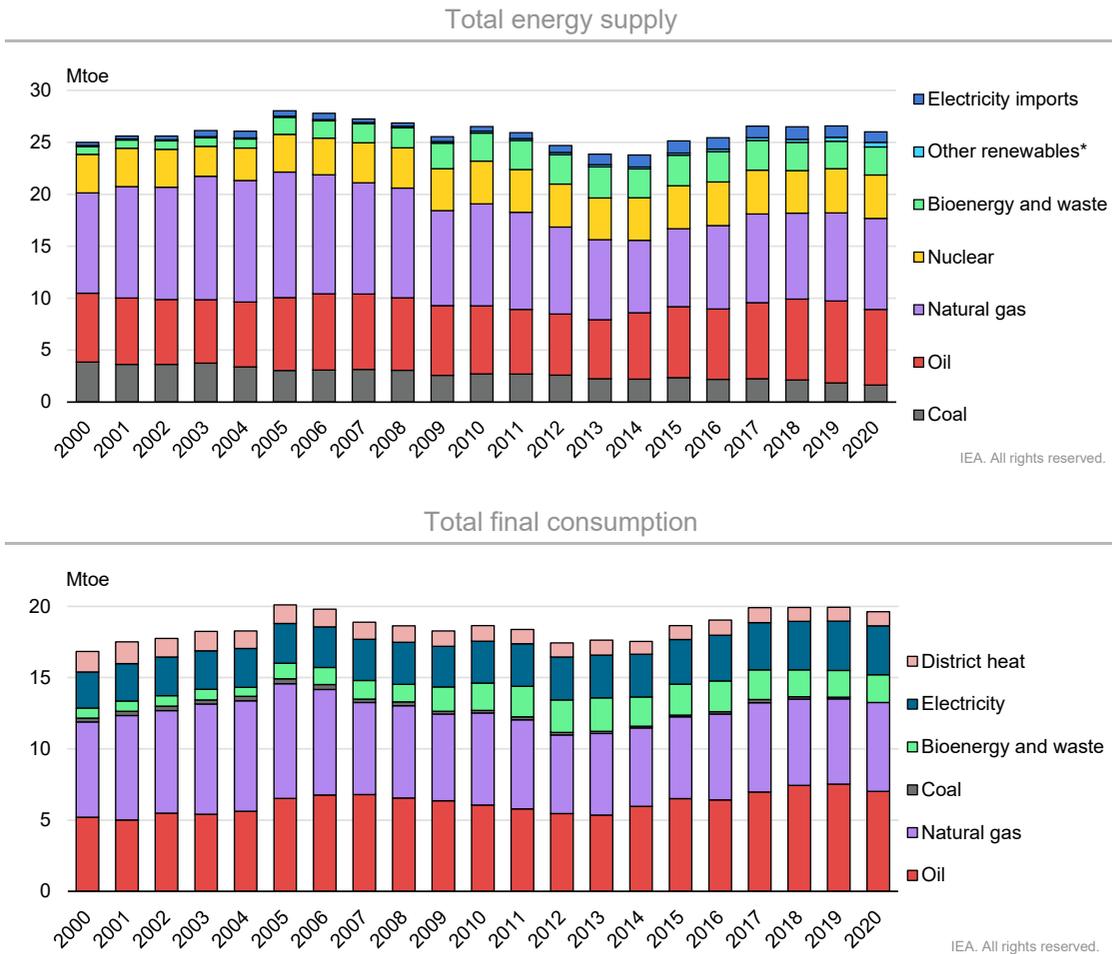
The main changes to the energy mix between 2010 and 2020 were a significant decline of coal supply (-37%), a decrease of natural gas (-11%) and an increase of oil supply (2%). Nuclear energy and bioenergy supply were almost constant, while the supply of other renewables (solar, geothermal and wind) increased by 173%, even if their share in TES remains small (2%). Electricity imports more than doubled between 2010 and 2020.

Energy demand and electricity generation

TFC increased from 19 Mtoe to 20 Mtoe between 2009 and 2019. In 2019, TFC consisted mainly of oil (37%), natural gas (30%) and electricity (17%). Bioenergy accounted for 9% of TFC, followed by district heat (5%), while the direct use of coal covered only 1% and

was used mainly in industry. A major part of the increase of TFC between 2009 and 2019 came from oil consumption, which rose by 18% from 2009 to 2019, driven by increased energy consumption in the transport sector. The consumption of electricity also increased by 22% in the same period, while the direct use of coal decreased by 36%.

Figure 2.3 Total energy supply and demand by source in Hungary, 2000-2020



Between 2010 and 2019, Hungary's energy mix saw declining coal supply and rising oil demand. In 2020, energy supply and demand decreased due to the Covid-19 pandemic.

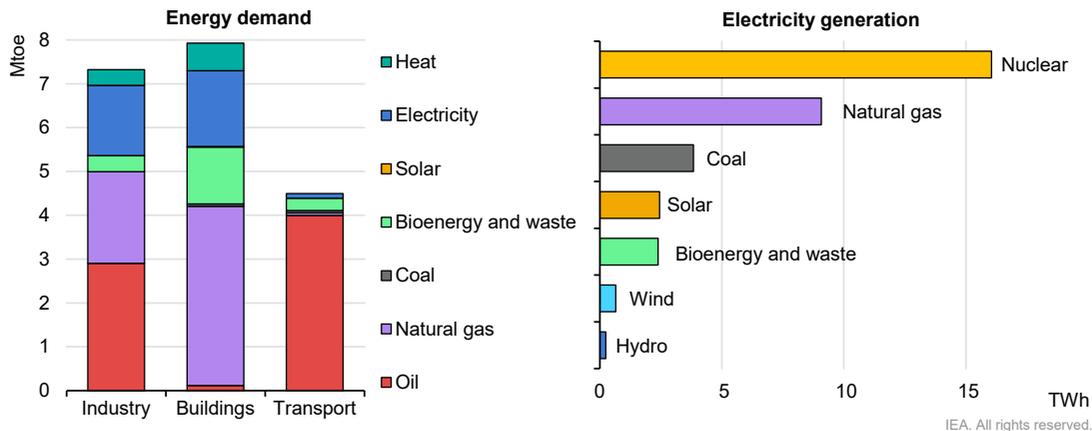
*Other renewables includes geothermal (0.068 Mtoe) and solar (0.013 Mtoe) in 2019.

Source: IEA (2022).

In 2020, energy demand (TFC) in buildings was slightly higher (7.9 Mtoe) than in industry (7.5 Mtoe), followed by transport (4.5 Mtoe) (Figure 2.4). While 90% of energy demand in transport was provided by oil, the energy mix in the industry and buildings sector is more diversified. In 2020, industry energy demand was covered by oil (39%), natural gas (28%), electricity (21%), bioenergy and waste (5%), district heat (5%), coal (2%), and geothermal (0.6%). Natural gas provided half of energy demand in the building sector followed by electricity (22%), bioenergy and waste (16%), and district heat (8%). Electricity generation in Hungary is dominated by nuclear and natural gas power plants, which in 2020 provided 46% and 26% respectively of total generation, followed by coal (11%), solar (7%) and

bioenergy (6%). Hungary has the third-highest share of electricity generation from nuclear among IEA member countries, after France and the Slovak Republic.

Figure 2.4 Energy demand per sector and fuel, electricity generation by fuel, 2020



The buildings sector dominates TFC, mostly sourced by natural gas. Nuclear, natural gas and coal source the electricity mix, which covers 23% of buildings and 22% of total industry TFC.

Source: IEA (2022).

Towards carbon neutrality by 2050

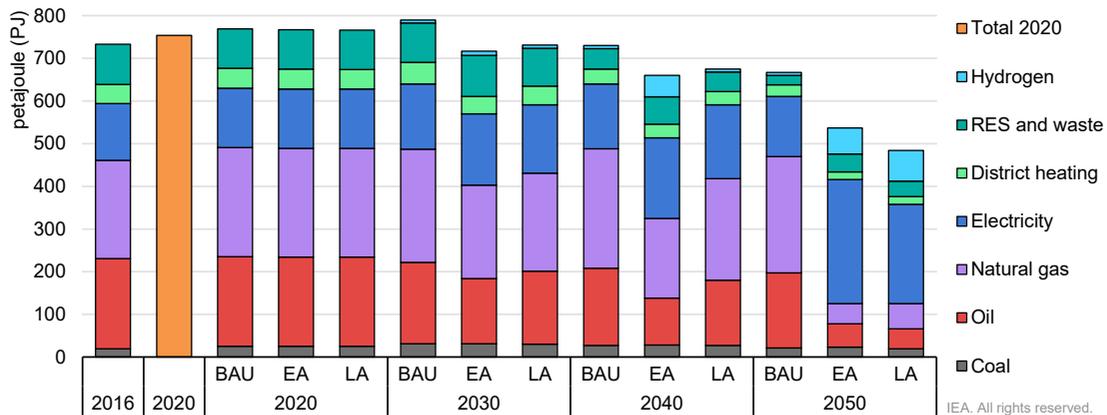
Hungary is committed to achieve carbon neutrality by 2050. The adoption of the Climate Protection Law in June 2020 made Hungary the first country in Europe's Central European region to set a legally binding domestic climate neutrality target for 2050.

In 2021, the NCDS was presented as Hungary's long-term strategy. It outlines a 30-year vision of socio-economic and technological development pathways to achieve carbon neutrality by 2050 across the economy (Hungary, 2021).

For the preparation of the NCDS, Hungary modelled three scenarios for greenhouse gas (GHG) emissions up to 2050. A business-as-usual scenario under which emissions in 2050 would decrease by only 56 million tonnes of carbon dioxide equivalent (Mt CO₂-eq) from 2019 GHG levels (64.4 Mt CO₂-eq). A late action scenario that assumes slow emissions reductions up to 2045 before accelerating over the last five-year period. The late action scenario results in total emissions of 42 Mt CO₂-eq. in 2030. An early action scenario front-loads emissions reductions due to higher energy efficiency gains and a higher share of renewables by 2030. In this scenario, emission reductions follow a more linear path from 2030 onward to reach net zero emissions by 2050.

The late action and early action scenarios both assume that CCUS will be economically viable in the energy and industry sectors after 2030. However, there is a difference of 80 000 t of emissions between the two scenarios in 2030, with the early action scenario having fewer emissions from the energy sector.

Figure 2.5 Final energy consumption by fuel under the three scenarios in Hungary, 2016-2050



Notes: BAU = business as usual, EA = early action, LA = late action.

Source: Hungary (2021).

The modelling results found that the composition of Hungary's final energy consumption (FEC) must change significantly to reach carbon neutrality by 2050. The most notable change comes from the large-scale electrification of the energy sector. By 2030, electricity will overtake oil as the second-largest share in FEC in the early action scenario and will also have increased, albeit at a lesser rate, in the late action scenario. Around 50% of FEC in 2050 will be electricity under the late action and early action scenarios. Electricity generation will increase strongly up to 2050, while the consumption of oil-based fuels will decrease to nearly a quarter, compared to 2016 levels, as a result of the electrification in the transport sector.

Until 2030, natural gas accounts for the largest share of FEC under both scenarios. But its share in FEC will decline significantly after 2040; and is expected to be phased out entirely in some sectors. Hydrogen will partly replace natural gas, mainly in the transport and industrial sectors, and in 2050, hydrogen will account for 11% of FEC in the early action scenario and for 15% in the late action scenario. And although Hungary is committed to phase out coal from electricity generation by 2030, coal is still expected to be part of the energy mix in 2050, mainly in industry, albeit with the lowest share of all energy sources.

In the early action scenario, final energy consumption in 2050 at 537 petajoules (PJ) is higher than in the late action scenario at 484 PJ due to the expected higher economic growth in the early action scenario driven by investments for the energy transition. However, in the early action scenario, the share of renewable energy sources, including from electricity generation, is projected to be 6% higher than in the late action scenario. Overall, the early action scenario is characterised by an accelerated large-scale clean electrification and decarbonisation of the electricity system.

The NCDS also sets out the policy actions to reach carbon neutrality by 2050:

- improve energy efficiency in the residential, commercial and industrial sectors
- electrify the energy system, notably the transport, residential and commercial sectors
- ensure commercial availability of CCUS after 2030
- deploy second-generation biofuels for transport
- boost the deployment of energy storage

- create a hydrogen economy
- improve recycling and waste
- invest in research, development and innovation (RDI)
- boost reskilling and training for the just transition.

Energy and climate targets

Hungary's medium- and long-term energy and climate policies are guided by the NECP (Hungary, 2020b) and the NES 2030 with an outlook to 2040.

The NECP and the new NES 2030 are aligned towards the key objectives to strengthen energy independence and energy security while decarbonising energy production through the transition towards clean, smart and affordable energy. The targets to 2030 were transposed into law through the Climate Protection Law. The NECP and the NES 2030 guide Hungary's policy actions to 2030 with targets to:

- reduce emissions by 40% in 2030 compared to 1990 levels
- cap total final consumption at 785 PJ (2005 levels) by 2030
- produce 90% of domestic electricity from carbon-neutral sources, phasing out coal
- install 6.5 GW of solar PV capacity by 2030 and 12 GW by 2040
- install at least 200 000 household roof-top solar panels (average output of 4 kilowatts [kW])
- renewables to account for at least 21% of gross final energy consumption
- source final energy consumption above 2005 levels from carbon-neutral sources in 2030.

Box 2.1 Hungary's National Energy and Climate Plan

In 2020, Hungary presented its final NECP to the European Commission (EC) under the EU Governance Regulation (MIT, 2020). By 2023, Hungary will also have to update its NECP in step with the EU net zero ambitions by 2050 and the EU Climate Law.

In October 2020, the EC published a staff assessment of Hungary's NECP, noting that the 2030 target for 21% renewables in gross final consumption was unambitious as a share of 23% is necessary to support the EU-wide renewables target. The EC also commented that Hungary's 2030 energy efficiency targets showed a very low level of ambition (EC, 2020).

The EU Climate Law sets into legislation the objective of a climate-neutral EU by 2050, and creates a system for monitoring progress and adjusting national and EU-wide action, if needed. In line with the Paris Agreement, the EU Climate Law provides for a five-year stocktaking process. The NECPs, which are regulated under the EU Governance Regulation, are at the heart of this process. In 2019/20, the first edition of NECPs was adopted for ten years up to 2030. In 2024, the EC will assess progress from the first NECPs. By 30 June 2023, member states are required to provide a draft update of the NECP and by 30 June 2024, their final updated NECP.

EU member states are also required to report on the implementation of their NECPs. The first of such reports (so-called integrated national energy and climate progress reports) is due by 15 March 2023. Any new policies and measures can be included in the report. The NECP also offers a good opportunity to improve the readability of Hungary's climate strategies, targets and action plans, which are set out in five strategic documents.

In July 2021, the EC presented a range of proposals to implement the higher emissions reduction ambition with the Fit for 55 package, including rules for reducing GHG emissions (Effort Sharing Regulation and Emissions Trading System) and proposals to revise the Energy Efficiency and Renewable Energy Directives, including their targets. The updated NECPs (by 2023/24) will have to reflect these increased climate and energy ambitions at the EU level, once negotiations are finalised, as well as the results of the national progress reports.

Hungary's Climate Protection Law of 2020 and its NECP do not yet reflect the new 55% EU-wide GHG emissions reduction target for 2030, but both the early and the late action scenarios of the NCDS are consistent with the increased target of -55% for 2030. Hungary will need to update its NECP with the 2030 ambitions for GHG emissions reductions, renewables and energy efficiency to support the EU-wide 55% reduction target.

Table 2.1 Hungary's 2020 and 2030 energy sector targets and 2020 status

		2020	2020 targets	2030 targets
Non-ETS greenhouse gas emissions*	CO₂-eq emissions versus 2005	-2%	Not exceeding a 10% increase	-7%
Energy efficiency	Primary energy consumption	23.9 Mtoe** 1 000 PJ	26.5 Mtoe 1 110 PJ	30.7 Mtoe 1 285 PJ
	Final energy consumption	18.0 Mtoe** 754 PJ	18.2 Mtoe 761 PJ	18.8 Mtoe 785 PJ
Renewable energy share	Gross final energy consumption	13.9%	13%	21%*
	Electricity	11.9%	10.9%	20%*
	Heating and cooling	17.7%	18.9%	30%*
	Transport	11.6%	10%	14%*
Cross-border electricity interconnection*		50% (2018)	55%	60%

* From Hungary (2020).

** From Eurostat (2021)

Just transition

Hungary's commitment to phase out coal from the electricity sector by 2030 at the latest requires attention in order to facilitate a just transition for the affected population and regions. While the remaining coal industry in Hungary is relatively small, it is nevertheless crucial to develop and implement a road map for the low-carbon transition of the affected coal regions.

Around 2 000 people are directly employed at the Mátra Power Plant and adjacent mines, and several thousand more are employed in indirect jobs in the local economy. Most of the 100 000 households supplied with household lignite-based heating are located in the region of the Mátra Power Plant. The government developed the LIFE-Integrated Project (IP) North-HU-Trans project for the single largest coal region in Heves and Borsod-Abaúj-Zemplén counties, in north-eastern Hungary. The project aims to retain 500 direct employees of the Mátra Erőmű plant as well as the employees of the related coal mines. The project was launched in September 2020 and is expected to be completed by the end of 2029.

To support the just transition, Hungary plans to tap into the EU Just Transition Fund (JTF), created as part of the EU Green Deal. Hungary is eligible to receive 1.4%, or EUR 237 million, of the total JTF budget of EUR 17.5 billion for the period 2021-27. The JTF targets Europe's coal regions that need more help than others to adapt to and benefit from the transition to climate neutrality, because of the decline and/or transformation of the economic sectors on which they depend. To access the JTF, all EU members must submit territorial just transition plans which Hungary is in the process of preparing. It has identified three regions that will be eligible for funding from the JTF, including the two regions where the operating coal mines and the Mátra coal-fired power plant are located. The territorial transition plans will take a holistic view of the concerned regions to account for the economic, social, employment and skills impact of the transition (see Chapter 9). Hungary plans to complement the JTF allocation by 15% national co-financing.

Investments for the energy transition

Hungary is using a mix of public and private funding to advance the energy transition. The government does not consider access to funding as a constraint for implementing its energy and climate policies and notes that sufficient funding from the EU has been available so far and is expected to continue to be available. The NECP states that an additional total of HUF 20 401 billion (Hungarian forints), or EUR 62 billion, over the period 2016-40 is needed to reach the targets set in the NECP. This is equivalent to an annual additional investment of HUF 582.9 billion (Hungary, 2020). Investment costs to 2030 are estimated at EUR 41.7 billion, and if including the Paks II NPP, they amount to EUR 53.6 billion. The cost of reaching net zero carbon emissions by 2050 are estimated at HUF 50 000 billion, or EUR 150 billion (Hungary, 2020).

Hungary launched a green bond framework. In 2020, the government issued a euro-denominated sovereign green bond to encourage investors to contribute to financing sustainable projects in Hungary. The green bond was over-subscribed, with investors making offers of almost EUR 7.7 billion for the EUR 1.5 billion 15-year bond. As an acknowledgement of this euro green bond issuance, Hungary received the Sovereign Green Market Pioneer Award from the Climate Bond Initiative. In 2020 Hungary issued 20 billion yen-denominated bonds. The green bond framework is in line with the upcoming EU green bonds standard. In April 2021, the government launched a green bond denominated in the local currency for HUF 30 billion. Since then, Hungary has issued new green bonds in HUF. Altogether Hungary has issued nearly 115 billion Hungarian forint-denominated green bonds. Hungary is the first foreign sovereign actor on the Chinese bond market through the issuance of so-called Green Panda green bonds in December 2021 in the amount of 1 billion yūan. In February 2022, Hungary's largest-ever issue of foreign currency bonds, again denominated in yen, was launched in the amount

of JPY 75.3 billion (Japanese yens) of which JPY 59.3 billion is considered as green bond. In 2019, the Hungarian central bank announced the creation of a dedicated green bond portfolio for its own investments. Proceeds from the issuance of the green bonds will be used to finance, or refinance, expenditures from the government's budget for measures and projects facilitating the transition to a low-carbon, climate-resilient and sustainable economy.

Hungary is planning to use the various funds provided by the EU to advance the energy transition.

The EU Recovery and Resilience Facility (RRF) is making available EUR 723.8 billion for the period 2021-27 with specific shares allocated to each EU member state. Hungary submitted its Recovery and Resilience Plan in May 2021, which includes measures for the energy transition, the circular economy and sustainable transport (EC, 2021b). Of particular note is the inclusion of measures for increasing the flexibility of the power system, notably investment in transmission and distribution grids to accommodate the rising share of variable renewables and provisions for the introduction of community renewable energy production projects.

Hungary decided to pre-finance expenditure under the Recovery and Resilience Plan from its general budget pending the approval of the plan by the EC. There is a two-step approach in the allocation of funds among member states. According to the first step, Hungary is eligible for up to EUR 16.83 billion under the RRF, of which EUR 7.17 billion is available as a grant and the remaining EUR 9.66 billion as a loan. According to the second step, Hungary's share will drop, due to its relatively high GDP growth rate. Hungary has submitted projects worth EUR 7 billion for the grant part. Hungary plans for EUR 17 billion for the RRF loan application, mostly focusing on investments in grids, renewables, diversification, energy efficiency, nuclear energy and hydrogen.

Energy pricing and taxation

The Hungarian energy sector is subject to various taxes, including the energy tax, value-added tax (VAT) and excise duty. A range of exemptions and tax breaks reduce the effectiveness of the tax rates (OECD, 2021) in terms of environmental steering.

The final consumption of electricity, natural gas and coal is subject to an energy tax (their intermediate consumption is exempted from the tax). Renewable energy is not subject to the energy tax to encourage its growth in the Hungarian energy mix. Residential energy consumption is also exempted from the energy tax.

Hungary also levies VAT, currently set at 27%, one of the highest rates among IEA countries, on the final consumption of electricity, natural gas, heat and other forms of energy. However, district heating benefits from a substantially lower VAT, at 5%.

An excise duty is levied on all energy products and electricity, varying by type of fuel and their use. For motor fuels – diesel, gasoline, liquefied petroleum gas and kerosene – the excise duty is linked to the Brent price. However, certain exemptions exist. Diesel use in the agricultural sector benefits from a refund of 82% of the excise tax. In total, Hungary has 71 different levels of excise duty. The excise duty is set at, or close to, the minimum levels under EU regulations, but is lower than those for other EU member countries that are also OECD countries (OECD, 2021).

This is done partly to offset the high VAT levels as well as to address energy poverty concerns in Hungary. Between 2011 and 2014, the government significantly decreased the electricity and natural gas tariffs for residential use to bring them in line with the price in neighbouring countries. Tariffs have been more or less stable since 2014.

In fact, the government sets maximum retail prices for electricity and natural gas for certain categories of consumers under the so-called Universal Service Scheme. The government notes that as a result, the share of households having arrears for their utility bills halved between 2013 and 2018 and the share of households unable to heat their houses has declined from 14.6% to 6.1%. Overcoming energy poverty and ensuring affordability are critical objectives of energy policy, notably amid record energy prices in 2022. Hungary's retail price caps shield consumers from these price hikes, while they expose suppliers to major financial losses, risking supply security for consumers. Price caps are not the most economic and environmentally suitable measure, as they may risk increasing Hungary's energy import dependency, notably on Russian natural gas.

Electricity, natural gas and district heating transmission and distribution system operators are required to pay a utility infrastructure tax based on the length of the utility network. The tax is currently HUF 125 (EUR 0.34) per metre.

Gender diversity

There are no specific government policies in place to promote gender equality in the energy sector. However, Hungary's private sector entities are implementing gender diversity policies and activities at a company level. For example, MOL, the largest Hungarian oil company, has made increasing the ratio of female staff at all levels of the organisation a key performance indicator. Another example is MVM, Hungary's largest power sector company. While MVM has not set any quantitative targets for gender diversity, the company has recently started a programme to facilitate reintegration after maternity leave and initiated a career-mentoring programme targeting female employees.

The non-profit "Women in Energy" association, founded in Budapest in 2017, aims to increase the share of female leaders in the energy sector in the Central and Eastern European countries. In co-operation with the Boston Consulting Group, the association undertook a study on gender diversity in the regional energy sector in 2018 (Beck and Pánczél, 2018).

At 28%, Hungary's share of females in the workforce in the energy sector is slightly higher than the regional average of 26%, while the share of female board members in Hungary is below the average for the region, according to the study. The survey found that throughout the region, the number of females studying engineering is positively correlated with a higher share of females attaining company board positions. The study highlighted two best practice examples. One is Innogy, Hungary's awareness-raising programme about career opportunities in the energy industry for female high school students. Another is MOL's Female Engineer Scholarship programme that combines financial support with skills support. No comprehensive sectoral data are collected on gender diversity across the energy sector. Data are collected on this topic on a regular basis by companies in Hungary.

Assessment

Hungary is among the first countries globally to turn its net zero emissions target into a legal commitment with the adoption of the Climate Protection Law in 2020. Altogether the Hungarian government has adopted seven strategies to guide Hungary's medium- and long-term energy and climate policy, most importantly the National Energy and Climate Plan of 2020 and the National Clean Development Strategy of 2021.

Reaching the 2050 target is possible, as the National Clean Development Strategy shows, but it will require developing clear policy road maps with key milestones per sector, which will need to be monitored closely to allow early corrective actions to be taken, if needed.

Hungary's Climate Protection Law also legislates the medium-term energy targets: after 2030, increases in final energy consumption above the 2005 level will be provided exclusively from carbon-neutral energy sources, and renewable energy sources will account for at least a 21% share of gross final energy consumption by 2030.

The government targets 90% of Hungary's electricity to be generated from low-carbon energy. To reach this target, the government has chosen to phase out coal in the power sector by 2030, increase solar PV capacity to 6.5 GW by 2030 and to 12 GW in 2040, maintain and modernise nuclear power production, and extend the capacity and flexibility of the power grid to accommodate renewable power, including through the roll-out of 1 million smart meters and 1000 MW of storage capacity by 2026.

The existing strategies and targets need to be reviewed in the framework of the European Green Deal. The EU Climate Law and related measures proposed under the Fit for 55 package will most likely require EU member states, including Hungary, to step up efforts to reduce CO₂ emissions on a faster trajectory and step up energy efficiency and renewable energy efforts. The National Clean Development Strategy's early and late action scenarios are both consistent with a higher EU emissions reduction target for 2030 (-55% reduction compared to 1990) required under the EU Climate Law. The government needs to review its NECP and related energy strategy to align with these new climate targets.

Commendably, Hungary merged the governance responsibility for energy and climate policy under the same secretariat within the Ministry for Innovation and Technology in mid-2018. This will facilitate policy implementation and tracking as well as Hungary's ambition to move to a new economic model based on green growth. Today, the Ministry for Technology and Industry deals with energy and climate matters – a separate Deputy State Secretariat for Climate Policy reflects the growing importance of climate policy within the government.

Over the last decade, the Hungarian economy has experienced a period of strong economic growth, which has pushed up energy consumption and emissions. Energy efficiency efforts have not been able to decouple growth and consumption. Hungary does not levy any carbon pricing and there are no plans to introduce national carbon pricing in transport or buildings. Energy efficiency is the main tool; however, progress has been hampered by a range of barriers. This includes the highly dispersed responsibility of implementing authorities, including several ministries, governmental institutions and non-governmental organisations.

Placing energy efficiency at the heart of energy policy, the government may wish to consider creating a dedicated agency for the implementation of energy efficiency programmes that is properly staffed and resourced. Such an agency could also be tasked with monitoring and evaluation of the quantitative impact of the energy efficiency programmes and could directly work with local authorities which sometimes lack the competencies required for multi-year, complex, deep renovation projects. Looking forward, the expected revision of the National Energy and Climate Plan to reflect the new EC targets for 2030 offers a good opportunity to place energy efficiency more firmly at the centre of policy making.

A successful transition involving appropriate support for workers and communities associated with the Mátra plant will be crucial because it could demonstrate to other sectors of the economy that the transition to a low emissions future can be achieved in a way that creates new opportunities and does not leave workers behind. Closure of the concerned mines and the lignite power plant will affect more than 10 000 employees in the regional economy and it is unclear yet if the LIFE-IP North-HU-Trans project led by the Ministry for Innovation and Technology will deliver a smooth socio-economic transition. The EU's Just Transition Fund and Hungary's Coal Commission, established in 2021 (in the framework of the LIFE-IP project), can help support affected workers and communities through the transition.

An essential enabler of the clean energy transition is a significant increase in the levels of human and financial resources committed to action. Hungary applied to the EU Recovery and Resilience Facility for projects focused on smart grids. Observers noted that the Hungarian funding request to the RRF does not pay sufficient attention to the contribution of energy efficiency in the building sector in the transition, echoing earlier comments made by the European Commission in its assessment of Hungary's National Energy and Climate Plan and the evaluation by non-government experts from E3G and Wuppertal Institute (Green Recovery Tracker, 2021; EC, 2020).

Human resources, reskilling and job increases are required globally, including in Hungary. Increased human and financial resources will be required if Hungary is to achieve its climate and energy targets. Hungary's private sector entities are implementing gender equality policies and activities at a company level. There are no specific government policies in place to attract more women to public policy jobs relating to the energy transition.

The government wants to ensure affordability and shields consumers from increased energy costs. The government also supports the energy transition through subsidies, but not through carbon content-based energy taxation. Regulated end-user prices under the Universal Service Scheme act as a barrier to energy efficiency and market entry into Hungary's highly concentrated electricity and gas retail markets. In effect, most of the foreign investors have sold their businesses to Hungarian companies since the introduction of the Universal Service Scheme.

The National Energy Strategy 2030 calls for the review of the price regulation in support of Hungary's energy transition. Hungary should reform its regulation to include more options of flexible pricing (with night-day tariffs and special rebates by consumer preferences). This will engage consumers and improve the signals for investment in comprehensive energy efficiency improvements in the residential sector, notably gas boiler upgrades, the installation of heat pumps and renewable energy, such as roof-top solar PV

systems. The recovery funding offers a unique opportunity to support consumers' investment that can reduce energy costs. In turn, this will contribute to the financial health of utilities, support energy efficiency, and facilitate Hungary's ability to meet its energy and climate targets to which it is legally committed.

Recommendations

The government of Hungary should:

- Update the National Energy and Climate Plan and the national climate strategy to align with Hungary's net zero emissions target for 2050, supporting an increased EU emissions reductions target of -55% by 2030, with energy efficiency as a priority and stronger targets, policies and measures.
- Develop a clear policy road map with key milestones, responsibilities and monitoring mechanisms for the energy transition to reach net zero emissions, working with all stakeholders. Develop a comprehensive decarbonisation sector strategy for transport.
- Ensure that sufficient human and financial resources are committed to the clean energy transition, including as part of the sustainable recovery from the Covid pandemic, with an emphasis on a just, diverse and inclusive transition.

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3. Energy and climate change

Key data

GHG emissions without LULUCF* (2019): 64.4 Mt CO₂-eq, -32% since 1990

GHG emissions with LULUCF* (2019): 58.9 Mt CO₂-eq, -36% since 1990

GHG emissions targets (base year 1990): -20% by 2020, -40% by 2030, net zero in 2050

Non-ETS emissions: 44.6 Mt CO₂-eq, -2.6% since 2005

Non-ETS targets (with respect to 2005): 10% increase allowed in 2020, -7% by 2030

Energy-related CO₂ emissions from fuel combustion (2020):

Total CO₂ emissions: 43.8 Mt CO₂, -20% since 2005

CO₂ emissions by fuel: natural gas 43.5%, oil 38.9%, coal 15.0%, waste 2.6%

CO₂ emissions by sector: transport 28.0%, electricity 23.5%, industry 25.3%, buildings 23.2%

CO₂ intensity per GDP: 0.15 kg CO₂/USD (IEA average: 0.19 kg CO₂/USD)

CO₂ emissions per capita: 4.47 t CO₂ per capita (IEA average: 8.0 t CO₂ per capita)

* Land use, land-use change and forestry (source: UNFCCC: https://di.unfccc.int/time_series).

Overview

Hungary legislated its target for net zero GHG emissions by 2050 in its 2020 Climate Protection Law, alongside the ambition of reducing emissions by 40% from 1990 levels by 2030.

By 2019, total GHG emissions had already decreased by 32%. However, emissions levels have stabilised since 2017. For 2020, Hungary was able to remain below the allowed 10% increase for emissions outside the EU ETS, mostly due to the impact of the Covid-19 pandemic, not due to structural changes. Industry and transport sector activities and related oil use are growing, with transport becoming the largest emitter. After a strong decline in the 2000s, ETS sector emissions, accounting for one-third of the total, have been on the rise by 10% since 2014, driven by increased activity in the chemicals and metals sectors.

Electricity remains the second-largest emitter in Hungary. Thanks to the switch from coal to natural gas in power generation, emissions from coal combustion have halved since 2000. Today, 50% of CO₂ emissions from electricity generation stem from the last coal-fired power plant, Mátra. Work is underway to achieve a 90% of low-carbon electricity mix

by 2030. In 2021, Hungary became a member of the Powering Past Coal Alliance and pledged to phase out coal in power generation already by 2025, five years earlier than planned.

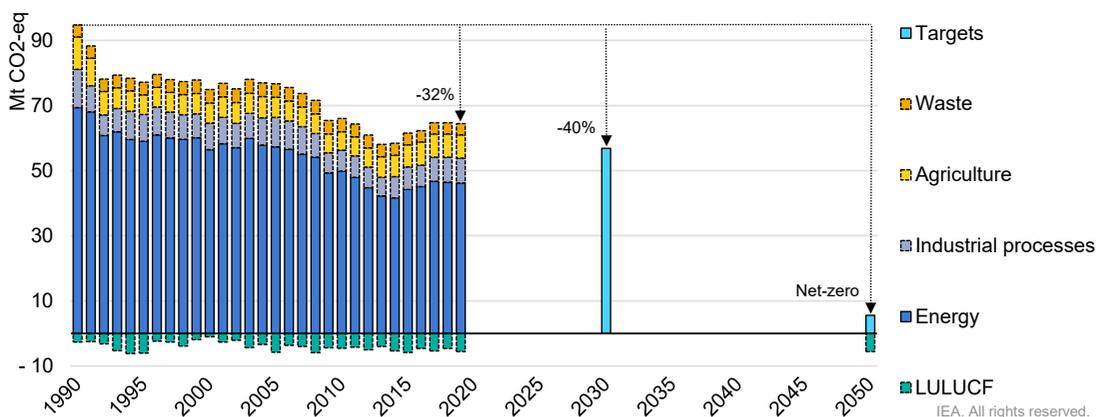
The EU Climate Law of 2021 requires a 55% emissions reduction by 2030 from 1990 levels across the EU. Hungary will therefore need to review its energy and climate targets for 2030 based on an evaluation of opportunities for early action, building on its long-term strategy.

Emissions trends

Between 2000 and 2019, Hungary's total GHG emissions excluding land use, land-use change and forestry (LULUCF) declined by 14%, from 74.9 Mt CO₂-eq to 64.4 Mt CO₂-eq. GHG emissions saw a rebound from the lowest point of 58 Mt CO₂-eq in 2013 and a stabilisation since 2017 (Figure 3.1). In 2019, the energy sector accounted for 72% of total GHG emissions.

Overall, emissions removals from LULUCF increased fivefold between 2000 and 2019, from 1 Mt CO₂-eq to 5.5 Mt CO₂-eq, thanks to the growing stock in forests and other wood lands and a slow rate of land use, which would have converted agricultural, forest and other semi-natural land into urban and other artificial surfaces (UNECE and FAO, 2021; EEA, 2021a).

Figure 3.1 Greenhouse gas emissions by sector in Hungary, 1990-2019 and targets



Overall GHG emissions in Hungary decreased by 32% between 1990 and 2019. However, the trend has been reversed since 2015, driven by increasing emissions in transport.

Notes: LULUCF = land use, land-use change and forestry. Dashed contours identify emissions outside the energy sector

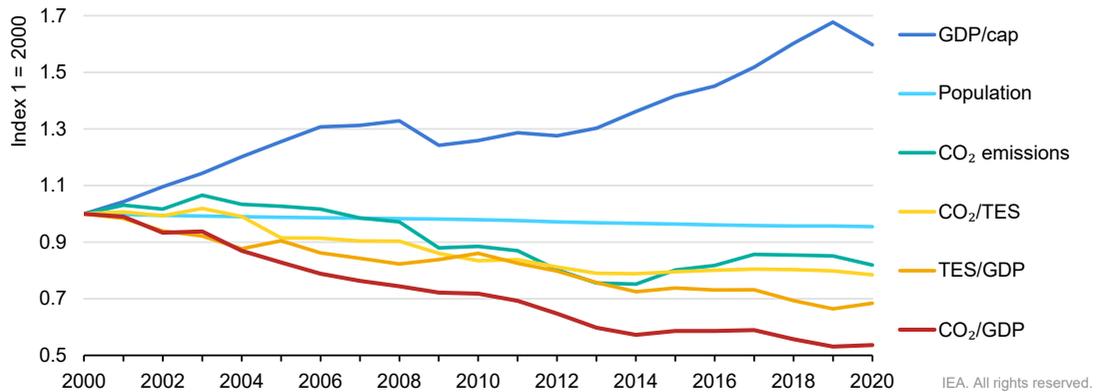
Source: UNFCCC (2021).

Energy-related CO₂ emissions

In 2019, energy-related CO₂ emissions were 46.2 Mt CO₂. Emissions and economic growth are decoupled in Hungary: while GDP per capita has on average increased significantly since 2000, emissions have mostly declined, despite the strong expansion of the economy between 2014 and 2017, which drove emissions up temporarily (Figure 3.2).

In 2020, total energy-related CO₂ emissions decreased by 5% to 43.8 Mt CO₂ in the wake of the Covid-19 pandemic and lower energy supply. In the same year, the main emitting sectors were transport (28%) and electricity and heat generation (24%), followed by industry (25%) and buildings (23%) (Figure 3.3).

Figure 3.2 Energy-related emission drivers and indicators in Hungary, 2000-2020

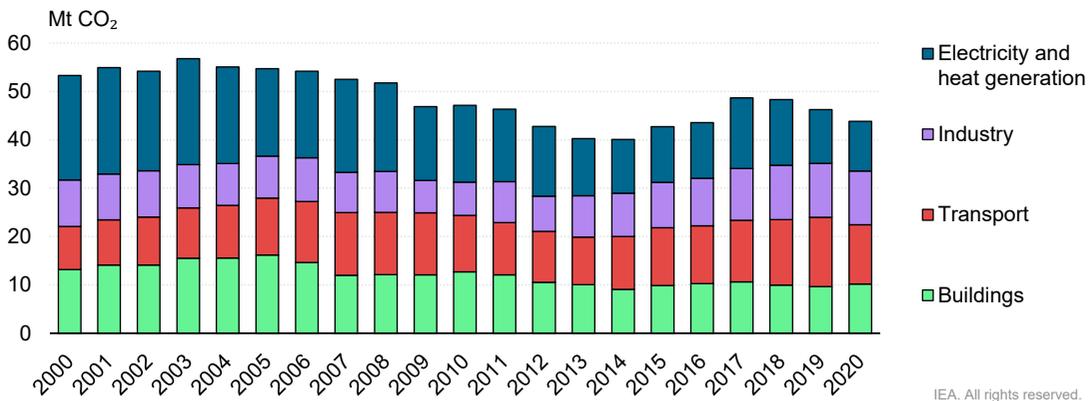


Oil is the largest source of CO₂ emissions. Its share has increased since 2013 with growing energy demand in the transport sector. Meanwhile, emissions from coal have decreased since 2000.

Notes: GDP = gross domestic product; TES = total energy supply.

Source: IEA (2022).

Figure 3.3 Energy-related CO₂ emissions by sector in Hungary, 2000-2020



After decreasing between 2003 and 2014, CO₂ emissions rebounded from 2014 to 2017. In 2020, CO₂ emissions decreased by 5% due to the Covid-19 pandemic.

Source: IEA (2022).

Within the energy sector, between 2010 and 2019, transport emissions grew by 23%, due to higher oil consumption driven by increasing transport demand from freight and passenger cars.

In 2020, emissions from the transport sector dropped by 14% year-on-year, due to the restrictions caused by the Covid-19 pandemic, and reached 12 Mt CO₂. In 2020, the transport sector was the largest emitting sector in Hungary. Emissions from road transport were the largest contributor in the transport sector, and experienced a 46% increase in the six years to 2019, and further growth is expected in the coming years. In terms of vehicle type, passenger cars were responsible for 52% of the transport energy consumption (with many second-hand cars), while road freight accounted for 40% and buses for 5%. From 2012 to 2021, the number of registered electric vehicles (EVs) grew from just 107 to almost 12 000, but this still represents only 0.5% of the total passenger car fleet, compared to the EU average of 0.9% (see Chapter 4).

Emissions from electricity and heat generation (10 Mt CO₂ in 2020) have decreased by 35% since 2010, thanks to a reduction in the use of fossil fuels. The Covid-19 pandemic has also likely contributed to the 5% year-on-year drop in 2020. Electricity sector emissions remain important, despite their decreasing trends.

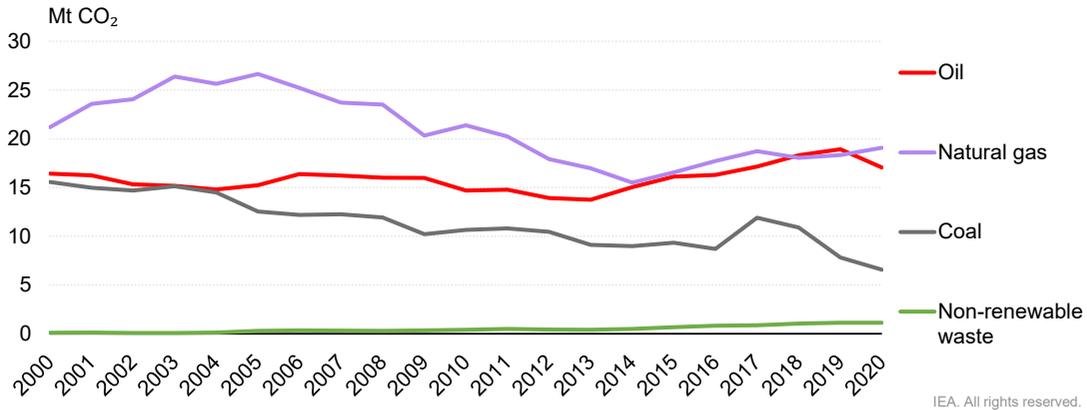
CO₂ emissions from coal combustion have significantly fallen by 58% since 2000, thanks to the expansion of nuclear and renewable power generation and the decreasing coal demand in the electricity sector, as coal was replaced by gas-fired power plants. However, the more than 50-year-old Mátra coal-fired power plant was still responsible for nearly half of total energy sector CO₂ emissions and 14% of total CO₂ emissions in 2019. It generated around 15% of Hungary's domestic electricity production. Solid biomass-based power generation accounted for nearly 43% of Hungary's renewable electricity generation in 2020, mainly due to large-scale biomass co-firing in the Mátra plant.

The industry sector generated 11 Mt CO₂ in 2020. Emissions from industry reached their lowest level in 2009 then increased by 61% thereafter until 2019, due to increasing use of oil and gas and increased activity in the chemicals and metals sectors. The Covid-19 pandemic did not have a major impact on emissions from industry, as these were stable from 2019 to 2020 (see Chapters 2 and 4).

CO₂ emissions from buildings decreased by 20% between 2010 and 2020, when they reached 10 Mt CO₂, reflecting the switch to natural gas and efficient district heating in new buildings. The buildings sector was the only sector with increasing emissions (by 5%) during Covid-19 lockdown in 2020.

Natural gas used to be the largest source of carbon emissions in Hungary, but it was overtaken by oil in 2018 (Figure 3.4) before bouncing back again to the top in 2020. Emissions from gas declined between 2005 and 2014, when they rebounded until 2017, in line with the increasing output from natural gas-fired power plants and the growing demand from buildings and industry.

Oil emissions fluctuated until 2013, when they started increasing at a rapid pace, with an average annual growth of 6% between 2013 and 2019. In 2020, emissions from oil dropped due to the transport restrictions caused by the Covid-19 pandemic, but they are expected to rebound to 2019 levels already in 2021, as most of the restrictions have been lifted.

Figure 3.4 Energy-related CO₂ emissions by energy source in Hungary, 2000-2020

Natural gas has overtaken oil as largest source of CO₂ emissions, while coal emissions are decreasing.

Source: IEA (2022).

Climate targets

As an EU member state, Hungary's climate policy is guided by the framework of EU climate policies: the 2020 Climate Package, the 2030 Climate Framework, the Clean Energy Package and the Fit for 55 package.

EU member states are jointly committed to reducing EU-wide GHG emissions by 20% below 2005 levels by 2020 and by at least 55% by 2030 compared to 1990 levels under the EU Climate Law, adopted in 2021.

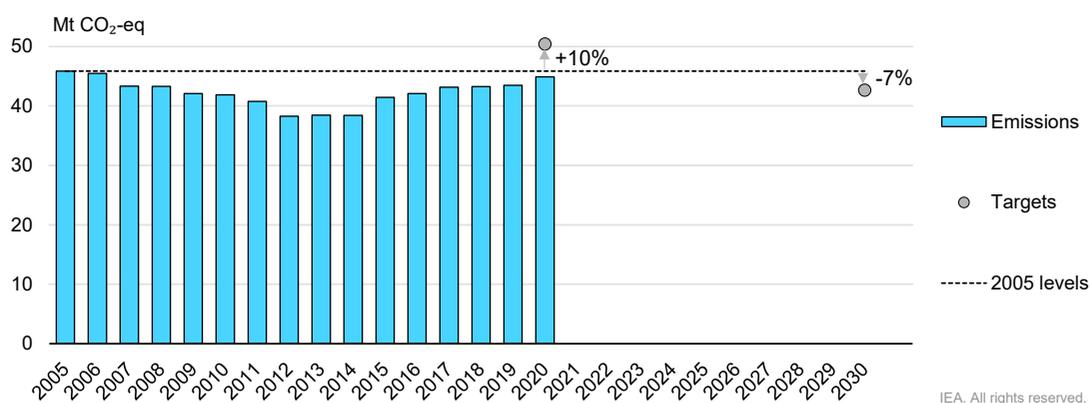
Emissions from large power plants, energy-intensive industrial facilities and civil aviation are regulated under the EU ETS, whereas non-ETS emissions are subject to the Effort Sharing Decision until 2020 and the Effort Sharing Regulation until 2030. In 2019, 69% of Hungary's GHG emissions were from non-ETS sources, with the largest shares from transport (32%) and buildings (27%).

After a strong decline in the 2000s, ETS sector emissions, accounting for one-third of Hungary's emissions, have been on the rise since 2014 (+16%), driven by increased industry activity in chemicals and metals. These trends suggest that the ETS has not been able to revert emissions trends up to 2019. With rising EU ETS prices, it remains to be seen how the industry sector will adjust.

The EU-level reduction targets for GHG emissions in the non-ETS sectors are translated into binding targets for each member country. Hungary's target under the Effort Sharing Decision is to limit its emissions growth to 10% above the 2005 level by 2020 (Figure 3.5).

In 2018, Hungary's non-ETS emissions were 2% lower than in 2005, implying that the country has overachieved its 2020 target. Hungary's NECP sets a target to reduce non-ETS GHG emissions by 7% by 2030 compared to 2005 levels. Based on existing measures, Hungary is expected to be on track for its 2030 target. It would even overachieve it with the adoption of new measures identified in its NECP.

Figure 3.5 Hungary's non-ETS emissions from 2005 and progress to 2020 and 2030 targets



Hungary's non-ETS emissions have decreased by 2% since 2005, remaining below the allowed cap of a 10% increase. If this trend continues, Hungary will be on track to the required 7% reduction by 2030.

Notes: ETS = Emissions Trading System. ESD = Effort Sharing Decision.

Source: EEA (2021b).

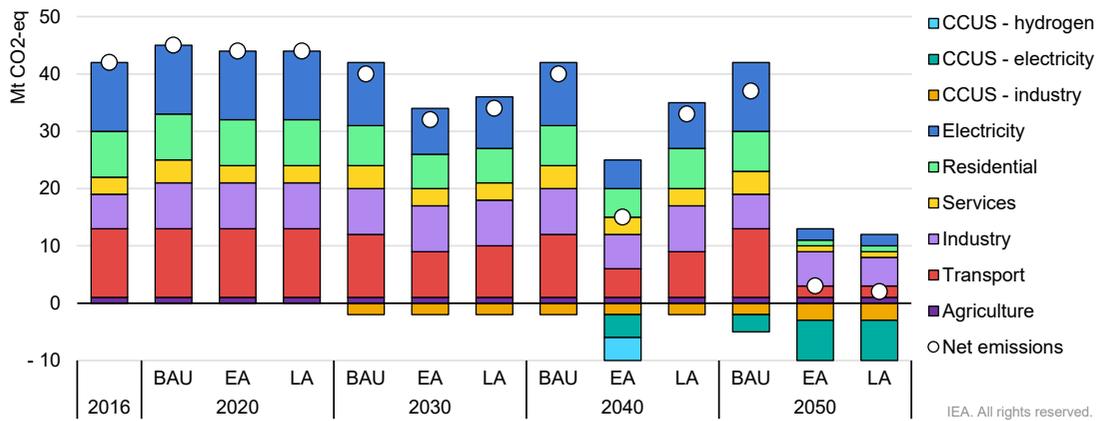
Hungary's pathway to net zero by 2050

In May 2021, Hungary adopted its long-term low GHG emissions development strategy, the so-called NCDS under Article 4.19 of the Paris Agreement. The NCDS presented pathways towards climate neutrality in 2050 under three different scenarios (see Chapter 2). Beyond the business-as-usual scenario, the NCDS modelled two key scenarios for net zero emissions in 2050: an early action scenario and a late action scenario. The value of avoided costs and added benefits were found to exceed investment costs under both scenarios, with the early action scenario delivering the best benefit-cost ratio (Hungary, 2021).

The net zero pathways underline the need for addressing electricity, transport and buildings sector emissions as a priority. Transport and industry emissions have been growing in Hungary. Almost half of its electricity production comes from nuclear energy, but the other half comes from fossil fuels, despite recent additions from solar PV. With the planned construction of new nuclear capacity and the retirement of old nuclear plants, this ratio is expected to be maintained up to 2025. Natural gas is the second-largest energy source in electricity generation, accounting for 26% of electricity production in 2020.

The government had originally planned to phase out coal-fired electricity generation by 2030, by replacing its last coal-fired generator, the Mátra Power Plant, with renewables and gas-fired generation at the same site. In 2021, at the meeting of the Powering Past Coal Alliance, the Secretary of State for the Development of Circular Economy, Energy and Climate Policy announced that Hungary would bring forward its coal phase-out plan by five years, from 2030 to 2025.

CCUS plays a significant role in Hungary's decarbonisation plans under its NCDS around 2040. Using CCUS on natural gas-based hydrogen production is an option considered for the early action scenario in 2040. The NCDS considers CCUS to contribute to substantial negative emissions in electricity and industry only in 2050.

Figure 3.6 Net zero pathways under Hungary's National Clean Development Strategy

The Hungarian net zero strategy draws on three scenarios: business-as-usual, early action and late action. CCUS provides important shares of emissions reductions in all scenarios.

Notes: BAU = business as usual, EA = early action, LA = late action.

Source: Hungary (2021).

To achieve net zero, Hungary plans to use natural sink capacities to balance out the remaining emissions in 2050. In the early action and late action scenarios, about 4.5 Mt CO₂ annually will be absorbed naturally, mainly due to the increasing forest coverage (Hungary, 2021). However, for this to happen, active reforestation activities beyond the current level of ambition are needed. In their absence, as modelled under the business-as-usual scenario, forests could become net emission emitters, albeit at small quantities of around 140 000-145 000 t CO₂ annually. Investment in forest management and sustainability of biomass use will be important if Hungary's energy system continues to rely on biomass.

Climate strategies and policies

In June 2020, Hungary adopted the Climate Protection Law (Law No. XLIV). It renders the 2030 emissions reductions, energy efficiency and renewable energy targets legally binding alongside Hungary's 2050 net zero emissions goal. Under the law, Hungary is legally committed to reducing GHG emissions by 40% in 2030 compared to the 1990 level. The law also requires that after 2030, in the event of an increase in FEC above 2005 levels, the increased consumption will be supplied exclusively from carbon-neutral energy sources and that renewable sources account for at least 21% of gross FEC in 2030.

Hungary has an overarching NECP, adopted in 2020, which sets out the actions to achieve the National Energy Strategy up to 2030 with an outlook up to 2040 (see Chapter 2 and Hungary, 2020). The key strategic goals of Hungary's energy policy evolve around energy independence, energy security and the decarbonisation of energy production.

Climate policies are set out in different strategies and action plans, focusing on the environmental dimensions. The NECP integrated and aligned several existing strategies.

Hungary's overarching second National Climate Change Strategy (NCCS-II) for the period 2018-2030 (with an outlook until 2050) sets out the existing policies and planned policy options for each sector. It follows a triple thematic structure: it devotes separate sub-programmes to the reduction of GHG emissions, adaptation to the harmful effects of climate change and awareness raising. Those are to be translated into specific measures in the national climate change action plans (NCCAPs) that are developed every three years. The first NCCAP was adopted in January 2020 and the second is under consideration by the government.

In addition, in January 2020, the government adopted a report on the impact of climate change in the Carpathian Basin, which presents the scientific results of research, thus contributing to better identifying future courses of action.

Adopted in February 2020, the Climate and Environmental Protection Action Plan sets out specific measures in eight action points to meet the climate and energy policy goals, to preserve our natural resources and ensure that future generations inherit the country in a liveable state. Energy sector actions include recycling and support of environmentally friendly technology use and renewable energy production by small and medium-sized enterprises (SMEs) transforming the Mátra Power Plant into an environmentally friendly facility through just transition, a sixfold increase in the capacity of solar power plants within ten years, support for the wider availability and use of affordable electric cars, and the introduction of green government bonds.

In 2021, the government also adopted the NCDS, the long-term climate strategy which sets the pathway to reaching the climate neutrality goal by 2050. The NCDS analyses three main scenarios for GHG emissions reductions.

The energy sector is also a central feature in the country's national environment programmes that cover six-year periods. The fifth National Environment Programme for the period 2021-26 will be submitted shortly to the Hungarian parliament for approval. Among its strategic areas are improving energy conservation and resource efficiency and increasing the use of renewable energies. Measures to achieve these goals include:

- developing legal and economic regulations and the financing system to encourage energy efficiency improvements and the use of renewable energy
- modernising heating, cooling and lighting systems in buildings and improving building insulation
- encouraging decentralised, local renewable energy production and use
- enforcing sustainability criteria for the production and use of biomass for energy purposes
- increased and effective control of thermal water extraction and the sustainable disposal of used thermal water
- avoiding or minimising the impacts on the natural landscape during the use of wind energy.

Hungary has a range of policies and measures for climate mitigation. This report will discuss the new measures, such as the Energy Efficiency Obligation Scheme, mandatory energy audits for large energy-intensive companies, support for renewable generation (primarily solar PV) under the METÁR tenders, building renovation programmes, funding for the decarbonisation of district heating, support for hydrogen, financial support for industry and households to transition away from coal use, and financial incentives for the use of biofuels and the purchase of EVs to decarbonise transport.

Adaptation

Hungary's annual average temperature has been increasing faster than the global average. Climate change will affect agriculture, energy, human health, water, forest management, and biodiversity in Hungary. The government presented a report on the scientific assessment of the possible effects of climate change on the Carpathian Basin. The report provides detailed, scientifically verified information on the effects of climate change on the Carpathian Basin in each sector, and identifies key responses and directions for further measures.

Hungary's National Adaptation Strategy forms part of its second National Climate Change Strategy of 2018. The second National Climate Change Strategy assesses the potential effects of climate change on Hungary. It covers the period to 2030 and includes an outlook to 2050. It includes measures and gives direction for climate change mitigation and adaptation that are being translated into specific measures in the NCCAP.

The first NCCAP includes a National Adaptation Programme. The main priority areas for adaptation are: energy infrastructure, human health, water management, disaster management and security policy, agriculture and rural development, nature protection, forestry, and tourism.

As regards energy infrastructure, it includes measures to strengthen the resilience of the electricity transmission and distribution systems during extreme weather events to ensure security of supply. It also addresses the need to make the electricity system more flexible to accommodate an increasing share of variable renewables and to be prepared for the planned electrification of the economy, which will result in growth in electricity demand.

The draft of the second NCCAP proposes undertaking an "assessment of the climatic and geological vulnerability of critical energy infrastructure elements in the electricity, gas and heating sector". The key objective is to explore the effects of climate change on the energy supply system, assess the system components' vulnerabilities and the adaptability of the system. The findings of the assessment will be published in the National Adaptation Geo-Information System that is designed to inform policy makers, energy service providers and infrastructure operators.

Assessment

Since 1990, Hungary's greenhouse gas emissions excluding land use, land-use change and forestry have decreased by 34% (in 2020), largely on track to the targeted 40% reduction by 2030. The increase in emissions in transport, industry (and agriculture sectors) was compensated by a decrease from energy use, the power sector and fluorinated gases.

Energy-related emissions represent the largest share of Hungary's GHG emissions, accounting for 71% of total emissions in 2020 (44.4 Mt CO₂-eq), with transport being the largest emitter followed by industry, power generation and buildings. These sectors that are not covered by the EU ETS are responsible for almost 70% of Hungary's emissions. Hungary's 2020 target for those sectors was to limit growth in emissions to 10% above 2005 levels. Hungary has overachieved on this target, with non-ETS emissions currently around 2% lower than 2005 levels. For Hungary to remain on track to achieve its 2030 target with a 7% reduction in emissions, structural changes are critical to address rising

emissions linked to increased activity in road transport and industry sectors and rising emissions from increased oil and gas use.

Hungary has committed to achieve climate neutrality by 2050 and reduce emissions by at least 40% by 2030 compared to 1990 levels. Both Hungary's 2030 and 2050 targets were legislated in 2020 through the Climate Protection Law.

The EU Climate Law legislates a more stringent EU target of a 55% reduction on 1990 levels by 2030 for the entire EU-27. Hungary intends to consider the adoption of a more ambitious 2030 target following the EU's legislative process. Early planning on increased ambitions would help the government manage the delivery of a more ambitious target coming online in the mid-2020s, which otherwise would leave only five years to deliver the required emission reductions.

The National Clean Development Strategy 2020-2050 shows that non-EU ETS sector emissions in 2030 would need to fall by 18% compared to 2005 levels to meet Hungary's current economy-wide 2030 emissions reduction target. Increasing its non-EU ETS target to 18%, from the 7% stipulated in the Effort Sharing Regulation, would therefore be consistent with the pathways set out in the NCDS and with the more ambitious EU-wide target. Such an increased target for non-ETS sectors will also require updating the policies and measures necessary for achieving such a target.

The next iteration of Hungary's NECP is an opportunity to update those actions. Several options for more ambitious actions by 2030 could be examined, notably:

- reinforcing energy efficiency measures
- accelerating renewable energy deployment (in light of possible delays in the nuclear programme)
- considering early coal phase-out in power generation
- promoting early action on low-emission hydrogen and CCUS already in the 2030s
- strengthening of carbon price signals in non-ETS sectors.

Hungary has legislated an energy efficiency target under which final energy consumption in 2030 should not exceed 2005 levels (785 PJ). Ambitious boiler and appliance replacement programmes can bring cost-effective energy savings in the short to medium term (see Chapter 4).

Another opportunity for higher ambitions by 2030 would be the early phase-out of coal use in power generation, five years ahead of the stated 2030 timeline, as announced by the State Secretary at the Powering Past Coal Alliance. Plans to advance the goal by five years can be cost-effective, as the site can be repurposed given it has all the permits and is connected to the grid. The government should review all technology options, including renewables, electrolysers and battery storage. To avoid a carbon lock-in that could slow the decarbonisation of the economy, as noted in Hungary's NCDS, any new gas-fired plant needs to be hydrogen-ready, or capture-ready. An early phase-out will require a financial and social commitment to the just transition in Hungary's mining sector (see Chapter 2) and the acceleration of renewable energy and/or nuclear development.

A possible gap that may arise from the potential delays in the country's nuclear programme may require a strong backup plan. Hungary may need to accelerate renewable energy, above the targeted minimum of 21% of gross final energy consumption by 2030. Hungary

may need to revise upwards its plans for increasing the share of renewables by 2030 and reverse the current halt in windncrea capacity by lifting administrative and financial barriers for new wind generation.

The IEA's last in-depth review in 2017 of Hungary's climate policies noted that carbon pricing in non-EU ETS sectors would be one policy option open to Hungary. This is now also under discussion at the EU level with the Fit for 55 package.

Hungary has seen slow progress in reducing emissions in the transport and heating sectors, which are outside of the EU ETS and rely increasingly on fossil fuels. Contrary to the decarbonisation targets, oil as a final energy source gained ground – from 6.5 Mtoe in 2015 to 7.5 Mtoe in 2020 (+15%). In the period 2015-2019, transport sector demand increased by 20%, especially due to the growing number of passenger cars and increased transport of goods. Though economic growth is important for the convergence of the Hungarian economy in the direction of the average EU level, growth of CO₂ emissions in the transport sector needs a dedicated strategy within the Hungarian decarbonisation strategies and programmes.

Existing policies targeted at electrification and biofuels will help to address transport sector emissions. However, significant challenges remain for the decarbonisation of the sector, including in relation to managing emissions from second-hand vehicles sourced from other parts of Europe. Increasing support for electric vehicle charging infrastructure could help to accelerate the low emissions transition of the transport sector. Additional policies could also focus on the heavy road freight sector, including in partnership with neighbouring countries. Hungary plans to roll out significant zero-emission freight and public transport capacities using hydrogen fuel.

Reducing emissions in the industrial sector will be challenging, especially in cement and metal manufacturing. Energy efficiency upgrades and electrification represent opportunities, as do fuel switching to hydrogen and CCUS. The incentives provided under the current high EU ETS prices may become a more crucial driver for the decarbonisation of Hungary's industrial sector, improving the business case for CCUS and hydrogen technologies.

Further work is needed to understand the storage capacity and the potential role of deep saline formations in the case of CCUS. Hungary's climate strategies should include further details on how CCUS will act as a negative emissions technology in the industrial sector (as envisaged in its NCDS) and how the technology could be deployed in the coming decade.

Moving to a carbon budget approach to account for national emissions reduction targets, consistent with the EU, United Kingdom and other IEA member countries, would allow Hungary to manage its cumulative emissions reductions, as opposed to focusing on achieving an outcome in a single target year. A carbon budget describes the maximum amount of CO₂-eq that can be released to meet a country's emissions target, or that can be released globally to meet a specific warming outcome. Cumulative emissions determine warming outcomes, which means tracking progress against a carbon budget is more aligned with achieving the temperature goals of the Paris Agreement.

Careful monitoring of progress will be needed under Hungary's sector-specific targeted policy approach to ensure energy and climate outcomes are consistent with Hungary's goals. Today, EU countries are required to develop scenarios with existing and with

additional measures and submit them to the European Environment Agency every two years. The government should implement a centrally co-ordinated approach for tracking and reporting on progress towards all Hungary's energy and climate goals. Such a forecast would allow any shortfalls to be identified early on and corrected with adjustments to the existing suite of policies. Hungary could make use of the NECP to allow for consistent tracking over time.

As the EU emissions targets now include LULUCF, this area deserves more attention. Hungary's NCDS considers the LULUCF sector to remain a sink by 2030; however, its CO₂ absorption capacity is expected to decline and the sector could become a net emitter in the longer term. Natural sink capacities will need to be expanded to successfully balance remaining emissions with increased forest management. Careful use of biomass will be needed to ensure the LULUCF sector can support Hungary's climate and energy plans to 2030 and 2050. Consideration should be given to biodiversity, soil degradation and public health issues associated with continued use of biomass.

Hungary has examined the adaptation challenges it will face, notably in the Carpathian Basin. The National Adaptation Strategy and its implementing second Climate Change Action Plan, under preparation, calls for an assessment of the resilience of the energy system against climate impacts and adaptation needs to higher temperatures affecting water- and air-cooling systems for power stations, and increased flood and forest fire events. Co-operation with neighbouring countries both on mitigation efforts and on adaptation, including flood prevention, will be important going forward. Continued and expanded integration of energy and adaptation policies will be needed.

Article 12 of the Paris Agreement calls for fostering public awareness of climate change and for public participation in measures to address climate change. Hungary has undertaken public consultation processes on key climate strategies. Continuing and expanded public engagement will be important given the scale of change needed under Hungary's climate objectives, and given the role workers and communities will need to play in the transition.

Recommendations

The government of Hungary should:

- Strengthen the 2030 greenhouse gas and related non-ETS sector emissions targets, taking into account emissions trends and stronger climate ambitions of the EU Climate Law and adopt the required additional policies and measures to achieve higher targets.
- Track consistently the achievement of climate targets by considering a carbon budget approach. Forecast emissions with and without additional measures to identify gaps.
- Develop a comprehensive package of policies to reduce greenhouse gas and health-related emissions from the transport sector, including by strengthening carbon pricing.
- Accelerate the full integration of adaptation challenges into energy policy development and energy infrastructure resilience planning.

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4. Energy efficiency

Key data (2020)

TFC: 19.9 Mtoe (oil 35.3%, natural gas 31.4%, electricity 17.3%, bioenergy and waste 9.8%, district heat 5.0%, coal 0.8%, geothermal 0.3%, solar 0.1%), +6.1% from 2010 to 2019, -1.2% from 2019 to 2020

TFC by sector: buildings 40.0%, industry 37.7%, transport 22.3%

TFC per capita: 2.04 toe/capita (IEA average in 2019: 2.90 toe/capita), +7.6% since 2010

TFC per GDP: 68 toe/USD million (IEA average in 2019: 65 toe/USD million), -15.5% since 2010

Hungary 2020 targets: primary energy consumption: 26.5 Mtoe (2020:* 23.9 Mtoe); final energy consumption: 18.2 Mtoe (2020:* 18.0 Mtoe)

Hungary 2030 target: final energy consumption: 18.8 Mtoe

* Source: Eurostat (2021).

Overview

Under Hungary's NCDS, energy efficiency needs to increase strongly, if limiting final energy consumption to around 734 PJ by 2030, or if assuming early action on energy efficiency, and ultimately to 500 PJ¹ by 2050. However, Hungary's NECP of 2021 has less ambitious energy efficiency targets for 2030, capping the country's final energy consumption to 785 PJ, which is the 2005 level (Figure 4.1).

In 2020, Hungary's consumption stood at 18 Mtoe, or 753 PJ. The impact of the Covid-19 pandemic allowed Hungary to achieve its 2020 targets, which aimed for FEC below 18.2 Mtoe in 2020. Prior to the crisis, Hungary's FEC² was 18.6 Mtoe (779 PJ) in 2019 and had seen an increasing trend from 2009. Further measures enhancing energy efficiency to achieve long-lasting structural changes will be necessary not only to achieve the 2030 target, but also to align with ambitious pathways towards climate neutrality by 2050.

¹ The long-term strategy targets for 2050 a final energy consumption of 538 PJ and 484 PJ by 2050 under the early action and late action scenarios, respectively.

² FEC is defined by Eurostat and differs from the IEA's TFC, as TFC also includes "non-energy use" of fuels (e.g. refinery feedstocks), while FEC does not include these.

The main tools for increasing efficiency include building renovation, more efficient appliances, fuel switching to low-carbon fuels and electrification, with the largest savings potential to come from the residential sector, which is responsible for the largest share in final consumption. Residential sector demand is driven by natural gas and biomass and an increase in consumption of electric appliances. Industry and transport have seen important increases in energy consumption and rely to a large extent on oil consumption.

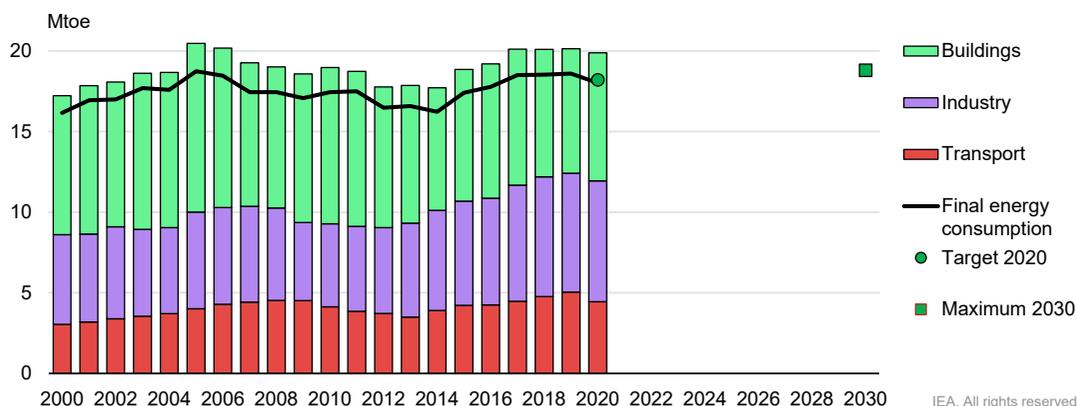
Consumption and energy-saving trends

According to IEA data, in 2020, Hungary's TFC was 20 Mtoe. Energy demand in Hungary slightly decreased from 2011 to 2013, rebounded until 2017, then plateaued from 2017 to 2020 at 20 Mtoe.

Hungary has largely decoupled economic growth and energy consumption. Between 2010 and 2019, GDP increased by 30% while TFC rose only by 6%. Consequently, the TFC/GDP ratio, which measures the energy intensity of the economy, decreased by 19% in the same decade.

Buildings account for the largest proportion of TFC. Building's energy consumption has decreased gradually since 2005 to cover 40% of TFC in 2019. The industry and transport sectors have steadily increased their energy consumption in recent years. In 2020 they accounted for 38% and 22% of TFC, respectively.

Figure 4.1 Total final consumption by sector in Hungary, 2000-2020 and targets



In 2019, final energy consumption was above the target for 2020, but Covid-19 impacts allowed Hungary to achieve the 2020 target. For 2030, the target is to maintain final consumption at 2005 levels.

Notes: Total final consumption by sector (IEA definition) also includes non-energy consumption in all sectors, and is thus higher than the EU's final energy consumption. The targets are defined according to the EU's final energy consumption. Industry includes agriculture.

Sources: IEA (2022); Eurostat (2021); Hungary (2020).

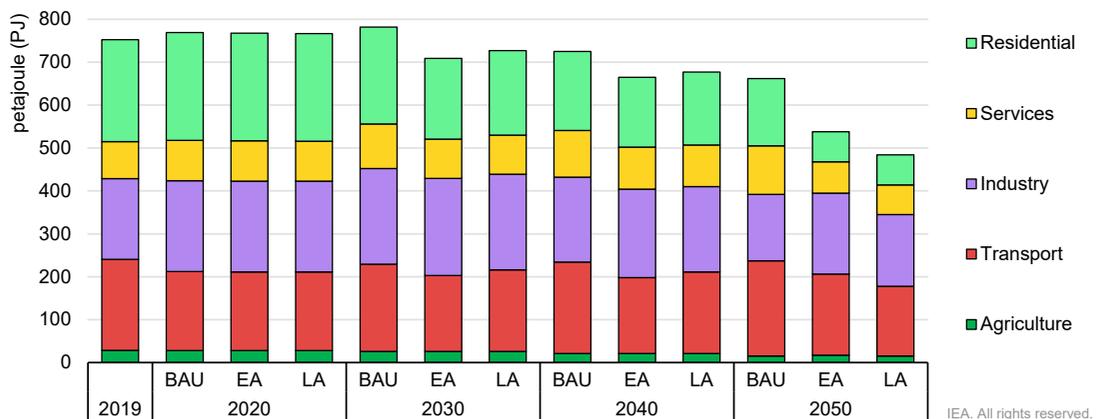
Energy efficiency targets

Under its Climate Protection Law, Hungary has set a goal to achieve climate neutrality by 2050. Energy efficiency will play a significant role in achieving near-term emissions reductions across the economy. The NCDS projects FEC by sector under three scenarios to reach carbon neutrality by 2050 (Figure 4.2): business-as-usual, early action and late action.

The early action scenario considers that Hungary's FEC in 2030 would reach a maximum of 734 PJ, with renewable energy penetration reaching 27%. The late action scenario assumes that, in line with the targets set in the Climate Protection Law, FEC could reach a maximum of 785 PJ in 2030, with the share of renewable energy increasing to at least 21%.

The residential sector has the highest potential to reduce consumption and fossil fuel use. The industry sector would see further growth during the 2030s; efficiency progress would be lower, but thanks to new technologies, industry demand would decline under both the late and early action scenarios after 2040. The transport and service sectors follow a similar trajectory with a gradual decrease until 2050. Thanks to efficiency, both sectors would see a demand reduction of 10-20% by 2050, compared to 2016.

Figure 4.2 Final energy consumption by sector under three scenarios in Hungary, 2019-2050



The residential sector is expected to cover the largest share of the energy savings in Hungarian energy projections up to 2050.

Notes: BAU = business as usual, EA = early action, LA = late action.

Source: Hungary (2021).

As a member of the EU, Hungary's energy efficiency policy up to 2020 was set in the national energy efficiency action plans that were superseded by the NECP. The NECP sets out the goals, targets and policies for 2030.

The Energy Efficiency Act of 2015³ transposed EU directives into Hungarian law, and states that Hungary must comply with energy savings obligations and contribute to the EU energy efficiency goal with indicative targets on primary and final energy consumption for 2020 and 2030.

For 2020, Hungary met its primary energy consumption (PEC) target of 1 110 PJ. PEC was 1 000 PJ in 2020, as demand in 2020 was negatively impacted by the Covid-19 crisis, especially in the transport sector. In 2019, Hungary's FEC was 779 PJ, compared to a target of 761 PJ for 2020. The target for 2020 was met, thanks to the economic downturn due to the Covid-19 crisis.

For 2030, Hungary is committed to not exceed a FEC of 785 PJ, the level of 2005. Hungary will allow higher consumption if the additional consumption above the 2005 levels comes from carbon-free energy, including nuclear electricity or hydrogen produced from nuclear energy (Table 4.1).

Table 4.1 Hungary's energy savings targets and 2019 and 2020 status

	2019	2020	2020 target	2030 target
Primary energy consumption	24.6 Mtoe 1 029 PJ	23.9 Mtoe 1 000 PJ	26.5 Mtoe 1 110 PJ	
Final energy consumption	18.6 Mtoe 779 PJ	18.0 Mtoe 754 PJ	18.2 Mtoe 761 PJ	18.8 Mtoe 785 PJ

Sources: Eurostat (for 2019 data); Hungary (2020) (for 2020 and 2030 targets).

Policies and measures across the economy

Hungary may face difficulties in meeting its cumulative energy savings targets of 167.5 PJ under Article 7 of the Energy Efficiency Directive (EED) for the period 2014-2020.

For the period 2021-30, Article 7 of the EED requires annual energy savings of 0.8%, compared to the average annual consumption of the base years 2016, 2017 and 2018. This corresponds to a cumulative energy savings target of 337 PJ.

In 2021, the government introduced an Energy Efficiency Obligation Scheme (EEOS) to encourage residential and corporate energy efficiency investments through a new market-based policy, and help the country meet the cumulative energy savings target for 2021-30 under the EED. Hungary obliges energy savings from energy providers, which should achieve savings in terms of energy sold. The EEOS applies to providers of electricity, natural gas and transport fuels. Energy consumers can implement energy-saving projects and apply for verification. Once their savings are verified, they can sell the certificate to the energy providers, who account these savings under their obligation. The Hungarian Energy and Public Utility Regulatory Authority (HEA) is tasked with the verification and monitoring of the scheme.

Under the EEOS, energy providers are obliged to either achieve an increasing level of yearly energy savings, defined as a percentage of the total amount of final energy sold by the company, or pay an energy efficiency contribution, covering part or all of the obligation.

³ <https://nit.hu/jogszabaly/2015-57-00-00>

Under the EEOS, new savings of 0.8% of annual final energy consumption shall be achieved on average over the last three years preceding 1 January 2019. In total, the scheme is projected to deliver 20 PJ of final energy savings by 2030.

The percentage of mandatory yearly savings starts at 0.05% of energy sold to end users in 2021, and increases yearly to reach 0.5% in the 2024-27 period. Energy providers can buy energy certificates from energy consumers to achieve their energy savings target, or pay HUF 50 000 (EUR 137) for each unfulfilled gigajoule (GJ) per year. The HEA can impose a fine of HUF 70 000 (EUR 191) for each unfulfilled GJ per year to companies found to be non-compliant. As in other countries, the fine is negligible for a company, and in many cases, it is cheaper to pay a fine than invest in energy efficiency measures to fulfil the obligations. Revenues from the payment of energy efficiency contributions and fines are used to finance policy measures to improve the energy efficiency of eligible households and combat energy poverty.

The EEOS legal framework is designed to allow for the creation of a secondary market for verified energy savings. The projects generating energy savings can be implemented by companies operating in any sector, and sold to the obliged entities. The government expects 50% of the savings to come from industry and 40% from the residential sector.

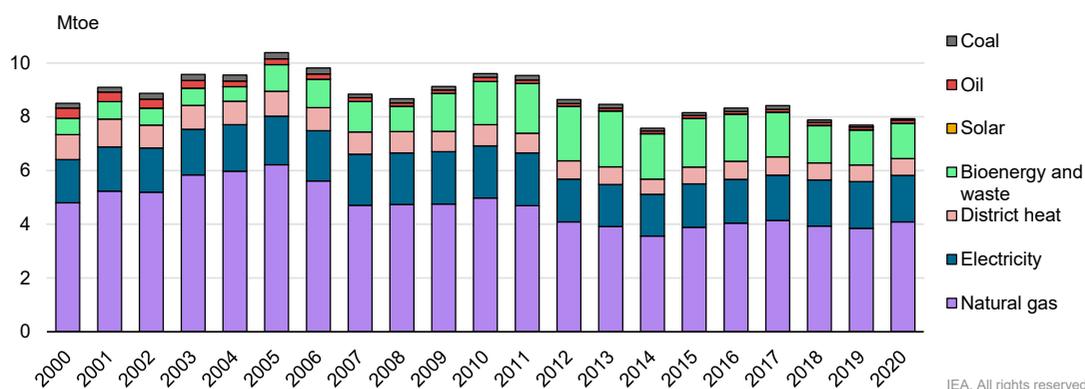
Across the economy, Hungary has awareness-raising programmes using the National Network of Energy Experts and employing energy experts in energy-intensive businesses. The government also supports energy efficiency through tax relief measures and direct investment support (under the Environmental and Energy Efficiency OP [KEHOP+]) as well as EU funding from operational programmes (Economic Development and Innovation OP [GINOP+], Territorial and Settlement Development OP [TOP+]), and the EU Recovery and Resilience Facility alongside local government support programmes (Modern Cities Programme and Hungarian Village Programme).

Buildings

The buildings sector includes residential (75% of TFC in buildings) and service sector buildings (25%). TFC from buildings was 8.0 Mtoe in 2020, 18% lower than in 2009 (Figure 4.3). IEA analysis suggests that consumption was driven downwards by improvements in energy efficiency and a decrease in activity, which offset structural changes that would have driven demand upwards (IEA, 2021).

In 2020, half of the energy used in the sector was covered by natural gas, 22% by electricity, followed by bioenergy and waste (16%), district heat (8%), and oil and coal (1% each).

Hungary's total building stock consists of about 3.7 million buildings, with a total floor area of about 174 million m². Of these, only around 200 000 buildings were built after 2001, while most are more than 30 years old.

Figure 4.3 Total final consumption in buildings by fuel in Hungary, 2000-2020

Energy consumption in the buildings sector decreased by 18% between 2010 and 2020. Natural gas covers half of the sector's energy consumption.

Source: IEA (2022).

Space heating was responsible for most (71%) energy use in the residential sector in 2019, followed by water heating (13%), residential appliances (11%) and cooking (5%). The main energy sources for space heating in the same year were natural gas (58%), bioenergy (31%) and district heat (8%). The energy for water heating comes mainly from gas and electricity, the energy for cooking from gas and LPG, with the remainder being electricity use from residential appliances.

IEA analysis highlights improvements since 2009 for most end-uses in the residential sector (IEA, 2021). The energy intensity per flow area for space heating decreased by 10%, from 0.64 GJ/m² to 0.60 GJ/m² between 2009 and 2019. In the same decade, the energy intensity per dwelling also decreased for both water heating (by 30%, from 11.4 GJ/dwelling [dw] to 8.0 GJ/dw) and cooking (by 8%, from 3.3 GW/dw to 3.4 GW/dw), mainly because of fuel switching from oil to gas and electricity. By contrast, the energy intensity of residential appliances increased by 6%, from 6.3 GJ/dw to 6.7 GJ/dw.

Policy and measures in the buildings sector

Hungary aims to increase energy efficiency in the buildings sector through regulations, information, and incentives and financing programmes for energy efficiency projects.

Regulations in the buildings sector would usually include building energy codes/buildings standards, regulations/energy performance requirements for renovation of existing buildings, minimum energy performance standards for main appliances and equipment, and requirements for building/energy management.

On 1 January 2022, a regular energy review system (inspection) was introduced. The regular inspection of heating and air-conditioning systems (with an effective rated output of more than 70 kW) shall evaluate the efficiency, improve the scaling of the heating systems and optimise their performance.

For the public sector to lead by example, and following EU regulation, the NECP includes a target to achieve an annual rate of deep renovation of 3% of the floor area of the central government building stock. In the case of the existing building stock, the government plans to achieve phased renovation and if possible the deep renovation by passive architectural

building modernisation, related cost-effective mechanical modernisations as well as by the mandatory installation of local renewable energy systems, since these measures ensure the achievement of the cost-optimal requirements. Since 2014, any organisation responsible for the operation and maintenance of public buildings must prepare an energy-saving action plan every five years, report annually on the implementation of the action plan and regularly report the energy consumption of the building. However, the government expects delays in the implementation of the action plans. In addition, as of 1 January 2022, energy efficiency renovation must achieve the minimum energy requirements of new buildings for at least 50% of the renovated space.

The Hungarian Civil Code (Act V of 2013) contains the general provisions regulating contracts for the design and carrying out of building works (and contracts in general), alongside the Construction Act (Act LXXVIII of 1997), also known as the Formation and Protection of the Built Environment Act (and Government Decrees Nos. 191/2009, 194/2009, 312/2012, 266/2013 and 143/2018).

The government has completed a mapping of the building stock and its energy performance, mostly for buildings constructed between 2006 and 2020 (no information is available for new constructions after 2020). Over the period of 2006-2020, the energy performance requirements were modified several times and the building performance improved during this period almost year by year, based on analysis of engineering, procurement and construction agreements (Lechner Knowledge Center, 2020). There is no labelling or certificate scheme in place that informs tenants or property owners of their building's performance.

Hungary also uses a range of incentives and financing, such as grants, loans or tax rebates linked to the energy performance of buildings, incentives for manufacturers of appliances, energy service companies (ESCOs), revolving funds or credit lines for building retrofit.

The Hungarian government is providing various tax incentives to encourage investments in energy efficiency. Energy providers, in particular district heating companies that invest in energy efficiency improvements, can reduce their corporate tax, set at 31% in 2021, by up to 50%. Companies that invest in energy efficiency improvements can recover up to 65% of their investment costs from the corporate tax, under certain conditions and up to a maximum of EUR 15 million. To claim the tax relief, the company must obtain an energy certificate from a certified energy auditor following an energy audit that is carried out after the investment has been undertaken. To provide a baseline against which to assess the energy efficiency improvement, a pre-investment audit needs to be undertaken as well.

The “Warm Homes Programme” was launched in 2014 with grants for measures that increase energy efficiency in the residential sector, such as modernisation of heating systems, better insulation and replacement of appliances. Households could apply for grants covering between 10% and 55% of the cost of the project. In each sub-programme, households could apply for HUF 350 000 (EUR 900) and HUF 2 500 000 (EUR 6 400) per apartment. The programme has already contributed to the modernisation of more than 300 000 households over the period 2014-2019, with total support of HUF 36 billion (EUR 93 million).

Currently, the so-called Home Renovation Grant is available for the general public, under which energy efficiency investments can be made (e.g. insulation, heating modernisation). The aid is available in the form of a grant for renovation works up to HUF 6 million, with a

4. ENERGY EFFICIENCY

maximum grant amount of HUF 3 million. At least 120 000 households have benefited from the grant by end of 2021.

A loan scheme with a 0% interest rate was launched in 2017 to finance residential building renovations. The programme is financed through two EU funds, for a total of HUF 105 billion (EUR 270 million). The loan is provided by the state-owned Hungarian Development Bank (MFB), and could be used for investments targeting thermal insulation, heating and cooling system modernisation, and the utilisation of renewable energy.

In October 2021, the government also launched a new grant scheme for households with incomes below the average Hungarian income. It is expected that two-thirds of the beneficiaries will receive support for installing PV panels on rooftops and one-third will also receive support for modernising windows and electrification of their heating systems (installing heat pumps) in addition.

There is potential for further improvements in the way ESCOs can be deployed in the buildings sector, based on the contract between the energy consumer and the energy efficiency service provider. Compensation for energy efficiency services, as provided under an ESCO contract, is paid once the energy efficiency improvement has been made as agreed in the contract (on-bill financing/repayment). This could also be linked to economic recovery programmes and aid mechanisms that are easy to administer and achieve a large-scale renovation agenda, including gas boiler replacement programmes and switching to more efficient appliances (see the example from France, which has designed a streamlined application under its MaPrimeRénov' as described in Box 4.1).

The Hungarian government also aims to increase the smartness of energy use across the economy in buildings, with a target of 1 million smart meters to be installed by 2030. The Long-term Renovation Strategy (Hungary, 2019) sets indicative milestones for 2030, 2040 and 2050 on how to achieve the decarbonisation of the building stock by 2050 (Table 4.2). The targets will be achieved through a combination of an increased share of buildings with net zero energy performance, a reduction of the final energy consumption in public buildings compared to their average level for 2018-2020, and by reducing the number of vulnerable households through thermal renovation of their homes.

Table 4.2 Indicative milestones for energy efficiency in buildings in Hungary, 2030, 2040 and 2050

	2030	2040	2050
Reduction of CO₂ emissions related to the energy use of buildings from the average level of 2018-2020	20% (residential buildings) + 18% (public buildings)	60%	90%
Percentage of buildings with near zero-energy performance	20%	60%	90%
Reduction of the number of vulnerable households from the 2021 base level	50%	80%	100%
Reduction of final energy consumption of public buildings from the average level of 2018-2020	18%	40%	60%

Source: Hungary (2019).

The government plans to establish a new Building Renovation Monitoring System (ÉMOR) to monitor the achievement of the milestones set in the Long-term Renovation Strategy (Hungary, 2019). The system would allow the government to verify the achievement of the strategic targets, and intervene further when needed. The ÉMOR is expected to be established between 2023 and 2027.

Box 4.1 France's large-scale renovation subsidy – 'MaPrimeRénov'

As part of its Recovery Plan, France is implementing a simplified large-scale renovation scheme for all households regardless of their income or housing structure. Specific budgets under the Finance Law 2021 include expanded support for building renovation, replacing the tax credit, in addition to other incentives such as value-added tax reduction for works and zero interest loan programmes. MaPrimeRénov' now supports energy efficiency in buildings, rental properties and heating across all income classes. With an online registration and handling of the application, supported by energy efficiency in buildings experts, the application is streamlined in support of ease of application and absorption of the recovery budget in the short to medium term. France had a energy transition tax credit (*crédit d'impôt pour la transition énergétique*, CITE) in place since 2014. This policy instrument provided an income tax credit of 30% for expenditures related to certain building renovation works aimed to improve the energy efficiency of private dwellings or the modernisation of heating installations. However, it was not accessible to all income classes and not possible for multi-dwelling apartment blocks. On 1 January 2020, CITE was replaced by MaPrimeRénov', which is a grant accessible to all owners and co-owners.

A new scale was set in 2020, taking account of the energy efficiency of actions with a fixed rate, simplifying the process for multi-unit collective renovation projects. The grant rate is increased for low-income households, to combat energy poverty. The National Housing Agency pays the benefits when the renovation work is performed.

District heating

Today, the main energy source for district heating (DH) is natural gas (78% in 2020), while coal accounted for just 2% in 2020. The share of renewable energy in DH is increasing: in 2020, bioenergy (mainly solid biomass) accounted for 10% and geothermal for 6%. A small share of heat comes from non-renewable municipal and industrial waste (2%) and from nuclear (1%). Around half (54%) of DH production comes from co-generation of electricity and heat. About 15% of Hungarian households are connected to a DH system, and the market has not changed significantly in recent years, even if a slight decrease of DH sales is observed. DH also covers 8% of energy demand of service sector buildings and 5% of industry.

Most of the Hungarian territory is suitable for geothermal DH, and the well-developed DH existing infrastructure would make it possible for geothermal energy to be integrated in DH networks (see Chapter 5).

The government has a goal to improve its district heating system and make it more efficient. In the context of an overall strategy aimed at decreasing Hungary's imports of natural gas, the Green District Heating Programme aims to reduce the consumption of natural gas in DH by 50% by 2030, and replace it with renewable sources. Geothermal, biomass and waste are among the renewable sources. For the period 2021-27, the shift to renewable DH and energy efficiency upgrades will be supported by operational support in the form of grants and from the Modernisation Fund that was launched in 2021.

Wholesale and household retail heat prices are regulated by the HEA. Between 2013 and 2014, end-user prices were cut by 23% in three phases and have not changed since. Wholesale prices are regulated based on cost of production and to allow a maximum profit. DH production from renewable sources and high-efficiency co-generation is eligible for an extra profit margin. A reduced VAT rate of 5%, versus the general rate of 27%, is applied to DH services as an indirect subsidy for DH suppliers to cover the losses caused by regulated wholesale and end-use prices. This indirect subsidy scheme is financed through a special levy on electricity prices. DH owners are obliged to pay an infrastructure tax linked to the length of their network. The government plans to revise and phase out this infrastructure tax by 2024 as part of its 2021 tax reform programme.

Customers are free to switch from a DH system to another heating supply, provided certain technical requirements are met. However, in practice very few customers do so, given the regulated prices and the government-supported building renovation programmes for properties supplied by DH.

Box 4.2 District heating in Budapest from waste and geothermal energy

District heating covers 30% of the heat market in Budapest. The district heating network is operated by Budapest District Heating Works Private (FŐTÁV), and consists of nine separate district heating zones. Part of the heat is supplied by the Budapest Waste Recovery Works, which is the only household waste-fired power plant in Hungary.

In 2021, FŐTÁV signed a co-operation agreement with the Icelandic group Artic Green Energy for the construction of geothermal heat plants to provide heat for the city network. The initial project aims to build 10-20 megawatt thermal (MW_{th}) of heat generation capacity. The first substantive phase of the project includes exploration of potential locations, obtaining the necessary permits and technical preparations.

In the long run, the company aims to achieve 150-200 MW_{th} of heat generation from geothermal wells, as well as increase heat generation from waste.

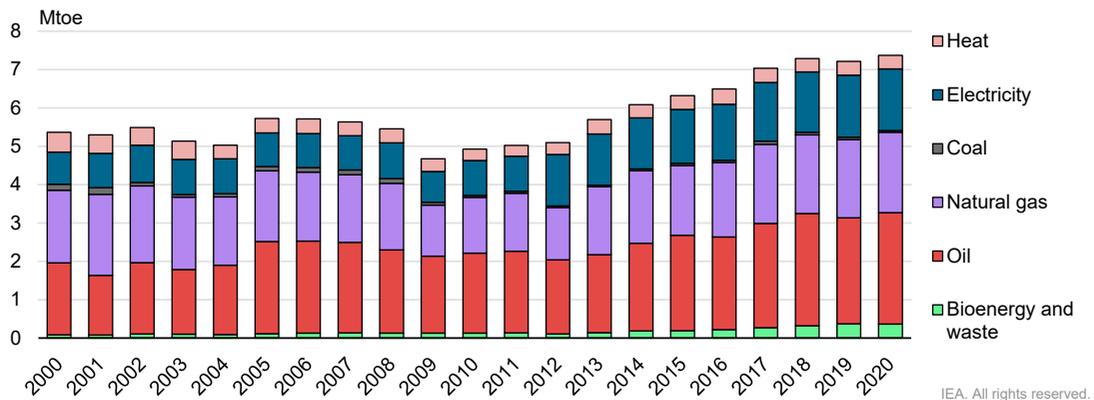
Source: FŐTÁV, 2021.

Industry

Energy demand from the industry sector increased by 46% between 2010 and 2020, when it reached 7.5 Mtoe. IEA analysis suggests that the increase in energy consumption was driven by increased activity, and was limited by some improvements in efficiency. In 2020,

oil accounted for the largest share of industrial energy demand (39%), followed by natural gas (28%), electricity (21%), bioenergy and waste (5%), and heat (5%), with only small contributions from coal (1%) and geothermal (1%) (Figure 4.4).

Figure 4.4 Total final consumption in industry by fuel in Hungary, 2000-2020



Industry energy consumption increased by 46% between 2010 and 2020. Oil and natural gas together cover more than half of industrial energy consumption.

Source: IEA (2022).

The chemical sector was responsible for 25% of manufacturing energy consumption in 2019, followed by basic metals (18%), food (14%), non-metallic minerals (13%), machinery (10%) and rubber (5%). The energy intensity per value added in the manufacturing sector increased from 3.2 GJ/USD to 3.5 GJ/USD between 2009 and 2019.

Policy and measures in the industry sector

The Energy Efficiency Act of 2015⁴ requires large companies⁵ to undertake mandatory energy audits. Companies not classified as SMEs must perform the energy audits every four years and register at the HEA, which is responsible for monitoring compliance and the quality of energy audits. Companies compliant with ISO 50001 are exempt from the energy audit requirement, as they already undertake audits within the ISO norm.

To support the implementation of audit results, in 2017, the government introduced a corporate tax incentive for the implementation and operation of investments aimed at improving energy efficiency. The tax incentive can cover up to 30% of the eligible cost, not exceeding EUR 15 million. To take advantage of the incentive, companies should obtain a certificate from a registered auditor at the HEA, through an energy audit proving that the investment aims at improving energy efficiency.

The EU ETS Directive allows EU member states to compensate the most electro-intensive sectors for increases in electricity costs as a result of the EU ETS, through national state aid schemes. Such measures have to be in line with EU state aid rules and must be

⁴ <https://www.enhat.mekh.hu/audit>

⁵ All companies not classified as SMEs are considered large companies. SMEs have a total number of employees less than 250 and an annual turnover higher than HUF 50 million.

approved by the EC. Hungary is considering using this option to protect its energy-intensive industrial sector from increased electricity prices in 2021, for instance by exempting the industry from taxes on electricity.

Transport

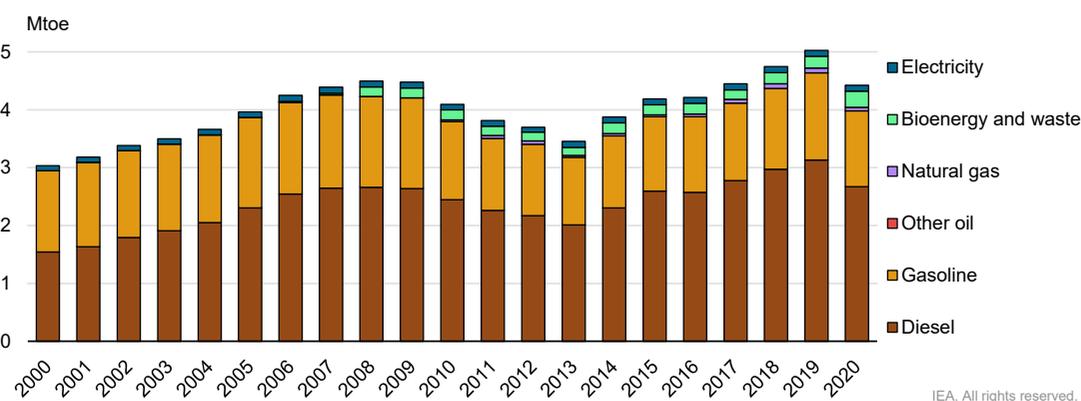
TFC in transport reached a record high in 2019 at 5.1 Mtoe, which is 66% higher than in 2000 and 12% higher than in 2009. After the global financial crisis in 2008, energy demand in the transport sector decreased until 2013 then increased notably until 2019 (Figure 4.5). The increase of energy consumption in the transport sector was driven by increased activity and worsening energy efficiency in both passenger and freight transport since 2010. In 2020, the restrictions to mobility due to the Covid-19 pandemic caused a 12% year-on-year drop of TFC in transport.

In 2019, oil met 92% of demand in the transport sector, of which 67% was diesel, 32% gasoline and 1% other oil products. Biofuels (of which 78% is biodiesel) covered 4% of TFC in transport, while electricity and natural gas accounted for 2% each.

Road transport accounted for 97% of the domestic energy consumption in transport, followed by rail (2.8%) and waterways (0.1%). In terms of vehicle type, passenger cars were responsible for 52% of the transport energy consumption, while road freight accounted for 40% and buses 5%.

The energy efficiency of transport vehicles has recently deteriorated. The energy intensity of passenger transport increased from 1.08 MJ per passenger-kilometre (MJ/pkm) to 1.28 MJ/pkm between 2013 and 2019. During the same period, the energy intensity of freight transport increased from 1.23 MJ per tonne-kilometre (MJ/tkm) to 1.72 MJ/tkm. The passenger vehicle fleet in 2019 in Hungary was 4.4 million. The average age of passenger cars was 13.5 years in 2019, higher than the EU average of 11.5 years, with 75% of passenger cars being more than 10 years old (ACEA, 2021). However, half of households in Hungary do not own a car.

Figure 4.5 Total final consumption in transport by source in Hungary, 2000-2020

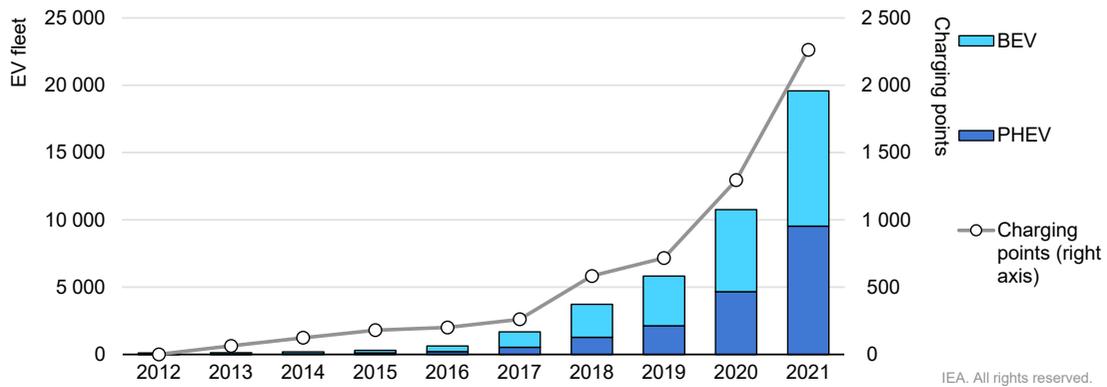


Energy consumption in the transport sector increased notably between 2013 and 2019, with diesel covering most of the added energy needs. The Covid-19 pandemic caused a 12% drop of TFC in transport in 2020.

Source: IEA (2022).

EV deployment is increasing in Hungary (Figure 4.6). From 2012 to 2021, the number of registered EVs grew from just 107 to almost 20 000, but this still represents only 0.5% of the total passenger car fleet, compared to the EU average of 1.5%. From 2014 to 2020, the number of publicly available charging points grew from just 123 to 2 264.

Figure 4.6 Registered electric vehicles and public charging points in Hungary, 2012-2021



The total EV fleet and the number of charging points have increased significantly in recent years, but EVs still represented just 0.5% of total cars in 2021.

Notes: BEV = battery electric vehicles; PHEV = plug-in hybrid electric vehicles.

Source: EAFO (2021).

Policies and measures in the transport sector

Fuel efficiency standards for passenger and heavy-duty vehicles are not a primary focus of Hungary's policies and measures in the transport sector. In the transport sector, the focus is on alternative fuels (biofuels, CNG/LNG) and electrification, including for public transport, and the creation of the necessary infrastructure. As the most important measure to increase fuel efficiency, Hungary aims to increase the share of diesel cars, and calls attention to the fact that in Hungary, the share of diesel cars is much lower than in most western European countries. The EEOS is supposed to drive energy savings at the level of the fuel supplier, but not at the level of the manufacturer or buyer of new vehicles.

The government is also supporting cities to develop their own Sustainable Urban Mobility Strategy. The National Transport Strategy aims to strengthen energy efficient transport modes, including by purchasing modern and electrified rolling stock for the railways and electric buses. In 2019, the government adopted the Electromobility Act and the implementing regulation on electromobility. In the longer term, Hungary is placing a great emphasis on the roll-out of hydrogen and hydrogen infrastructure in the transport sector.

Since 2016, a number of tenders have offered financial support to the public for the purchase of electric vehicles, with total tender support of HUF 21 billion (EUR 55 million). In 2020, a price cap was introduced: the financial support of HUF 2.5 million is available only for vehicles with a price lower than HUF 12 million, while vehicles with a price between HUF 12 million and HUF 15 million can only receive a support of HUF 0.5 million. In May 2021, the government launched two tenders for pure electric cars: one was open to the general public, including educational institutions and non-governmental organisation, while the second targeted taxi services and other passenger car transport services. Within the

framework of the call for tenders published in July 2021, the government facilitated the purchase of EVs (scooters, cars, trucks) by companies and sole proprietors.

The Green Bus Programme was launched in 2019, providing a total of HUF 36 billion (EUR 92 million) from CO₂ revenues in the decade 2020-29 to support the purchase of electric buses and the construction of related charging infrastructure in towns with more than 25 000 inhabitants. In 2021, the government had already allocated HUF 18.4 billion (EUR 47 million) for the purchase of 127 electric buses and the installation of the related charging infrastructure. The government also plans to use funding from the EU RRF to finance grants for a total of about HUF 50.7 billion (EUR 130 million) for the purchase of 300 electric buses and their charging infrastructure between 2022 and 2025. After implementing this programme in big cities, the government will extend it to cities with less than 25 000 inhabitants. As of 2022, in the case of the use of public resources, only electric buses can be licensed in cities with a population above 25 000.

Since 2020, the government also launched three tenders for the purchase of electric bicycles for a total of HUF 2.4 billion (EUR 6.3 million) in grants.

Since 2015, environmentally friendly vehicles have specific licence plates. These green plates allow exemption from: the vehicle tax, the taxation of company cars, registration and the transcription tax. Local governments can also grant benefits to vehicles with green plates, such as free or reduced-cost parking and access to limited traffic zones. The government supports the installation of EV charging infrastructure through a corporate tax credit for enterprises installing electric chargers, and legislation that mandates certain shops, car parks, offices and condominiums to install EV chargers.

Assessment

The government has expanded the package of energy efficiency policies and measures since the last in-depth review. However, in the context of energy security and high energy prices, energy efficiency action should be fully valorised in Hungary. There are still a number of areas for improvement for maximising the potential of energy efficiency across the economy and meeting emissions reductions, affordability and energy security goals.

First, energy efficiency is a major sector for job creation and economic recovery. A new employment deal could be achieved by targeting households and SMEs, which are currently not the focus of energy efficiency programmes. This would involve private renovation programmes in country homes, upgrades of gas heating efficiency or the boiler replacement programme, the installation of heat pumps, or the production of biogas.

Second, prioritising energy efficiency as a “first fuel” is a very effective policy to manage energy price and inflation increases for residential and commercial sectors. Wholesale energy prices are on the rise in Hungary, pushed by rising prices for imported gas and electricity. As end-use prices remain regulated in Hungary, this will create a risk of insolvency for private and state-owned utilities and energy companies.

No assessment has been undertaken of the technical, economic and policy potential of energy efficiency across all sectors of the economy. While good data exist for the residential and public building stock, there are gaps for the transport, industry and commercial sectors. If these were addressed, a comprehensive assessment of the potential for energy efficiency would be possible. Such an assessment could result in

policy road maps to illustrate how energy efficiency can be maximised in the pursuit of climate and energy targets as well as job creation benefits. Maximising demand-side energy efficiency has the potential to lead to savings in supply-side infrastructure investment as well. Quantifying the potential here will help prioritise efforts and strike the right balance between investment in energy efficiency and in renewable energy technologies.

Monitoring the impacts of the various policies and measures may have been extended since the last review; however, there is no ready source of information providing details on costs and benefits (impacts) of the full list of energy efficiency policies and measures in one place. A central repository for the achievements to date could provide a basis for comparison with future ambition and required expenditure, and strategic planning of further action.

The IEA welcomes that in 2021, Hungary introduced an EEOS to help it achieve the required energy savings. The HEA and the government should monitor that there are sufficient resources to release the certificates. Contingencies should be provided to ensure energy poverty programmes are funded even if expected fees from the EEOS are not forthcoming, or if they are overestimated. Sub-targets should be considered for later years to ensure that market development for energy efficiency services occur across the household, business and industry sectors.

Buildings

The Long-term Renovation Strategy sets out indicative milestones for 2030, 2040 and 2050 on how to achieve the decarbonisation of the building stock by 2050. The government's first priority is on public buildings, with a focus on vulnerable households. For this, the government will provide support programmes, such as the Home Renovation Programme, but not many details are available yet about the funding and eligibility.

The government has well identified the barriers that may hinder implementation of the targets set for the building sector. The solutions to be applied to various building types should be determined to ensure the right actions are applied to the right buildings. This will require analysis to determine whether heat pumps might be applied to existing buildings, versus alternatives like district heating, for example. The mapping of district heating and heat markets should inform such an evaluation.

The Hungarian government is not yet making incremental use of stronger building codes, labelling or energy performance certificates. Among them is an insufficiently evolved ESCO market in Hungary, including a lack of skilled labour, and uncertainty about how to transparently assess the level of performance guaranteed by the ESCOs. Another barrier is the insufficient legal framework for the construction of buildings to meet the near zero requirements and the regulation for the certification of the energy performance of buildings. Addressing these barriers will be essential for the development of the ESCO market. ESCOs could be allowed to utilise financial supports as part of establishing and bidding for tenders. This would improve the payback period and likely make many more projects viable – providing volume for the ESCO market. The IEA notes that the regulated prices for electricity and natural gas act as a barrier for implementing energy efficiency measures.

Delivery of various policies and measures under the banner of the “Warm Homes Programme” has led to the modernisation of more than 300 000 homes over the period 2014-2019. Total spend on each of the programme strands is well publicised; however,

the number of homes upgraded per strand, the extent of the upgrades (deep versus shallow), the measures installed, and the energy and carbon impacts of the upgrades could be clarified. Looking forward, reporting on the costs and benefits of all programmes could be more comprehensive and allow comparing past achievements with the required future accelerated trends – thereby illustrating any policy gaps.

Good data exist for the residential and public services building stock with a high level of disaggregation by sub-sector and building archetype. There is a data gap for the commercial buildings sector that, if closed, could lead to more targeted support schemes and regulations for the business (including SMEs) sectors. Certification, labelling and energy performance data disclosure should be made mandatory for non-residential (and preferably residential multi-family) buildings.

Based on data provided for 2017-2020, the zero-interest rate loan scheme for households appears to have been a success. A new HUF 100 billion scheme is planned and energy efficiency will be improved for about one-third of households that take up the complex package. The planned establishment of the Building Renovation Monitoring System (ÉMOR) is welcomed.

Further studies of net zero carbon pathways for buildings will enable targeted solutions across Hungary's building stock. The move towards net zero carbon buildings should include a requirement for improving the operational energy efficiency of buildings, building regulations and public procurement regulations. These should include requirements for the use of low-carbon materials and a reduction of embodied carbon in construction, renovation and demolition of buildings, as well as manufacturing and disposal of appliances, using a life-cycle approach, among others.

Heating and cooling and district heating

There is no comprehensive strategy for net zero emissions from heating and cooling. Hungary expects industry to have an ongoing demand for coal, oil and natural gas until 2050, under the National Clean Development Strategy. It is not clear how this could be compatible with a net zero emissions by 2050 pathway. A comprehensive heating and cooling strategy is required under the EU EED; this should be used to illustrate how Hungary will reach net zero heating and cooling by 2050.

District heating is a major energy source in Hungary, and in 2020 it provided heat to 15% of households. Recently, improvements in energy efficiency, combined with warmer winters and regulated gas prices lowered the prospects for market growth in DH. Decade-long low natural gas prices combined with regulated tariffs made individual natural gas boilers more competitive in new buildings. The rise in natural gas prices (for large users) could make efficient DH cost-competitive with respect to natural gas.

Current measures for DH are focused on modernising the existing network, shifting to renewable sources for DH systems and some changes to regulation of networks. However, there does not appear to be a broader strategy or target to increase the number of buildings connected to DH networks, and it is not clear if this is part of the long-term decarbonisation strategy for heat in buildings.

Spatial mapping of heating demand (heat mapping) and heat sources could facilitate the further development of DH and further deployment of renewable energy sources. Heat

mapping could highlight the potential to enlarge DH networks, for example extending the network surrounding Budapest into the city centre.

The potential use of geothermal resources for DH should be further explored and policies and measures adopted to support heating for residential or industrial uses, using the very good geothermal potential in Hungary (see Chapter 5). To overcome the barrier of high risk of investment for geothermal projects, the government could use policy tools such as guarantee and insurance schemes that have shown positive results in other IEA member countries.

Industry

The Energy Efficiency Act of 2015 requires large, energy-intensive companies to undertake mandatory energy audits every four years and employ an energy manager. However, companies that do an audit are not obliged to implement the findings and SMEs are not included in this regulation in Hungary. In some IEA countries, companies are obliged to implement measures with a payback time shorter than three to five years. The government should focus on SMEs where large energy efficiency potential is available. There also should be clear timelines set by the audit for implementing the measures and on-site inspections to assess the implementation of the measures. The creation of a register of opportunities based on these audits could be used to illustrate project pipelines and facilitate uptake and project aggregation to deliver savings identified by mandatory audits.

Opportunities exist, for example, to support energy efficient design for new industrial processes, to create networking opportunities for industry sub-sectors to share successes in seeking efficiency improvements, to aggregate projects for economies of scale, and to consider fuel switching from direct fossil fuel use to electricity. Also, smart energy management and the use of digital tools can optimise various processes, while automatic fault detection further increases system efficiency. A detailed study of the potential would be welcome in this area.

Hungary is considering using the indirect cost compensation mechanism outlined in the EU ETS Directive for sub-sectors most exposed to increasing prices (e.g. cement, clay, steel, etc). Any such compensation should only be paid where a legal requirement to pursue annual energy efficiency improvements is required.

A more detailed understanding of energy use in industrial sub-sectors, including by energy end-uses, end-use technologies and services, and existing technology efficiency would facilitate the design of a more detailed policy package supporting energy efficiency in the industrial sector.

Transport

Current policies and measures focus on the short-term shift to low-carbon technologies for passenger and public transport, with significant support for electromobility in recent years. The use of pilot programmes, for example the Green Bus Initiative, is proving impactful. There is potential for further savings through programmes focused on energy demand for heavy goods vehicles, including eco-driving. A strategic assessment for efficient freight movements considering all nationally available options would be a welcome addition.

Long-term plans towards net zero and related programmes should be better articulated. The government should communicate trajectories for the roll-out of transport technologies consistent with Hungary's 2030 and the 2050 climate targets, and produce policy road maps for achieving them.

The government should consider adopting an “avoid, shift, improve” framework as a basis for a comprehensive policy package for energy efficiency and carbon savings in transport. “Avoid” facilitates the development and planning of an efficient transport system. It seeks to eliminate the need for trips and reduce trip length, for example through sound spatial planning. “Shift” actions seek to improve individual efficiency by promoting modal shift, through cycling and walking infrastructure. The more fully developed strand of “improve” is evident in Hungary via its electromobility support.

The government could also better balance public funding of road development and upgrades with cycling and walking infrastructure, with the latter considered favourable in the context of a shift to sustainable transport and travel. A national cycling and walking plan could be developed. The potential to maintain demand reductions in transport observed due to Covid-related measures, such as from “working from home”, should be considered to drive down passenger car demand. This, in turn, will also allow addressing energy security concerns from rising oil prices and insulate better against market volatility.

Recommendations

The government of Hungary should:

- Enhance reporting of the impact of existing policies and measures to inform policy development, based on measured and verified energy savings from existing and new programmes via formalised policy and programme evaluations.
- Study policies and measures used to support behavioural change in comparable countries and evaluate their usefulness and applicability to Hungary with a view to enhancing the uptake of energy efficiency improvements.
- Closely monitor the initial period of the Energy Efficiency Obligation Scheme to determine the need for sub-targets and their stringency to ensure that savings are garnered across all sectors, including activities to upgrade homes occupied by the energy poor.

Buildings

- Develop a streamlined, large-scale and combined low-interest loan and grant scheme, with a one-stop shop for deep renovation, notably as part of the recovery funding, to support investment in energy efficiency and renewable energy technology in buildings across the residential, commercial and public building stock.
- Address the challenges of deep renovation of multi-family apartment building, e.g. through energy efficiency retrofit investments by homeowner associations in multi-apartment buildings and renovation loans combined with grants from state budget resources.

- Facilitate development of the energy service company market by allowing participants to use any financial support scheme, and by addressing other legal impediments.

District heating

- Develop a strategic plan for district heating that includes a spatial mapping of future heating demand, and potential heat supply (renewables and waste heat) with a view to increasing the number of district heat connections for residential, business and public sector consumers.

Industry

- Develop a detailed strategy to support energy efficiency in industrial facilities and sub-sectors (both ETS and non-ETS sectors), based on an assessment of their efficiency potential, notably for small and medium-sized enterprises, and opportunities for strengthening energy management, through smart/digital solutions, options to decarbonise and electrify, where relevant.

Transport

- Develop a broader policy package for the transport sector that clearly articulates the options across the “avoid”, “shift” and “improve” spectrum of actions, with specific attention to spatial and integrated transport planning; policies for freight; and a review of planned expenditure on road transport versus cycling, walking and public transport.

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5. Renewable energy

Key data (2020)

Renewables in TFEC: 2.6 Mtoe/14.8% of TFEC (solid biomass 1.5 Mtoe, liquid biofuels 0.28 Mtoe, solar 0.26 Mtoe, electricity from bioenergy 0.21 Mtoe, geothermal 0.12 Mtoe, heat from bioenergy 0.09 Mtoe, wind 0.06 Mtoe, hydro 0.02 Mtoe)

Renewables in electricity generation: 5.53 TWh/15.8%* (solar 2.5 TWh, solid biomass 1.7 TWh, wind 0.7 TWh, biogas 0.3 TWh, hydro 0.2 TWh, renewable waste 0.2 TWh, geothermal 0.02 TWh)

Renewable shares:** gross final consumption 13.9%, electricity 11.9%, heating and cooling 17.7%, transport 11.6%

Renewable 2030 targets: gross final consumption 21%, electricity 20%, heating and cooling 30%, transport at least 14%

* According to the IEA definition: share of renewables in electricity generation.

** Computed according to Eurostat definitions for consistency with EU targets. Eurostat definitions include normalisation of wind and hydro renewable electricity consumption, and multiplication factors for advanced biofuels and renewable electricity in transport (EC, 2022).

Overview

Biomass and solar PV have been the key renewable energy sources developed in Hungary. In fact, solar PV has overtaken biomass and accounted for almost half of electricity generation from renewables in 2020. With renewable energy accounting for 13.9% of gross final consumption, Hungary has overachieved its target of 13% for 2020.

Going forward, efforts are needed to boost the share of renewables in gross final consumption to the targeted 21% in 2030. In the light of higher EU-wide ambitions, Hungary is also considering raising its 2030 target to a higher level of 23% or even 25%, banking on strong solar PV growth.

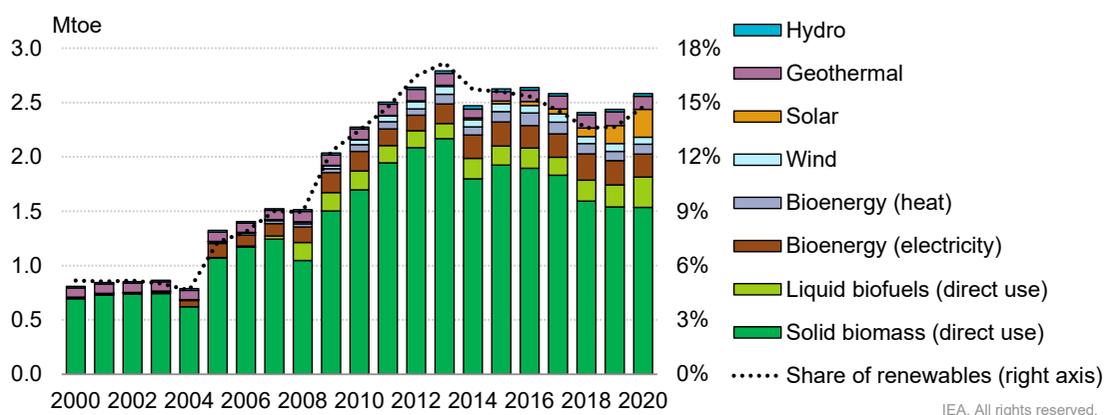
To date, government support policies have focused on the deployment of solar PV. Large potential for scaling up renewable energy remains, for instance in geothermal energy or wind power. The government has plans to mobilise funding and implement derisking mechanisms for geothermal in the coming years. Moreover, wind power development, currently *de facto* on hold, could be used alongside other renewable energy sources for cost-effective domestic hydrogen production.

Renewable energy trends

According to IEA data, the share of renewables in total final energy consumption (TFEC) was 14.8% in 2020 (Figure 5.1). The share of renewables has overall increased since 2009 thanks to the rising use of biomass, peaking in 2013 (17% of TFEC). Thereafter, the share of renewables decreased until 2018, as the use of bioenergy in heating declined. Since 2018, the growth of solar PV is driving the share of renewables up again.

Direct use of solid biomass accounts for most of renewables in Hungary's TFEC (59%), followed by direct use of liquid biofuels (11%), solar (10%), electricity generation from bioenergy (8%), geothermal (5%), heat generation from bioenergy (3%), wind (2%) and hydro (1%).

Figure 5.1 Share of renewables in total final energy consumption in Hungary, 2000-2020



The share of renewables in TFEC peaked in 2013, after which it started declining, driven by decreasing use of bioenergy for heating.

Source: IEA (2022).

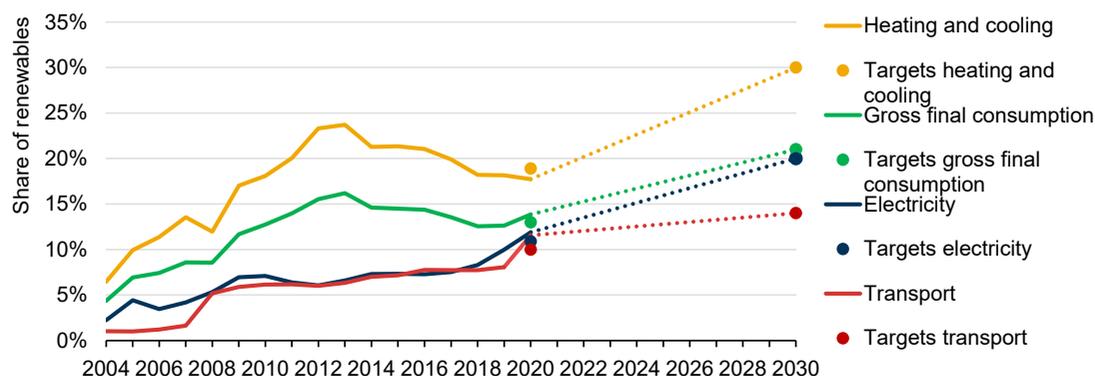
Renewable energy targets

Hungary's renewable energy targets are mainly driven by obligations under the EU's Renewable Energy Directive (RED) for the period to 2020 and by RED II through the NECP for the period to 2030.

As recalled by the European Commission in its assessment of Hungary's preliminary NECP, the National Renewable Energy Action Plan of 2010 set a national target of a 14.6% share of renewables in gross final energy consumption in 2020 (EC, 2010). The NECP reduced the 2020 target to 13%, which is Hungary's mandatory target under RED I (EC, 2020).

Hungary exceeded its overall renewable energy target for 2020, as defined by Eurostat definitions.⁶ In 2020, its shares of renewables accounted for 13.9% in gross final energy consumption, 11.9% in electricity, 11.6% in transport, and 17.7% in heating and cooling, which was slightly below the target (Figure 5.2 and Table 5.1).

Figure 5.2 Share of renewables in energy sectors in Hungary, 2004-2020 and targets for 2020 and 2030



Hungary is on track to achieve its 2030 targets in all sectors. More efforts are needed to achieve the 2030 targets, including in electricity.

Source: EC (2022).

The NECP also sets targets for 2030; in 2030, Hungary aims to reach at least 21% renewables in gross final energy consumption as its national contribution to the EU-wide target of 32%. Hungary's 2030 target would be reached through a share of 20% in electricity, 30% in heating and cooling, and at least 14% in transport. In its assessment of the NECP, the EC considered the 2030 targets as not sufficiently ambitious (EC, 2020).

Table 5.1 Hungary's 2020 and 2030 renewable energy targets and status in 2020

Renewable share by sector (% of gross final consumption)	Status	Targets	
	2020	2020	2030
Gross final consumption	13.9%	13%	21%
Transport	11.6%	10%	14%
Electricity	11.9%	10.9%	20%
Heating and cooling	17.7%	18.9%	30%

Sources: Hungary (2020); EC (2020, 2022).

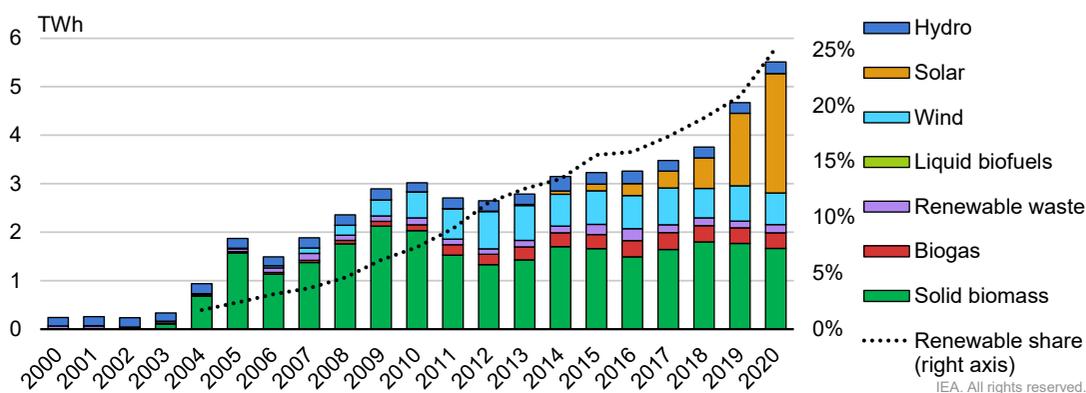
⁶ Eurostat applies formulas to normalise fluctuations of electricity generation from wind and hydro, and multiplication factors that give higher shares to advanced biofuels and to electricity in transport.

Renewables in electricity

From 2010 to 2020, the share of renewables in electricity generation, using the IEA data and definitions, doubled, from 8% to 16%, with most of the progress coming from the rapid growth of solar energy, especially since 2016 (Figure 5.3). Among IEA member countries, Hungary ranks the third-lowest, ahead of the Czech Republic and Korea.

In 2020, 5.5 terwatt hours (TWh) of renewable electricity was generated from renewable energy sources: 2.5 TWh from solar, 1.7 TWh from solid biomass, 0.7 TWh from wind, 0.3 TWh from biogas, 0.2 TWh each from hydro and renewable waste, and a very small contribution from geothermal (0.02 TWh). The large share of solid biomass (31%) is mainly due to the large-scale biomass co-firing at the Mátra coal power plant, but also due to co-firing in some smaller power plant units.

Figure 5.3 Renewable energy in electricity generation in Hungary, 2000-2020



The share of renewables in electricity generation has increased significantly since 2016, driven by wide deployment of solar PV.

Source: IEA (2022).

The total capacity of installed solar PV increased from 1 MW in 2010 to 1 400 MW in 2019 and by 1 April 2022, installed capacity of solar exceeded 3 000 MW. Boosting solar power deployment is a key focus of the government for renewables in the electricity sector. The government plans to increase solar capacity to exceed 6 000 MW in 2030 and 12 GW by 2040. The situation is rather different for wind power, where no new capacities have been added in the last ten years. In 2020, Hungary had an installed capacity of 323.3 MW of wind power.

Hungary's adopted its Hydrogen Strategy in 2021. To meet hydrogen demand across all sectors (industry, transport and buildings), Hungary plans to produce 20 000 t per year of low-emission hydrogen (produced via steam methane reforming of fossil fuels) and 16 000 t per year of low-emission hydrogen by 2030 (produced from solar PV), with some pilot projects under way, such as the Aquamarine project (see Box 6.1 in Chapter 6; Hungary, 2021). Hungary plans to install 240 MW of electrolyser capacity by 2030. There is large potential to develop renewable electricity capacity to reduce the share of low-carbon hydrogen and scale up the share of green hydrogen (FCH, 2022), where surplus electricity is available. Wind power development could be a key driver if Hungary wants to increase the share of green hydrogen.

Policies and measures for renewable electricity

Hungary's renewable energy support scheme (METÁR) came into force in 2017. Contracts signed before the end of 2016 continue to receive the previous feed-in tariff (KÁT). Under METÁR, a feed-in tariff is available for small-scale renewable installations (50-500 kW) and a "green premium" granted for small- to medium- (0.3-1 MW) and large-scale renewable power plants (1-20 MW) through tendering. All renewable technologies are eligible under the support scheme (solar energy, geothermal energy, biogas, hydropower, biomass, wind energy) and tenders are technology-neutral.

A "brown premium" is in place for solid biomass and biogas plants, which are no longer eligible for the feed-in tariff or the green premium, to ensure their continued operation. Co-firing and waste-to-energy power plants may receive support only for the part of electricity produced from renewable energy sources (proportional to the combustion heat).

Under METÁR, renewable electricity producers are responsible for selling the electricity on the market themselves or they can join a balancing group. The producer receives a premium on top of the market price for renewable electricity that is fed into the grid by signing an agreement with MAVIR, Hungary's transmission system operator (TSO). MAVIR defines, allocates and settles the amount of feed-in tariffs and feed-in premiums to be paid. The premium equals the subsidised price minus the reference market price, with the subsidised price being the winning bid price and the reference market price the hourly price on the day-ahead market. The premium is granted for a maximum duration defined individually in each tender and can be reduced in accordance with other investment subsidies.

The Hungarian energy regulator, the Hungarian Energy and Utilities Regulatory Authority (HEA), is organising the tenders on behalf of the ministry and issues guarantees of origin. Three tenders have been organised and the first two have been fully completed. The first tender, which took place in 2019, awarded support for generation of 193 gigawatts hour (GWh)/year. In 2020, the second tender increased support to 390 GWh/year. In the second tender, bids were received for 2 145 GWh/year. The third tender closed on 30 July 2021. A total of 183 bids were received for the call, of which 57 were successful. The winning bidders will build solar power plants with a total installed capacity of 183 MW. The number of bidders increased substantially over the period 2019-21 and a huge cost decrease can be observed for large-scale plants. In March 2022, a new call for tenders was published by the HEA at the request of the Ministry for Innovation and Technology (MIT), which invites hybrid renewable energy solutions, joining a battery storage capacity with the power plant.

In 2021, investment in a utility-scale solar PV project went ahead without a subsidy, relying solely on the expected rise in forward prices for electricity in Europe. The project is a 1.3 MW solar power plant in Tolna, in central Hungary, developed by Dutch-based solar project developer Photon Energy.

The budget of the METÁR tender support scheme was EUR 2.8 million (HUF 1 billion) per year between 2016 and 2019 and EUR 7 million (HUF 2.5 billion) per year after 2019 until 2026. The budget for the brown premium support scheme is much higher and has an annual limit of EUR 56 million (HUF 20 billion) over the entire period between 2017 and 2026.

The construction and grid connection of wind power plants has come to a standstill in the last ten years. Government Decree 277 of 2016 declared that wind turbines cannot be installed in a radius of less than 12 kilometres from populated areas. Hungary's energy

and climate strategies focus on solar PV and do not include wind power in the future electricity generation mix beyond the existing capacities. Only wind turbines with a construction right obtained in the tender according to Ministerial Decree 33/2009 are eligible to participate in METÁR tenders. Tender capacities for wind power plants have remained at zero since 2016 and no new wind energy projects have been bid for in METÁR tenders.

The government has put in place special provisions to facilitate renewable electricity generation to be fed into the grid. A co-ordinated grid connection capacity allocation on the country level was introduced in 2021 and is likely to result in new network connection possibilities reserved previously by developers. The connection regime also provides for an emergency break option for MAVIR if PV capacity grows faster than the flexibility of the system can handle. Plants that exclusively use renewable energy sources are eligible for a 50% reduced grid connection charge.

System integration of rising shares of solar PV will become a challenge during the times of the day when solar PV generation is low, such as in the evening/night (the so-called duck curve). In Europe, as in the Hungarian Great Plain and surrounding Carpathian Mountains, wind power generation can complement solar PV production for most seasons and months in the year (see also Chapter 7).

Net metering is only available to household size plants with a maximum capacity of 50 kW and is only available until the end of 2023 for new installations, in compliance with the EU Clean Energy package. The government is currently developing a new scheme that would replace net metering from 2024 onward. The new scheme is tentatively called “gross metering” and would account separately the amounts and related costs for the electricity fed into the grid and the electricity consumed by the grid. Producers under the net metering scheme do not pay a network service fee, which is instead split among all other consumers. The gross metering scheme will rationalise and better allocate the costs incurred due to the operation of the household size PV installations.

On 1 January 2021 a new law was implemented that provides the framework for prosumers, flexible pricing, aggregators and (renewable) energy communities. The law defines a renewable energy community as an energy community that produces, consumes, stores or sells electricity from a renewable energy source. Hungary is also adopting minimum requirements for buildings as part of the nearly zero-energy buildings requirement that applies since 1 January 2021.

From 2014 to 2020, Hungary allocated around EUR 160 million of EU funding to renewable energy investments under EU sectoral and territorial operational programmes. Until 2027, Hungary will provide further investment aid to renewable energy and other types of energy projects from the national budget using carbon credit revenues and potential EU funds.

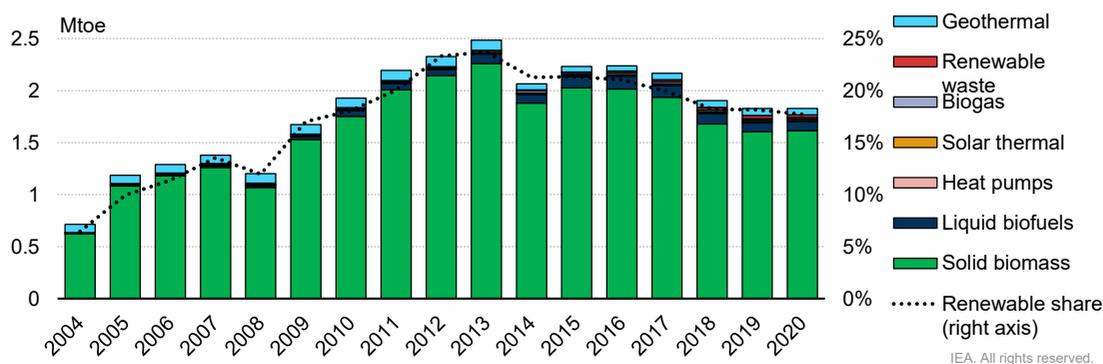
Renewables in heating and cooling

In 2019, the heat output from renewables was 1.8 Mtoe, accounting for 18% of the total energy consumption in heating (Figure 5.4). The heat output from renewables has increased by 10% since 2009. After rapid growth between 2009 and 2013, when the share of renewables in heating reached a record high of 24%, it decreased again until 2019. Part of the decline of solid biomass in heating is due to lower heating demand, as well as price changes. Between 2014 and 2019, firewood became less competitive compared to natural gas. While prices for firewood increased by 40%, natural gas prices remained stable.

Consequently, demand for firewood declined by 24% while demand for natural gas increased by 15% for household heating.

In 2019, most of the renewable heat was generated from solid biomass (89%), followed by geothermal (8%) and small shares of renewable waste (1.7%), biogas (0.8%), and solar thermal and heat pumps (0.7% each).

Figure 5.4 Renewable energy in heating and cooling in Hungary, 2004-2020



Renewables in heating and cooling peaked in 2013 and decreased thereafter as solid biomass became less competitive compared to natural gas.

Source: EC (2022).

Hungary is committed to increase the share of renewable energy sources in heating and cooling to 30% by 2030. However, the government doubts that increasing, or just maintaining, the large share of solid biomass is sustainable in the long term and is turning to electrification of heating.

The government aims to install at least 400 MW of heat pumps in 100 000 systems by 2030. For comparison, in 2019, 148 MW of heat pumps were installed. In addition, the National Energy Strategy 2030 also supports the development of electricity-based heating in regions where the use of the gas distribution networks is below average, and in areas where no access to the gas distribution grid is available.

Switching from the use of natural gas to the use of renewable sources in the district heating system is another government priority. The goal is to reduce the share of natural gas consumption in district heating production to 50% under the Green District Heating Programme.

Policies and measures in heating and cooling

Hungary does not offer any specific support for combined heat and power; however, the government is considering introducing this in the future with support for heat storage, integration with battery energy storage devices and other emerging technologies.

Various financial support schemes are available to homeowners and property developers who consider installing renewable heating technologies such as solar and heat pumps, as well as for the use of geothermal energy under certain conditions.

The number of geothermal-based district heating systems almost doubled in Hungary between 2014 and 2018, but from a very low base and the untapped potential is still

important. Since 2014, Hungary benefits from the EU-supported project GeoDH.eu, which provides a guide for the deployment of geothermal DH, along with a detailed map⁷ of the subsurface potential, combined with existing DH networks. The government estimates that the potential for deep geothermal to contribute to district heating is between 30 PJ and 65 PJ per year, which is notable considering the current use of about 9.3 PJ per year⁸.

The resource risk, linked with the uncertainties of the subsurface, is usually a major obstacle to the deployment of geothermal installations. The Mining Law Act and Act of Water Management do not have any particular provisions enabling or clarifying the rules for geothermal energy (notably using hot water springs) and new calls for tender and local concessions for harnessing geothermal energy have stagnated in recent years.

Other European countries have developed various derisking policy instruments, such as loan guarantees, grants or risk insurance funds, to provide support to geothermal projects. For example, the Netherlands increased its use of geothermal energy from almost zero to about 30 PJ per year from 2007 to 2017. A policy toolbox including an operating grant and post-damage guarantee, including collaboration with insurance companies, has supported the geothermal boom in the Netherlands.

Renewables in industry

In 2020, energy consumption in industry consisted of 5.7% renewable fuels and waste (12 PJ), 9.9% district heating (21 PJ) and 31.6 % electricity (67 PJ). The remaining 52.8% (112 PJ) was fossil fuels, with natural gas having the largest share (62 PJ). The goal is that the country's energy consumption in 2030 will not exceed the 2005 level. Reducing energy consumption is a priority, but in the case of economic growth, neither industry's nor transport's energy consumption can be limited, so the post-2030 commitment of the strategy is to increase energy consumption only by using carbon-neutral sources. Projections until 2050 indicate that natural gas will be partly phased out with the help of electrification of processes and hydrogen. Oil and coal use is projected to remain and to be offset by negative emissions. An alternative to relying on negative emissions is to switch to processes based on renewable fuels or electricity instead.

Hungary relies on the EU ETS as an incentive for the transition of the industry sector. Some industry sectors, such as cement and steel, have inherent GHG emissions from their processes. The solution is to switch to alternative processes without GHG emissions or to adopt carbon capture and storage (CCS). These solutions often require energy and often involve the use of hydrogen. Petrochemical industry and refineries are other sectors with big challenges. Bio-based feedstock can be one option in the short term. However, in the medium to longer term, solutions like hydrogen and CCS will be necessary.

Renewables in transport

In 2020, the share of renewables in transport in Hungary was 11.6%, using the Eurostat definition, of which biodiesel accounts for 67%, biogasoline 20% and renewable electricity 14% (Figure 5.5). The share of renewables in transport has increased from 5.9% in 2009,

⁷ <http://geodh.eu/geodh-map>

⁸ https://map.mbfisz.gov.hu/geo_DH/

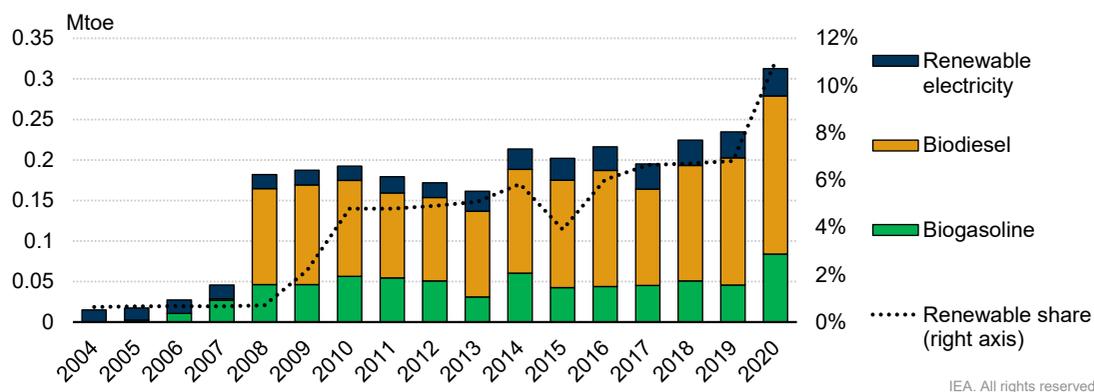
driven by the use of biodiesel, which increased by 28%. Among IEA member countries, Hungary had a median share of renewables in transport in 2019 (14th lowest) and the 6th highest in the EU (EC, 2022).

The main support scheme for promoting the use of renewables in the transport sector in Hungary is the quota system for biofuels that was introduced in 2017, with a 4.9% blending requirement. From 1 January 2020, the mandatory minimum content of the renewable blending component for petrol and diesel increased from 6.4% to 8.2% and to 8.4% from 2022. The bioethanol minimum ratio of unleaded gasoline 95 octane is 6.1%.

The increase in blending mandates and the ongoing roll-out of electric mobility contributed to Hungary exceeding its 10% target for 2020. First-generation biofuels cannot exceed 7% of FEC in 2020 while the share of second-generation biofuels and biogas should be at least 0.2% in 2022 and increase to 1% in 2025 and 3-3.5% in 2030.

Hungary plans to reach the minimum of 14% in 2030 through 7% of first-generation biofuels; 3.5% of second-generation, so-called advanced, biofuels; and 3.5% of electricity (Hungary aims to have 90% of low-carbon electricity generation by 2030).

Figure 5.5 Renewable energy in transport in Hungary, 2004-2020



Hungary mainly relies on biodiesel to meet renewable energy targets in the transport sector.

Source: EC (2022).

Policies and measures in transport

Electromobility in Hungary is supported through a phased programme, the Jedlik Ányos Plan, which created the legislative framework in the period 2015-2019 and provided public funding to develop the necessary charging infrastructure. The government adopted the second phase of the plan in 2019 that includes various support programmes targeting different kinds of EVs and the enhanced development of necessary charging infrastructure (see Chapter 4). In the longer term, the government sees hydrogen playing an important role in the transport sector. The government is considering reviewing and renewing the Jedlik Ányos Plan 2.0 to further incite the development of the electromobility sector and expand the deployment of EVs.

Assessment

Hungary's long-term transition towards net zero emissions relies on the shift from fossil fuels to renewables, alongside the expansion of nuclear.

Hungary has achieved its renewable energy targets for 2020. With renewable energy accounting for 13.9% in gross final consumption, Hungary has overachieved its target for 2020 (13%). However, distance to the target remains high for 2030, when the country aims to have 21% of renewable energy, through a share of 20% in electricity, 30% in heating and cooling, and 14% in transport. Achieving these targets requires a significant increase in the deployment of renewables in electricity (from 12% in 2020) and heating and cooling (from 18% in 2020).

To meet its net zero trajectory, an increased ambition of up to 25% is under discussion by the Hungarian government in the context of the EU's Fit for 55 package, which will require higher targets under the revised EU Renewable Energy Directive.

Renewables in electricity

One of the major positive developments in Hungary since the last review is the investment in solar PV. In 2019, Hungary introduced green premiums based on tenders to align with fast cost declines across the world. Supported by new METÁR tenders and a net metering scheme (in place until 2023), solar PV deployment has gained pace. The installed capacity of solar panels increased from 1 MW in 2010 to 1 400 MW in 2019 and reached more than 3 000 MW by 1 April 2022. In 2020, a total of 5.5 TWh was generated from renewable energy sources, consisting mainly of solar (2.5 TWh), solid biomass (1.7 TWh) and wind (0.7 TWh).

Hungary is striving to increase the share of carbon-neutral domestic electricity production to 90% by 2030. Electrification is considered one of the key solutions for reaching the net zero emissions target by 2050. Hungary also aims to decrease its rather high dependency on electricity imports. Projections indicate almost a doubling in electricity production until 2050. Alongside nuclear, the increased domestic electricity production is planned to come from renewables, predominantly solar PV. The government plans to reach installed capacity of solar PV of at least 6.5 GW in 2030, which will likely be reached well ahead of time. Long-term projections indicate an increased dominance, reaching 12 GW in 2040 and increasing further on towards the net zero emission goal of 2050.

The shift to a solar-based power system requires a shift in the system operation. Today, the Hungarian electricity system is (like in most other countries) based on a centralised structure around large generation facilities. The deployment of a greater share of variable renewable electricity generation, notably solar PV, changes this structure to a more decentralised system. The secure integration of rising shares of solar PV into the electricity grid will require substantial investments in grid infrastructure and new solutions for storage and other forms of flexibility, such as demand-side management.

As of 2021, Hungary was not yet reporting any curtailment of PV generation, but this is likely to occur soon if substantial investments in storage and flexibility are not forthcoming. The scale of investments in variable renewable electricity generation must be matched by an equal scale of investments in storage and flexibility solutions, also including seasonal storage, to avoid too much curtailment. In line with the goals of the National Energy Strategy 2030, calls for tenders have been issued for innovative electricity storage. The

scale and speed of transformation that the electric system are facing is huge and a big challenge for TSO and distribution system operators (DSOs) alike. Careful monitoring of the development, contingency planning, good future projections and strategies and regularly updating them will be of utmost importance.

Installed wind power capacity has not increased in the last ten years. Legislation introduced in 2016 declared that wind turbines cannot be installed in a radius of less than 12 kilometres from populated areas, *de facto* bringing wind power development in Hungary to a standstill. Hungary's energy and climate policies also do not include wind power in the future electricity generation mix beyond the existing capacity. This is a missed opportunity, as the variability of solar and wind can compensate each other at times, reducing stress on the limited dispatchable sources Hungary has. To date, Hungary banks on the use of the renewable energy potential of its neighbouring countries, such as Austria.

The wind conditions in Hungary are not excellent, but are sufficient to be exploited more. The legally mandated 12-kilometre minimum distance to the closest populated areas is considerably greater than in most other European countries. Noise regulations and local permitting from municipalities are alternatives that could replace this limit for the planning of wind farms with respect to populated areas.

The financial and regulatory conditions for renewable energy investors need to be facilitated across government. Renewable energy use in industry is another important avenue for Hungary's net zero energy future. Investors in large projects that are not eligible for renewable energy support are subject to a Robin Hood tax, with a 31% deduction for pre-tax profit, a tax burden which may hinder future renewable energy investment.

Renewables in heating and cooling

Driven by solid biomass use, renewables in heating experienced rapid growth between 2009 and 2013, when the share of renewables in heating reached a record high of 24%. Driven by milder winters and switching from firewood to natural gas following price signals, biomass use has decreased. In 2019, most of the renewable heat was generated from solid biomass (89%), followed by geothermal (8%) and small shares of renewable waste (1.7%), biogas (0.8%), and solar thermal and heat pumps (0.7% each).

Hungary is committed to increase the share of renewables in heating and cooling to 30% by 2030. Biomass is important in the short to medium term, but in the long run priority is given to heat pumps and other electric heating solutions, due to the limited availability of sustainable biomass. In addition, the National Energy Strategy 2030 also supports the development of electricity-based heating in regions where the use of the gas distribution network is below average, and in areas where no access to the gas distribution grid is available.

District heating is one good option for decarbonising the heating and cooling sector. The potential for geothermal energy is of particular interest for Hungary and is significant (estimated at 30-65 PJ/year), but progress has been slow and there are no targets. However, the government is setting up the Geothermal Guarantee Fund and the Green District Heating Programme. The IEA encourages the government to promote all efforts to reach the targets of the Green District Heating Programme (defined by the NECP) and to establish the Geothermal Guarantee Fund (as planned under National Energy Strategy 2030). International experience shows that geothermal energy requires a range of specific framework conditions to spur investment.

The use of heat pumps is another technology option under the long-term strategy for switching away from fossil energy in heating and cooling. The National Energy Strategy 2030 has a goal of at least 400 MW of heat pump capacity with 100 000 systems (up from 148 MW in 2019). Compared to the potential, this is a modest target and development can be ramped up. If the regulated price for gas were to be removed, this ramp up could probably be achieved without economic support for those households that are not “energy poor”. Increased prices for natural gas and information and marketing campaigns would help this market take off.

Renewables in transport

In 2020, renewables in transport accounted for 11.6% of Hungary’s gross final transport consumption, using the Eurostat definition, of which biodiesel accounted for 67%, biogasoline 20% and renewable electricity 14%. Growth of the sector is driven by the support scheme with quotas for biofuels, which were raised over time. Starting 1 January 2020, the mandatory minimum content of the renewable blending component for petrol and diesel increased from 6.4% to 8.2% and to 8.4% from 2022. The bioethanol minimum ratio is 6.1%.

Total energy consumption for the transport sector is increasing, and although the share of renewable energy has increased, this also means that the total use of petroleum products has increased. The objective until 2030 is to limit this growth to a maximum of 10%.

For 2030, Hungary increased its 8% target to 14% of renewables in transport, to be reached by 7% of first-generation biofuels, 3.5% of second-generation biofuels and biogas, and 3.5% of electricity.

Most of the specific incentives in place target passenger transport. Making the transition to zero emissions in the long-distance freight transport sector is an even bigger challenge. It is important to have good data, clear ambitious targets and adequate policies for freight.

Electric mobility and hydrogen have been identified as key technologies for the transport sector under the long-term strategy. Thanks to incentives, the number of EVs has grown steadily, although from a low level. The share of EVs in the total passenger vehicle fleet is still low (0.3% in 2020). Investments in charging infrastructure and grids for fast charging are a prerequisite for the successful roll-out of EVs.

As a country with a strong agricultural sector, there is likely good potential for production of biogas and second-generation biofuels. The decarbonisation of the transport sector will increase the demand for biofuels around the world. Domestic production is a strategic resource that can lower the import dependency of fuels for Hungary.

The IEA considers the targets for biogas in the National Energy Strategy 2030 low compared to the potential. Biogas can play an important role for part of the decarbonisation needs by creating circular flows where different residual streams are utilised and recirculated. The competence and capacity to implement these solutions on a larger scale are available within the region, with several neighbouring countries investing in the technology. Predictable market conditions that create demand for biogas and second-generation biofuels are important for companies to make investments in these facilities. Biogas can also be used to substitute fossil gas in the gas system, but incentives will be needed to promote investments in biogas production.

Recommendations

The government of Hungary should:

- Strengthen the ambitions and national targets for renewables in the different sectors, in line with the increased ambitions from the EU Fit for 55 package.
- Adopt additional policies for storage and demand-side management for the system integration of variable renewable electricity generation.
- Reduce barriers in permitting of renewable electricity installations to improve the resilience, diversity and efficiency of the electricity system, notably for wind power and geothermal energy.
- Analyse and implement additional policies to facilitate a fast transition to zero-emission vehicles and to make use of the potential of domestic production of sustainable biofuels and biomethane, with specific attention to freight transport.
- Create specific support schemes for geothermal energy in district heating and heat pumps to ramp up the ambitions for the transition from fossil fuels in the heating and cooling sector for households and industry.
- Support the Hungarian industry in the transition towards net zero emissions by developing detailed road maps for different sectors and by designing funding schemes for clean energy technology projects.

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6. Energy research, development and innovation

Key data (2020)

Total public RD&D expenditure: EUR 16.1 million

Share of GDP: 0.012% (IEA average:* 0.04%)

Share of energy in total RD&D: 0.2%

* Average of 25 IEA countries as data for Australia, Finland, Greece, Italy, Luxembourg, New Zealand, Spain and the Republic of Türkiye (hereafter, "Türkiye") are not available for 2020.

Overview

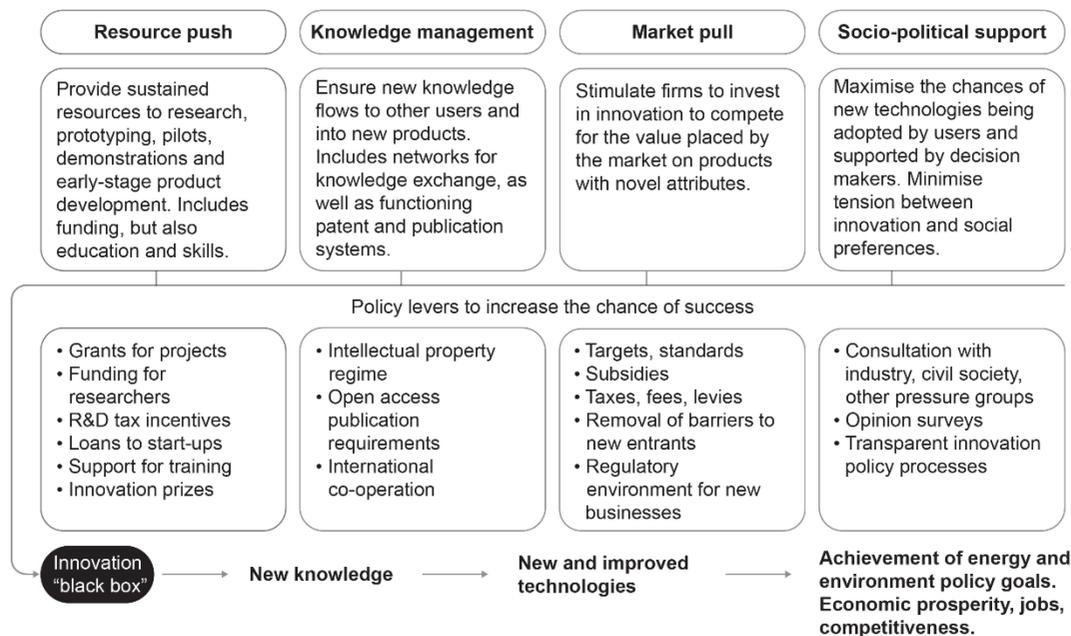
With the Ministry for Technology and Industry (MTI) in charge of energy and climate policies, Hungary has a solid institutional framework and potential to develop its capacities in the area of energy research and development (R&D).

Hungary's excellent network of national laboratories, with strong international and private partnerships, illustrate this potential. In the energy sector, public R&D funding is focused on solar energy and smart grids, while private funding on R&D focuses on the automotive sector and hydrogen. However, Hungary's public funding for energy R&D and technology and innovation collapsed in 2012 when it amounted to EUR 100 million and has not recovered since. In 2020, it amounted to EUR 16 million.

To keep up the pace in the roll-out of the key technologies as set in Hungary's NECP, such as solar PV, batteries and electric mobility, Hungary will need to rely on critical minerals and technology developments globally and in Europe. It is necessary to secure the value chains and access to the materials, as they will be of high demand globally. Developing and securing the competences needed for the implementation of these key technologies is also necessary for their successful and efficient roll-out. Hungary has a lot of potential to boost its technology and innovation in the energy sector, but has no dedicated strategy for clean energy technologies.

IEA framework for energy innovation policy

Technology innovation processes are complex and decision makers must pay attention to a variety of elements that characterise successful energy innovation systems (IEA, 2020). The IEA groups these elements into four core functions: A) resource push; B) knowledge management; C) market pull; and D) socio-political support (Figure 6.1).

Figure 6.1 The IEA's four functions of a successful innovation ecosystem for energy

IEA. All rights reserved.

Source: IEA (2020)

Successful innovation systems involve a wide range of actors and a wide variety of functions, each of which can be enhanced by public policy. Such a system will need to have action under each of these four headings to successfully translate research into technological change.

A sustained flow of R&D funding, a skilled workforce (e.g. researchers and engineers) and research infrastructure (laboratories, research institutes and universities) is required: these resources can come from private, public or even charitable sources, and can be directed to specific problems or basic research (resource push).

Knowledge should be exchanged easily between researchers, academia, companies, policy makers and international partners (knowledge management).

The expected market value of the new product or service must be high enough to make the R&D risks worthwhile, and this is often a function of market rules and incentives established by legislation. If the market incentives are high, then much of the risk of developing a new idea can be borne by the private sector (market pull).

There needs to be broad socio-political support for the new product or service, despite potential opposition from those whose interests might be threatened (socio-political support).

This chapter applies this IEA innovation framework to the Hungarian case to assess the current state of play and derive concrete recommendations to enhance clean energy innovation (IEA, 2020). It includes: A) energy R&D strategies and recent trends in funding for energy R&D by public and private actors; B) an overview of key knowledge institutions and management; C) illustrations of public support for business innovation and market creation; and D) references to monitoring frameworks to track innovation progress.

A. Strategies for energy R&D and innovation

The energy sector is covered under several relevant policy and strategy documents that define Hungary's approach to energy research, development and demonstration (RD&D), including the National Research and Development and Innovation Strategy, the National Energy Policy for 2030, the National Energy and Climate Plan, and the National Clean Development Strategy. Hungary does not have a dedicated energy research, development and innovation (RDI) strategy. In 2021, Hungary adopted the National Hydrogen Strategy (Hungary, 2021) as hydrogen is identified as a key contributor for the energy transition and for reaching the carbon neutrality target in 2050 (see Chapter 2).

Together these strategic documents drive Hungary's energy RDI policy and are generally in agreement, with goals for energy RDI that support an increase in the country's RDI performance and maximise the economic development opportunities generated by the needs to mitigate and adapt to climate change and the provision of sustainable energy supply.

The National Research and Development and Innovation Strategy (2021-2030) was approved by the government on 13 July 2021 and is the country's overall horizontal strategy aligned with the EU's development cycle. The strategy sets horizontal objectives across the economy:

- encouraging openness to innovation, creative thinking and value creation
- creating an RDI-supporting regulatory framework and business environment
- strengthening regional, social and economic cohesion through RDI
- creating a funding system that promotes both stability and provides new incentives
- stimulating challenge- and demand-driven RDI
- ensuring gender equality in the RDI system.

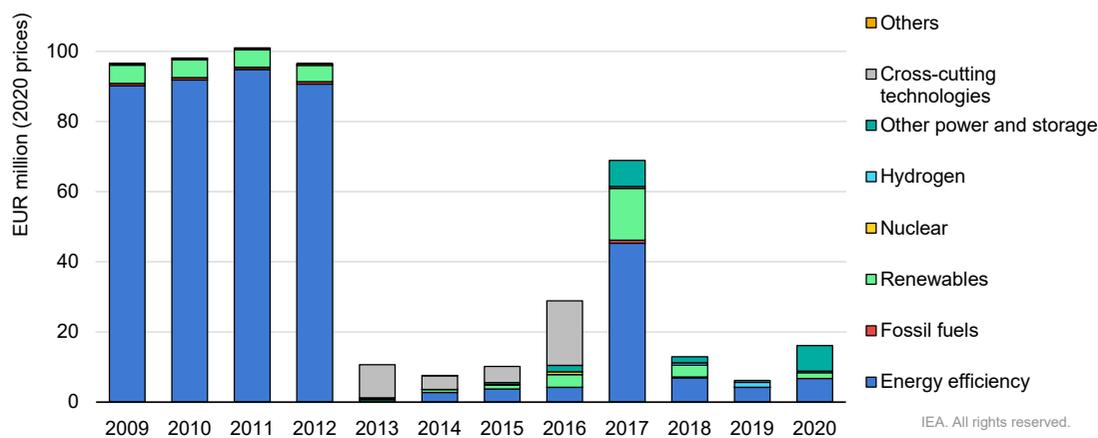
Adopted in July 2021, the new national Smart Specialisation Strategy (S3) runs alongside the period of the RDI strategy across sectors. One of the S3's eight priority areas, the energy and climate priority supports RDI related to energy production, storage, use and dissemination of existing and new technologies that replace natural gas, oil and petroleum products and to reduce the use of fossil fuels through improved energy efficiency and the creation of a hydrogen economy. As Hungary expects nuclear to play an important role in its energy transition, RDI activities related to nuclear technology innovation, the safe use of nuclear energy and the storage of radioactive waste are included. In October 2018, the MIT launched the Energy Innovation Council for nine key areas:

- innovative system balancing (flexibility, storage and demand-side management)
- innovative energy supply solutions such as smart metering
- energy efficiency innovation programmes
- facilitation of the use of Hungary's natural gas reserves to increase domestic production
- smart regulation, including introducing regulatory sandboxes
- greening transport
- use of renewable sources with a focus on non-variable technologies
- innovation in the nuclear energy sector
- innovative seasonal electricity and heat storage solutions.

Public funding for energy R&D and innovation

In 2020, Hungary invested HUF 5.7 billion (EUR 15 million) in energy-related RD&D (Figure 6.2), much below the average funding levels of IEA member countries. After the collapse of public funding in 2012 (around EUR 100 million), the government has not been able to recover funding levels, with the exception of 2017, when it amounted to around EUR 70 million. Renewable energy and energy efficiency remain the most important priority sectors for public R&D funding, followed by energy storage technologies.

Figure 6.2 Energy-related public RD&D budget by sector in Hungary, 2009-2020



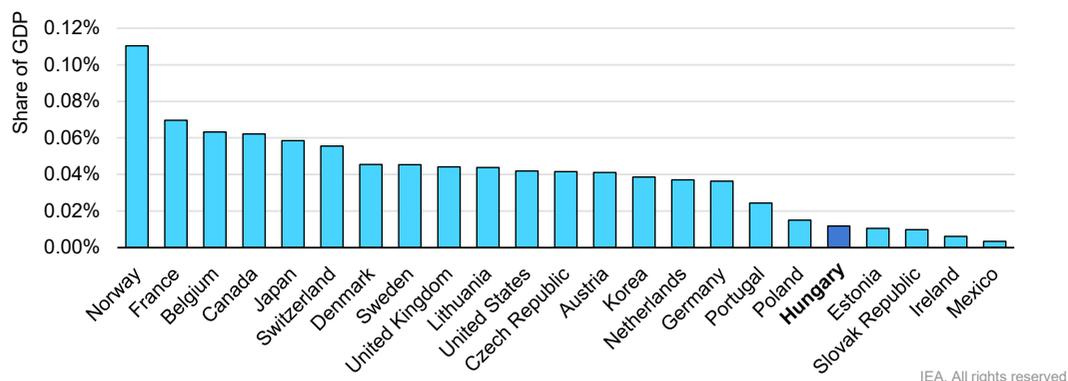
Source: IEA (2021).

The National Research, Development and Innovation Office (NRDI) is responsible for the government's public funding of RDI activities. Hungary relies on two main channels of public support for RDI: the EU and the NRDI Fund, though the NRDI Fund is not energy-sector specific. And while the NRDI has no specific objectives related to energy RDI, it is in charge of managing the energy invocation calls. Funding for those comes from the "Green Economy Financing Systems" Scheme.

In 2020, the MTI, jointly with the NRDI, launched four energy innovation calls to support investments in clean energy solutions and for the transition to a carbon-neutral economy. Two more calls were launched in 2021. The four calls in 2020 focused on pilot projects to:

- establish and operate energy communities (EUR 5.6 million)
- support alternatives to natural gas supply of residential and commercial buildings (EUR 8 million)
- improve power grid stability and resilience (EUR 8 million)
- support the conversion of excess carbon-free power-to-gas (hydrogen and biomethane) (EUR 22 million).

With an energy-related RD&D budget of 0.012%, Hungary ranks fifth-last in an IEA comparison.

Figure 6.3 Energy-related public RD&D spending per GDP in IEA countries, 2020

IEA. All rights reserved.

Note: 2020 data are not available for Australia, Finland, Greece, Italy, Luxembourg, New Zealand or Türkiye.

Source: IEA (2021).

B. Knowledge management

The MTI is responsible for climate, energy, transport, waste and industry, and innovation policy making and design. It also prepares both the innovation and energy strategies and related policy documents.

The NRDl Office supports Hungary's national research infrastructure and its laboratories of international significance across all sectors and the Energy Research Centre (NRDI, 2020).

Similar to the US lab concept, Hungary has set up 17 national laboratories that serve as a platform to engage with leading Hungarian business and international partners for exploratory and experimental research. Four of the laboratories carry out activities in the energy sector, with a focus on electronics, electric vehicles, and smart grids and systems, such as the Budapest Neutron Centre, the FIEK MVM Smart Power Laboratory, the Modular Hybrid Drive System Laboratory and the Atomki Tandetron Laboratory. In the field of environment and climate change, the centre for international territorial water management and climate adaptation at the University of Debrecen focuses on the use of solar power in agriculture.

Hungary plans to set up a network of science and innovation parks to foster technology transfer and increase co-operation between research and businesses. Not many details are available yet, nor has it been decided if one of those parks will be focused on energy and climate.

At the international level, Hungary is not a member of the Clean Energy Ministerial, nor of Mission Innovation. It only participates in one IEA technology collaboration programmes on fluidised bed conversion.

Most international RDI co-operation is undertaken within the EU Horizon 2020 framework. Since 2017, Hungarian applicants, mainly from the private sector, have been granted EUR 26 million in funding for 83 international collaboration projects in the field of energy and climate science.

Hungary also joined the ERA-Net Smart Energy System Programme and by 2021, one Hungarian participation in a call, jointly with partners from Germany and Sweden, was successful. The call focused on how innovative network management solutions can increase the integration of renewable energy sources in distribution networks.

Hungary is also a member of the Visegrad group of countries (V4). The V4 entered into an agreement with Korea that included research in the field of energy and climate; two projects are currently ongoing.

Hungary also maintains a portfolio of bilateral science and technology collaboration with energy innovation as a key focus. Since 2017, 24 bilateral projects in this area received EUR 2 million in funding. The main partners were India, Korea, Thailand and Türkiye.

C. Public support for business innovation and market creation

Private funding comes from energy companies active in Hungary. For instance, the Hungarian Gas Storage company is involved in the Aquamarine project (Box 6.1) that plans to implement an electrolysis system with around 2.5 MW performance and a corresponding hydrogen gas preparatory technology at the Kardoskút underground gas storage site for blending hydrogen into the gas network. Total project costs are around EUR 8 million, with around EUR 5 million to be provided from the innovation call and the remainder from the company.

Aligned with Hungary's large automotive sector, the country supports market creation and business innovation in EVs and smart mobility. A battery factory will be built and run by SK Innovation (the world-leading manufacturer of batteries for e-mobility solutions and energy storage systems). The government gears research infrastructure to serve the needs of the automotive industry, notably on EVs and autonomous driving. Two examples are worth highlighting: the ZalaZONE's vehicle test track in Zalaegerszeg simulates real urban environments and the Budapest University of Technology and Economics' Modular Hybrid Drive System Laboratory allows EV makers to test drive systems and components.

D. Monitoring and evaluation

The NRD Office is tasked with the monitoring and evaluation of overall RDI projects, including for energy. This is done by examining the regular written reports by project beneficiaries and by conducting individual interviews. The NRD Office also undertakes special audits to ensure the proper use of funds. The monitoring focuses on formalities such as the deviation from work plans and changes in staff working on a project as well as on the proper use of resources.

The government is creating a dedicated monitoring and evaluation system for the new RDI strategy which may cover aspects such as the institutional framework for RDI, regulatory instruments and legislative background as well as the evaluation of individual measures and schemes. The RDI strategy will be assessed at the mid-term of implementation to allow corrective measures to be taken if needed.

The government also has a dedicated monitoring framework for the S3 strategy that will assess alignment with priorities, the achievement of objectives and the governance

structure. The framework builds on the lessons learnt from the earlier S3 strategy that covered the period 2014–2020, which showed that there was insufficient targeting of funding among priorities and that the priorities were too broad in general and did not achieve the objectives, It is to steer RDI towards real specialisation.

Special focus – Hydrogen

On 12 April 2021, the government adopted a National Hydrogen Strategy and created a National Hydrogen Strategy Board in August 2021 to provide proposals and advice for implementing the strategy. The strategy's key objective is the creation of a hydrogen economy to help Hungary become carbon neutral by 2050 (Hungary, 2021). The importance of developing and deploying hydrogen is also recognised in the NECP, the NES 2030 and the National Clean Development Strategy.

In April 2021, Hungary established a National Hydrogen Technology Platform that issued a white paper as the basis for preparing a hydrogen economy development strategy (adopted on 12 May 2021). The platform brought together stakeholders from government, industry and the research community. In August 2021, the platform was transformed into the Hungarian Hydrogen Technology Association, which will be supporting the implementation of the Hydrogen Strategy.

The Hydrogen Strategy recognises the key role of hydrogen derived from renewables. However, it also highlights the potential of hydrogen production from nuclear energy, and the contribution of other types of low-emission hydrogen to support the development of a viable hydrogen market. The strategy spells out quantitative targets for 2030 (Table 6.1) and projects (Table 6.2).

Industry and transport will drive demand for hydrogen. Consumption of hydrogen will gradually widen from ammonia production, other chemical industries and the refining sector in 2020 to the transport sector and for blending with natural gas by 2030, and further to the steel and cement sectors by 2040.

Until 2030, hydrogen supply will predominantly be hydrogen, derived from fossil fuels, with hydrogen produced from renewables only accounting for marginal shares. However, by 2040, the ratio will change and grey hydrogen will account for less than 10% of total production (Hungary, 2021).

In 2020, Hungary produced 160 000 t via steam methane reforming and approximately another 100 000 t as a by-product. In April 2021, the country's first hydrogen refuelling station opened in Budapest.

The government has identified six priority projects for implementing the strategy.

To support the development of a hydrogen economy, the government plans the creation of so-called hydrogen valleys: a portfolio of interconnected projects that demonstrate how an entire hydrogen ecosystem can be created in specific regions. The aim is to create two hydrogen valleys by 2030. The hydrogen valleys will also offer new economic opportunities for Hungarian manufacturing industries and technology development, with a special focus on SMEs.

The government plans to put in place a supportive regulatory framework to accelerate the development of the hydrogen economy. Specifically, Hungary is implementing several hydrogen pilot projects, which have already identified some regulatory barriers such as the lack of guarantee of origin scheme. As a next step, Hungary will propose the implementation of a regulatory sandbox. However, the implementation of a regulatory framework for hydrogen is subject to establishing an enabling legal and regulatory framework at the EU level; work on this is ongoing.

Moreover, Hungary plans to create a National Hydrogen Technology Laboratory as part of the Renewable Energy Laboratory to foster RDI.

Table 6.1 Target system of the National Hydrogen Strategy (priority objectives)

Priority objectives 2030			
Production of large volumes of low-carbon and decentralised carbon-free hydrogen	Decarbonisation of industrial consumption, partly with hydrogen	Green transport	Electricity and (natural) gas support infrastructure
Establishing the conditions necessary to produce low-carbon and carbon-free hydrogen that is in compliance with user requirements and is competitively priced.	At first, predominantly low-carbon hydrogen will be used to make the industrial processes and product use “more green”, with a shift to carbon-free hydrogen in the longer term.	Accelerating the transition to clean transport modes through a gradual transition from gas oil use to clean alternatives. By 2030, hydrogen could be an alternative in heavy-duty vehicle traffic.	Make the sector able to integrate primarily seasonal energy storage ability – through intersectorial synergies, establishing infrastructure that will enable the transition to carbon neutrality and reconstructing existing infrastructure.
<ul style="list-style-type: none"> • 20 000 tonnes/year low-carbon hydrogen • 16 000 tonnes/year “green” and other carbon-free hydrogen • 240 MW electrolyser capacity 	<ul style="list-style-type: none"> • 20 000 tonnes/year low-carbon hydrogen • 4 000 tonnes/year “green” and other carbon-free hydrogen • 95 000 tonnes of CO₂ emissions avoided 	<ul style="list-style-type: none"> • 10 000 tonnes/year “green” and other carbon-free hydrogen • 20 hydrogen refuelling stations/40 refuelling points • 4 800 hydrogen fuel cell vehicles • 130 000 tonnes of CO₂ emissions avoided 	<ul style="list-style-type: none"> • 60 MW average cut-off capacity • Minimum 2% per year volume blending ratio in the natural gas system (where appropriate)

Note: Low-carbon and green hydrogen are the terms used by Hungary’s Strategy.

Source: Adapted from government of Hungary (2021).

Table 6.2 Priority projects of the National Hydrogen Strategy

Name of the project	Connection to the objectives of the strategy	Main elements of the project	Estimated need for support, HUF billion
Greening Freight Traffic	<ul style="list-style-type: none"> Greening transport Exploiting industrial and economic development opportunities 	<ul style="list-style-type: none"> ✓ Construction of a refuelling network ✓ Development of the hydrogen-powered truck background and service sector ✓ Purchasing vehicles 	35-40
Greening of local transport-related public services (Green Bus Program Plus)	<ul style="list-style-type: none"> Greening transport Exploiting industrial and economic development opportunities 	<ul style="list-style-type: none"> ✓ Construction of a refuelling network ✓ Development of hydrogen-powered refuse collection vehicles and buses ✓ Background industry structure ✓ Purchase of vehicles 	10-20
Hydrogen Valley Project	<ul style="list-style-type: none"> Decarbonising industrial consumption Greening transport Exploiting industrial and economic development opportunities High-volume carbon-free hydrogen production 	<ul style="list-style-type: none"> ✓ Establishment of two hydrogen valleys: <ul style="list-style-type: none"> • for industrial use in north-eastern Hungary • for mixed use in a decentralised manner in Transdanubia 	10-15
Carbon-free hydrogen production, transport and energy storage (Hydrogen Highway Project)	<ul style="list-style-type: none"> High-volume carbon-free hydrogen production Supportive electricity and (gas) gas infrastructure Exploiting industrial and economic development opportunities 	<ul style="list-style-type: none"> ✓ Production of green hydrogen ✓ Adapting existing natural gas transmission and storage, as well as the end-user side ✓ Energy storage ✓ Building background industry 	20-30
Blue Hydrogen Project	<ul style="list-style-type: none"> Decarbonising industrial use High-volume carbon-free hydrogen production 	<ul style="list-style-type: none"> ✓ Dissemination of carbon capture and storage technology ✓ Research on the utilisation of CO₂ ✓ Pyrolysis pilot project ✓ Construction of background industry and services 	20
Research, development and innovation (RDI) for building a hydrogen economy	<ul style="list-style-type: none"> RDI and education that support the success of hydrogen in the transition 	<ul style="list-style-type: none"> ✓ RDI for other priority projects (focus on basic and applied research) ✓ Education training 	10

Note: Low-carbon and green hydrogen are the terms used by Hungary's Strategy.

Source: Adapted from Hungary (2021).

Box 6.1 Aquamarine hydrogen production and storage project

In the context of the EU-funded project Sustainable Energy Storage Innovations in the Danube Region Countries, the Aquamarine project, operated by the Hungarian Gas Storage company, aims to implement hydrogen production via electrolysis at a large scale, and combine it with underground hydrogen storage at an existing facility.

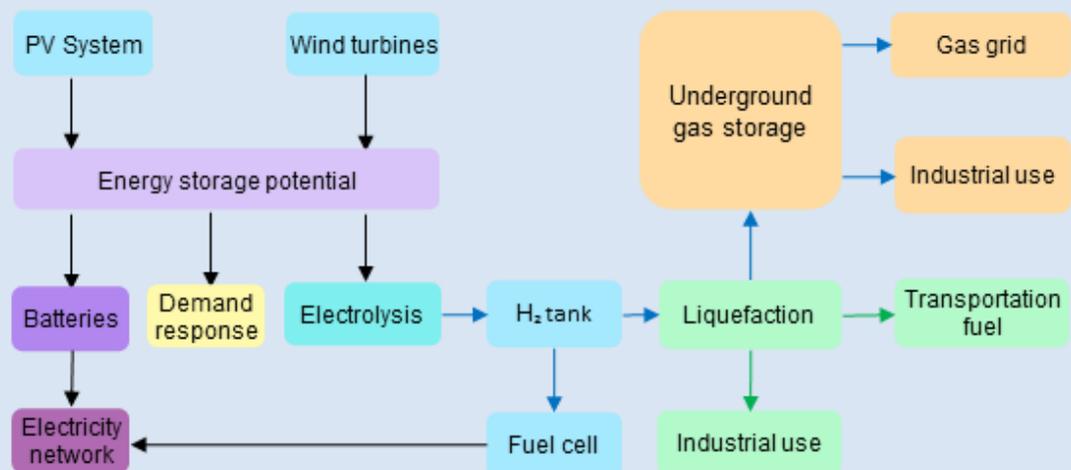
Central in the project is the construction of a 2.5 MW electrolyser, aimed to produce hydrogen with the excess electricity produced from variable renewables (Figure 6.4). Hydrogen is then stored and either used in a fuel cell to produce electricity for the network when needed, or liquefied. The liquefied hydrogen would then be directly used as transport fuel or in industry, or injected in the existing underground gas storage at high pressure (above 100 bar).

The project consortium includes international energy companies, research institutes and universities, to study the suitability of the existing infrastructure for hydrogen-mixed natural gas storage. Technical studies have been carried out by international institutions to study the feasibility of the project using the existing infrastructure, including research works on hydrogen-natural gas mixing, harmful effects of hydrogen on steel of pipelines and liquid hydrogen storage.

Future milestones for the project include: starting in 2023, the production of hydrogen and use of hydrogen-mixed natural gas in applied industrial research programmes; in 2024, the mixing of hydrogen in the natural gas network; in 2025, a joint research programme to study the reservoir for hydrogen-mixed natural gas storage.

In July 2021, the consortium announced that a diaphragm Burckhardt compressor will be used to compress the hydrogen before injection in the underground gas storage.

Figure 6.4 Aquamarine hydrogen project conceptual map



The Aquamarine hydrogen project includes hydrogen production via electrolysis at an existing underground gas facility.

Source: Adapted from: <https://mfgt.mvm.hu/en/Akvamarin>

Assessment

In 2020, Hungary invested 0.2% of its GDP in energy-related R&D, which is the fifth-lowest share among IEA member countries. Hungary does not allocate R&D funds to a specific field of science, so allocations to energy may have been higher than indicated.

Hungary does not have a dedicated energy RDI strategy; innovation in the energy sector is covered by several energy strategies.

The National Research and Development and Innovation Strategy (2021-2030), adopted in 2021, has created a national framework of governance, and is implemented through the new national Smart Specialisation Strategy across sectors. The S3 sets up eight national economic priority areas; energy and climate is one of them. This priority area focuses on energy production, storage, new technologies to replace natural gas and oil-based energy production, reducing the use of fossil fuels, including through improved energy efficiency and the creation of a hydrogen economy.

The government created an Energy Innovation Council in 2018, which has identified nine key areas for energy R&D. Every year, the National Research, Development and Innovation Office creates the budget for energy innovation support. Four energy innovation calls were launched in 2020 to support investments in clean energy solutions and for the transition to a carbon-neutral economy; two more calls were launched in 2021.

Hungary plans to set up a network of science and innovation parks to foster technology transfer and increase co-operation between research and industry. One of the parks will be dedicated to energy and climate.

The government recently developed a National Hydrogen Strategy. Hungary sees hydrogen as a key contributor for the energy transition – power-to-gas technology, and blending natural gas with at least 2% of hydrogen to be injected into the gas grid.

Hungary is also focusing on greening transport and plans to establish the first facility in the EU to test the recycling and reuse of batteries that are no longer usable for electric vehicles. The government also supports pilot projects to test how EVs can increase network resilience, and projects for testing second-generation biofuel production technologies.

Given the current state of play for CCUS technology development, Hungary does not expect a major build-up of CCUS before 2040. Hungary has not set a firm quantitative target for CCUS, although the early action scenario of the National Clean Development Strategy banks on a contribution from CCUS to the tune of 25% of total emissions reductions by 2050. The technology is recognised as a very important condition for the energy transition. Globally, industrial-level application of CCUS is expected to become economically viable in the 2020s and could be used to facilitate the production of “blue hydrogen”.

Hungary has set up 17 national laboratories that serve as a platform to engage with new international exploratory and experimental research. Four of the laboratories are undertaking activities related to the energy sector, with one focusing on climate change. However, Hungary is not very active in multilateral co-operation: it is not a member of the Clean Energy Ministerial, nor of Mission Innovation and only participates in one IEA technology collaboration programme. Most international co-operation falls under the

European framework and under the Visegrad group of countries. Hungary maintains a portfolio of bilateral science and technology collaboration with energy innovation being a key focus.

Like many other countries, Hungary has difficulty attracting young and skilled human resources to the energy sector; this is true for the entire value chain, and especially for conducting fundamental and applied energy- and climate-related research. The country has also had a substantial brain drain in the last decade. By creating a dedicated programme and clean energy technology and innovation strategy, talented Hungarian scientists are tempted to return to the country with offers for employment at universities, research institutes or national laboratories. Such a programme could give the scientists the opportunity to create their own project group in Hungary and conduct research in optimal conditions.

Recommendations

The government of Hungary should:

- Enhance efforts to attract talented people to energy- and climate-related studies and work and improve co-ordination between institutions responsible for the education system and those responsible for research and development policies.
- Put in place an effective evaluation and monitoring programme for research, learning from international good practice and with the view to feed back into setting priorities.
- Increase participation in international research fora such as the IEA technology collaboration programmes and EU R&D programmes, particularly in areas where Hungary already has domestic research, development and innovation activities.
- Expand efforts to collect data related to private sector energy RDI and share methodologies and knowledge with international peers.
- Establish a government research programme for carbon capture, utilisation and storage and hydrogen, linked to relevant international programmes, in light of the important role this technology is to play in reaching Hungary's net zero emissions target in 2050.

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7. Electricity

Key data (2020)

Electricity generation: 34.9 TWh (nuclear 46%, natural gas 26%, coal 11%, biofuels 7%, solar 7%, wind 2%, hydro 1%), -7% since 2010

Electricity net imports: 11.7 TWh (imports 19.2 TWh, exports 7.5 TWh)

Electricity consumption: 41 TWh (industry 49%, buildings residential 29%, buildings services/other 19%, transport 3%), +15% since 2010

Peak load: 7.3 GW (January 2022)

Installed capacity: 10.3 GW (2022)

Overview

Electricity demand in Hungary has been on the rise since 2015, and is expected to grow in the coming decade. Hungary is a net importer of electricity, importing around 30% of its consumption needs, thanks to rising interconnectivity with its neighbours. According to MAVIR, in 2021, nuclear energy accounted for almost half of electricity generation in Hungary, followed by strong contributions from natural gas (28%), coal (11%) and solar (5%).

As set out in the NES and the National Energy and Climate Plan (MIT, 2020), the government aims to reach a 90% carbon-free electricity generation mix by 2030. Coal-fired electricity generation is declining, thanks to the growth of solar and natural gas. Mátra, the last coal-fired power plant, is planned to be closed by 2030, potentially by 2025 under Hungary's pledge in the Powering Past Coal Alliance. Nuclear is set to remain an important source of electricity generation as Hungary invests in the Paks II project, which would bring 2.4 GW on line by 2030. Up to 2030, the government has to manage the transition when retiring coal and existing nuclear, adding new nuclear and 6.5 GW of solar PV generating capacity by 2030 and 12 GW by 2040.

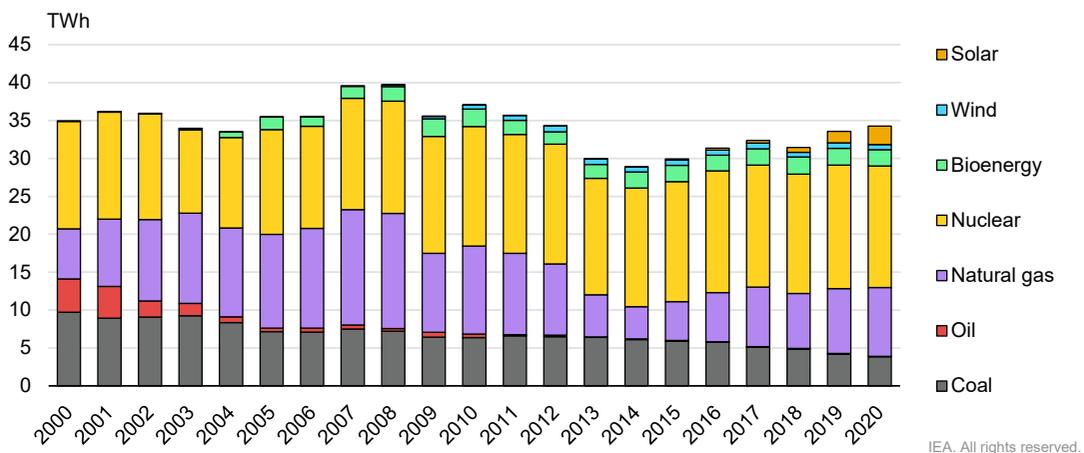
Hungary's electricity market is liberalised, but state-owned MVM is the dominant player in electricity generation, wholesale supply and the retail market. The government operates a Universal Service Scheme which provides household consumers with electricity at regulated prices that are considerably lower than those in neighbouring countries. The NES 2030 called to amend the design of the scheme in line with efforts to spur energy efficiency, smart grids, lower the financial burden on electricity utilities and encourage private participation in the electricity market.

Electricity supply and demand

Electricity generation

Since 2015, electricity generation in Hungary has been on an upward trend, reaching 34.9 TWh in 2020 (Figure 7.1). Nuclear energy produced at the Paks NPP accounted for the largest share, with 16.1 TWh (46%) of electricity generation. Natural gas accounts for the second-largest share (9.1 TWh, 26%), up from just 17% in 2015. Thanks to growth in solar PV, the share of renewables has also been rising and accounted for 16.5%, up from 11% in 2015. The role of coal has strongly decreased, making up 11% of electricity generation in 2020, compared to 21% in 2013. Oil plays a negligible role.

Figure 7.1 Electricity generation by source in Hungary, 2000-2020



Hungary's electricity generation is predominantly from nuclear and natural gas; generation from coal has been declining while renewables generation from solar PV is on the rise.

Source: IEA (2022a).

In total, fossil fuels make up 37% of Hungary's electricity generation mix, which places Hungary in the median among IEA countries when ranking them by fossil fuel use in electricity (Figure 7.2). Despite the substantial role of nuclear energy and the growth of renewable energy capacity, Hungary continues to rely on gas for balancing and on coal-fired generation for baseload requirements.

Total installed electricity generation capacity in Hungary at the end of February 2022 was 10 324 MW, with combined-cycle gas turbine capacity representing the bulk of total capacity (40%), followed by nuclear (20%) and solar (18%) (Table 7.1). The installed capacities of electricity generation sources have remained stable, except for solar, which saw a sharp increase from 70 MW in 2017 to 1 839 MW as of the end of February 2022 (excluding standalone PV).

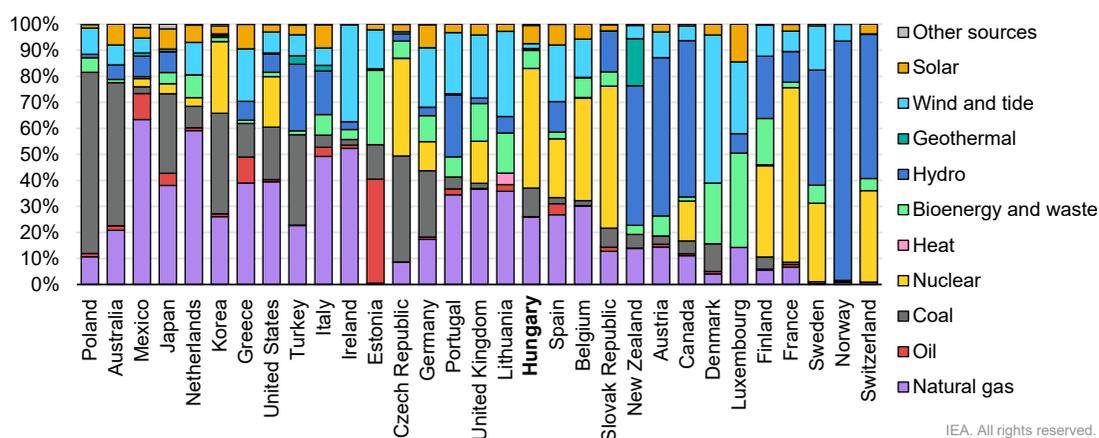
Hungary expects total capacity to increase to 14 500 MW in 2030, with more than a fourfold increase of solar PV and a doubling of nuclear capacity. Natural gas capacity would instead more than halve (see section on electricity security).

Table 7.1 Electricity generation capacity, 2017, 2022 and estimates for 2030

Capacity (GW)	2017	2022	2030*
Coal	1.17	1.17	0
Natural gas	4.19	4.01	1.92
Oil	0.41	0.42	0.42
Nuclear	2.00	2.03	4.54
Wind	0.33	0.32	0.33
Solar PV	0.07	1.83	6.92
Hydro (total)	0.06	0.06	0.06
Bioenergy	0.40	0.34	0.40
Geothermal	0	0.003	0.06
Total	8.62	10.1	14.5

* Estimates based on market simulations in the Hungarian Ten-Year Network Development Plan by MAVIR.

Source: MAVIR.

Figure 7.2 Electricity generation by source in IEA countries, 2020

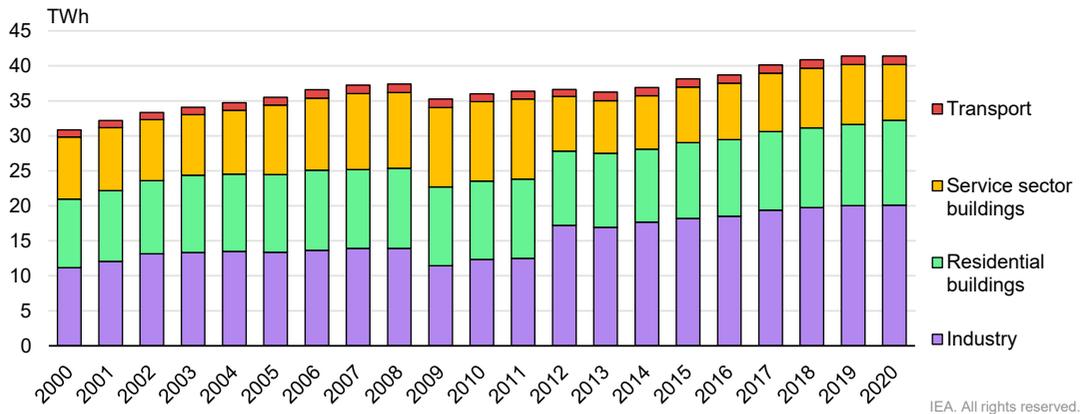
IEA. All rights reserved.

The share of fossil fuels in Hungary's electricity generation mix reflects continued reliance on gas and coal alongside nuclear.

Source: IEA (2022a).

Electricity demand

Electricity demand has risen progressively since 2015, reaching 41 TWh in 2020, a 9% increase on 2015 (Figure 7.3). In 2020, the industry sector accounted for the largest proportion of electricity demand (49%), while residential buildings and services buildings accounted for 29% and 19%, respectively. Demand from the transport sector is relatively minor, accounting for 3% of total electricity demand in 2020. Electricity demand in industry stems from chemical industry and metal manufacturing.

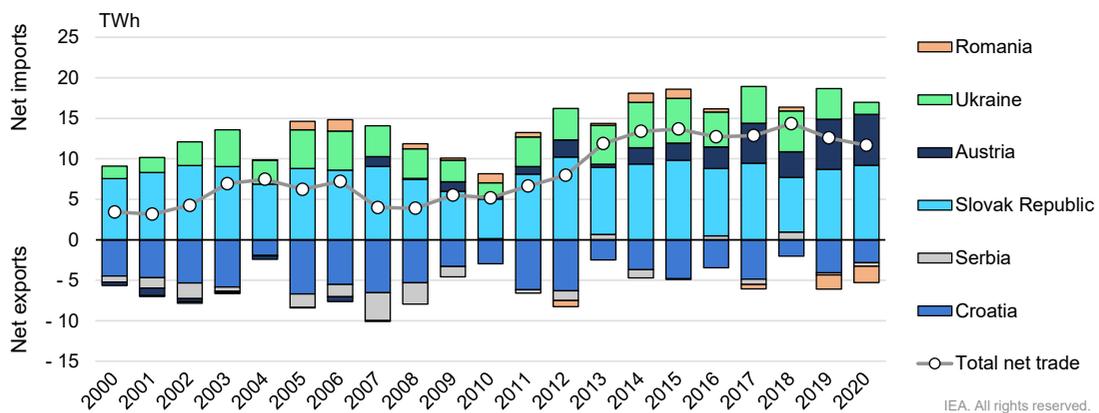
Figure 7.3 Electricity demand by sector in Hungary, 2000-2020

Electricity demand has been on an upward trajectory since the mid-2010s, driven by industry, which together with residential and commercial buildings account for the bulk of demand.

Source: IEA (2022a).

Electricity trade

Hungary is a net importer of electricity, with net imports satisfying around 30% of total consumption. Over the past decade, total net imports have increased, reaching 14.3 TWh in 2018. In the past years, net imports have fallen to 12.6 TWh in 2019 and 11.7 TWh in 2020 (Figure 7.4).

Figure 7.4 Hungary's electricity net imports by country, 2000-2020

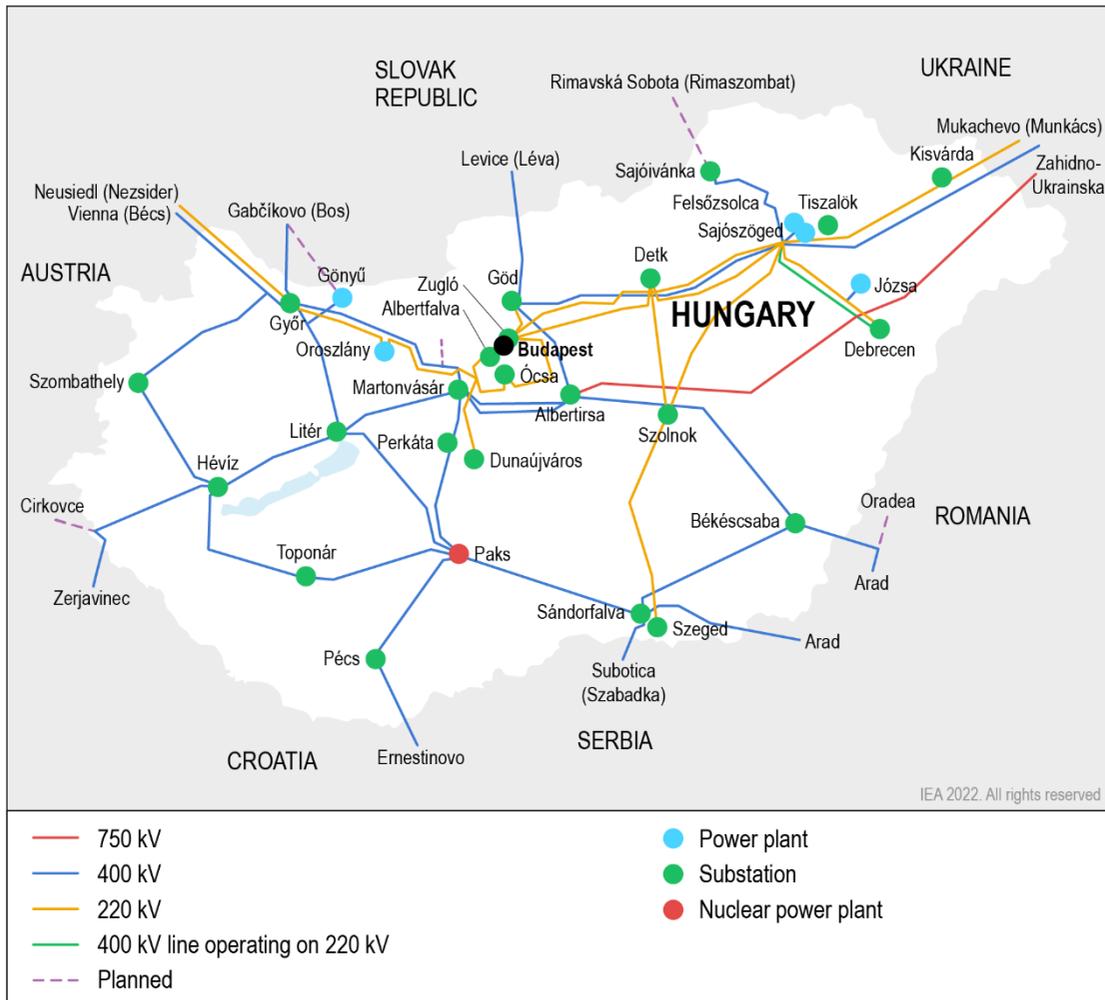
Hungary is a net importer of electricity with imports from Austria, the Slovak Republic and Ukraine.

Source: IEA (2022a).

Cross-border interconnections

Hungary has electricity interconnections with six neighbouring countries (Austria, Croatia, Romania, Serbia, the Slovak Republic and Ukraine). In 2021, the transmission capacity of Hungary's interconnections represented about 55% of the gross installed capacity in Hungary, significantly higher than the 15% interconnection EU target for 2030.

Figure 7.5 Electricity supply infrastructure in Hungary



Three new 400 kV interconnectors with the Slovak Republic were commissioned in 2021, significantly increasing the cross-border capacity between the two countries. An interconnection with Slovenia, the only neighbouring country with which Hungary previously did not have an interconnection, has been completed on the Hungarian side, and is currently under construction on the Slovenian side with an estimated commissioning date in July 2022 (Figure 7.5). The Slovenian project will add around 1 100 MW of new cross-border transmission capacity in total. A new 400 kV interconnection with Romania is also planned for 2030 (ENTSO-E, 2021).

The Hungarian TSO MAVIR facilitated the successful synchronisation of the electricity grids of Moldova and Ukraine with the Continental European Grid on 16 March 2022.

Electricity supply infrastructure

Transmission and distribution systems

Electricity transmission is carried out by MAVIR (Hungarian Independent Transmission Operator Company), a subsidiary of MVM. As such, MAVIR is an independent system operator.

The Hungarian distribution network is 163 854 km in total length, an increase of 2 899 km compared to five years ago. The increase mainly has come from adding new underground cables, with a minor increase in overhead lines. Over the period 2016-2020, Hungary saw an increase in the number of new network connections, mainly due to the construction of new residential buildings and from industrial facilities, official buildings and the service sector. The number of connections for household-sized solar power plants also increased strongly over the period 2018-2020.

Six DSOs are licensed by the regulator, the HEA. E.ON operates three DSOs, covering most of western and central Hungary, including Budapest. MVM operates two DSOs, covering the north-east and south-east regions of the country. OPUS Global operates one DSO in the eastern part of Hungary.

Market structure

The wholesale electricity market is operated by HUPX (Hungarian Power Exchange), which was established as a subsidiary of the TSO, MAVIR, in 2010. HUPX operates the HUPX DAM (day-ahead market) as well as the HUPX IDM (intra-day market) markets. The HUDEX (Hungarian Derivative Energy Exchange) was founded in 2017 by HUPX, and operates the derivatives exchange for electricity. Since 2019, HUPX also serves as the nominated electricity market operator following its nomination by the HEA.

In June 2021, Hungary took another step towards the implementation of the flow-based market coupling, as required under the EC target model. The joint Interim Coupling Project of the German-Austrian-Polish-Czech-Slovak-Hungarian-Romanian electricity TSOs and nominated market operators allows implicit cross-border capacity allocation between Hungary and Austria. With the creation of the single day-ahead coupling, Hungary has now met another main goal of the EU's Third Energy Package. Hungary introduced financial transmission rights in monthly capacity allocation between Austria and Hungary as of July 2021. The flow-based market coupling and the financial transmission rights became operational at the other connection points in early 2022.

Ownership of electricity generation capacity

Hungary's electricity market is liberalised, but state-owned MVM is the dominant player in electricity generation and wholesale supply and is a major company in the retail market.

MVM owns 40% of total installed capacity in Hungary and accounted for a 60% share of total electricity generation in 2020. MVM now owns and operates the two largest domestic power plants, the Paks NPP with (2 000 MW installed capacity) and the Mátra Power Plant (950 MW, lignite, biomass and natural gas). MVM's purchase of OPUS Global's majority stake in the Mátra plant was completed in 2020.

MET Group, an integrated European energy company headquartered in Switzerland, is also a significant player in electricity generation in Hungary. It owns and operates the Dunamenti Erőmű Zrt. Plant (794 MW, natural gas-fired) as well as two large-scale PV parks (Kaba 43 MW and Százhalombatta 17.6 MW). Four other foreign-owned companies own and operate power plants in Hungary with relatively small shares (between 2% and 4%) of total installed capacity. Uniper owns the Gönyű gas-fired power plant (433 MW), Alpiq owns the Csepel power plant and other smaller units (a total of 403 MW), EP Energy has the Budapesti Erőmű Zrt plant and other smaller units (a total of 396 MW), and Veolia has a total of 250 MW in smaller units.

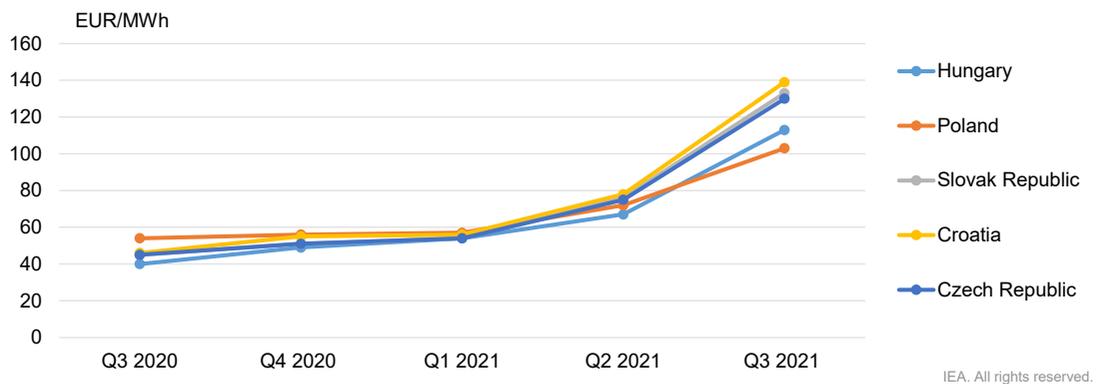
Wholesale electricity market

There are 158 electricity traders registered by the HEA, of which 92 are limited traders and 66 are non-limited traders with the right to supply final consumers.

The wholesale market is divided between sales to the universal service providers and sales to other traders. MVM provided 88% of the electricity sold to universal service providers in 2020 (10.7 TWh). Of the 66 non-limited traders, 2 suppliers hold a universal service licence: MVM and E.ON. ELMŰ-ÉMÁSZ revoked its universal service supplier licence in 2021. Other major players in the wholesale market are Alpiq Csepel Kft., Budapesti Erőmű Zrt., Dunamenti Erőmű Zrt., ISD POWER Kft., Uniper Hungary Energetikai Kft. and Veolia Energia Magyarország Zrt.

In 2020, the HEA carried out an investigation of the level of competition in the electricity wholesale market in Hungary (HEA, 2020). The investigation found that although greater competition from imports has reduced the concentration of the Hungarian wholesale electricity market in the last decade, the wholesale sector can be still considered to be a “concentrated market”, and that MVM's influence is very considerable. As a result, the HEA concluded that MVM subsidiary, Energiakereskedelmi Zrt, should sell an average of 400 MWh/h of electricity annually at a public auction or in stock exchange trading. However, no legal obligation was imposed on MVM to do so.

Driven by increasing gas prices across Europe, Hungary's wholesale electricity prices in Q3 2021 rose to 113 EUR/MWh, from 67 EUR/MWh in Q2 2021 and 40 EUR/MWh in Q3 2020, according to EU data. Neighbouring countries in the EU market have followed similar patterns (Figure 7.6).

Figure 7.6 Average electricity wholesale prices in Hungary and neighbouring countries, Q3 2020-Q3 2021

Source: EU Energy Market Reports data and IEA data, https://energy.ec.europa.eu/data-and-analysis/market-analysis_en

Retail electricity market

In the retail market, E.ON is the market leader, with a 55-58% market share, MVM has a share estimated at 22-24% while other independent traders hold an 18-20% share. In the Universal Service Scheme market segment, MVM is the market leader, jointly with E.ON. E.ON and MVM are also the owners of Hungary's distribution networks. E.ON's market share in the retail sector will likely decrease in the near future following the planned sale of one of its subsidiaries, E.ON Energiakereskedelmi, to the Spanish company Audax Renovables; this sale was approved in 2020.

Electricity prices

Hungary maintains regulated retail prices under the so-called Universal Service Scheme, with 5.3 million consumers covered, of which 5.1 million are households and 0.2 million small businesses. In 2019, 99.6% of electricity provided to household consumers was delivered through a universal service contract. Any consumer can choose to leave the Universal Service Scheme and enter into a market-based contract but, in practice, virtually all household consumers choose to be supplied under the conditions of the Universal Service Scheme. Residential consumers and consumers with a connection capacity of no more than 3 x 63 A for their low-voltage consumption sites are entitled to purchase electricity as a universal service.

The Universal Service Scheme obliges companies which operate in the segment to provide qualifying customers with electricity at prices regulated by the government. The utility has to pay for the difference between the wholesale costs and regulated rates. The vast majority of non-household consumers, which account for around 70% of electricity consumption, cannot avail of the Universal Service Scheme for electricity and therefore purchase electricity on the open market at unregulated prices.

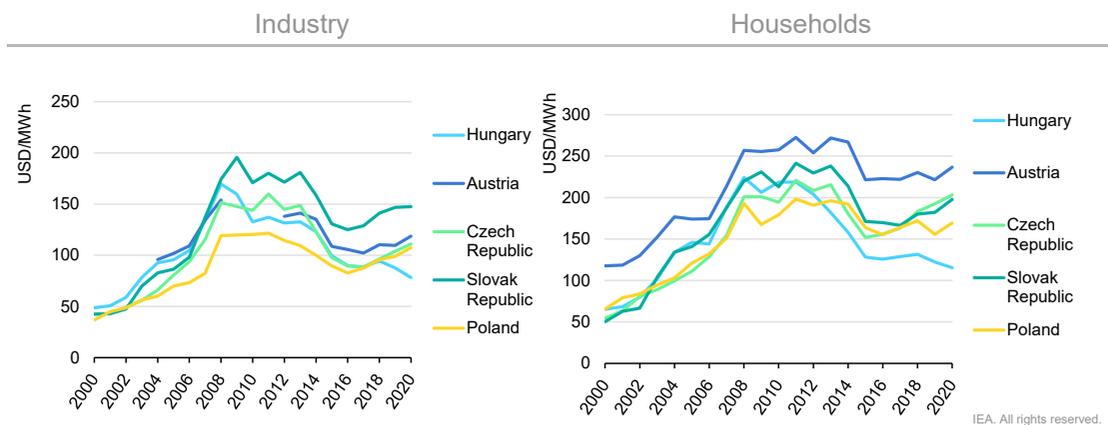
The NES 2030 proposes a review and if necessary revision of Hungary's Universal Service Scheme for electricity. It suggests considering reviewing automatic access to the Universal Service Scheme for consumers and replacing it with a scheme which offers "flexible service packages". However, it should be mentioned that the Hungarian Electricity Act already obliges electricity suppliers to provide dynamic electricity price contracts to consumers.

With the increase in wholesale electricity prices/costs in Europe driven by gas price hikes, regulated electricity retail prices no longer reflect rising gas import and electricity import costs, network tariffs and taxes, meaning that suppliers generally suffer significant losses providing electricity to consumers within the Universal Service Scheme.

In 2020, the average end-user price included the energy component (34%), a supplier margin of 0.4%, a transmission cost of 6.6%, a distribution cost of 38% and VAT of 21%. Non-household consumers operating outside the Universal Service Scheme also pay an energy tax.

Average industry and household retail electricity prices in Hungary are significantly lower than in neighbouring EU countries (Figure 7.7). In 2020, the average electricity price for industry was 78.3 USD/MWh, compared to the IEA EU average of 112.1 USD/MWh. In the same year, the average household electricity price in Hungary was 115.5 USD/MWh, compared to the IEA EU average of 226.3 USD/MWh (Figure 7.8).

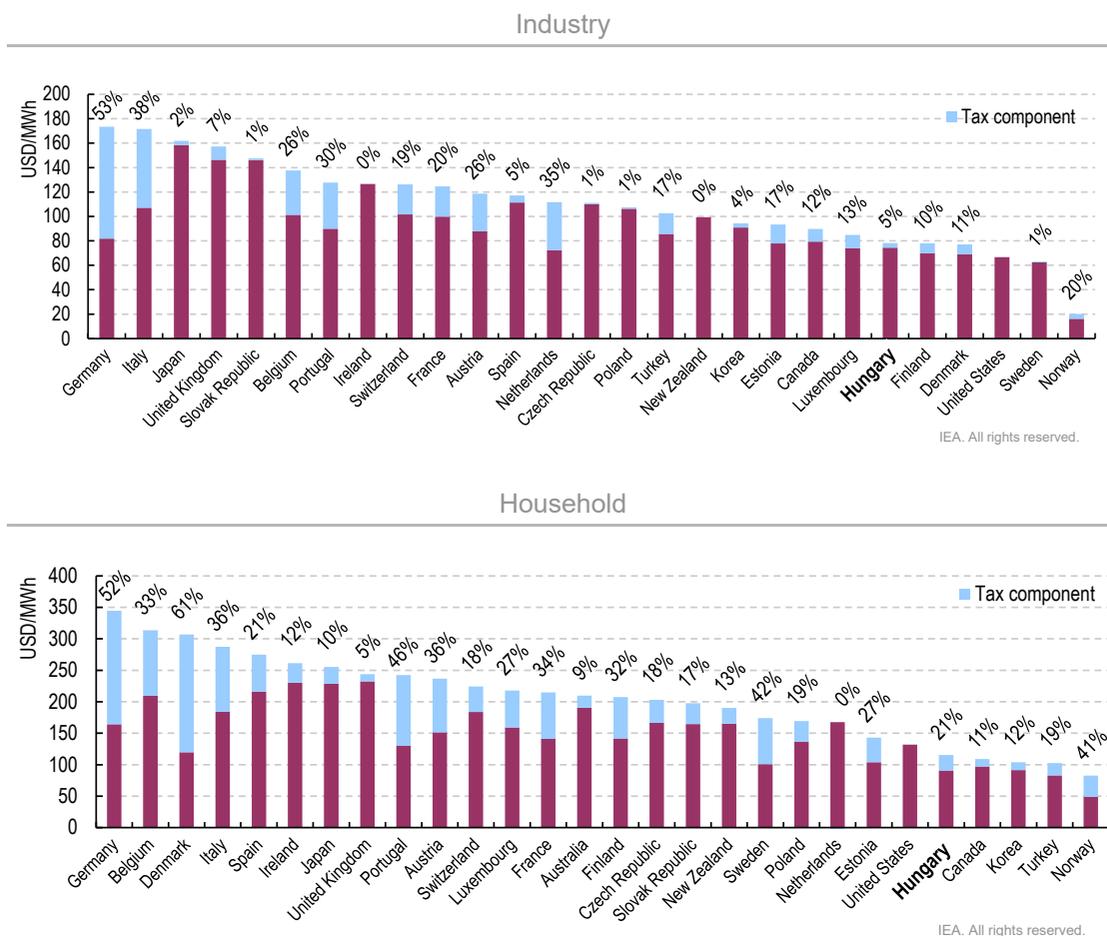
Figure 7.7 Electricity retail prices in Hungary and selected IEA countries, 2000-2020



Hungarian retail electricity prices are the lowest among its regional peers.

Note: Data for Austria's industry prices are unavailable from 2001 to 2003, and from 2009 to 2011.
Source: IEA (2021).

Figure 7.8 Electricity retail prices and taxes in IEA member countries, 2020



Average electricity retail prices in Hungary are well below IEA averages.

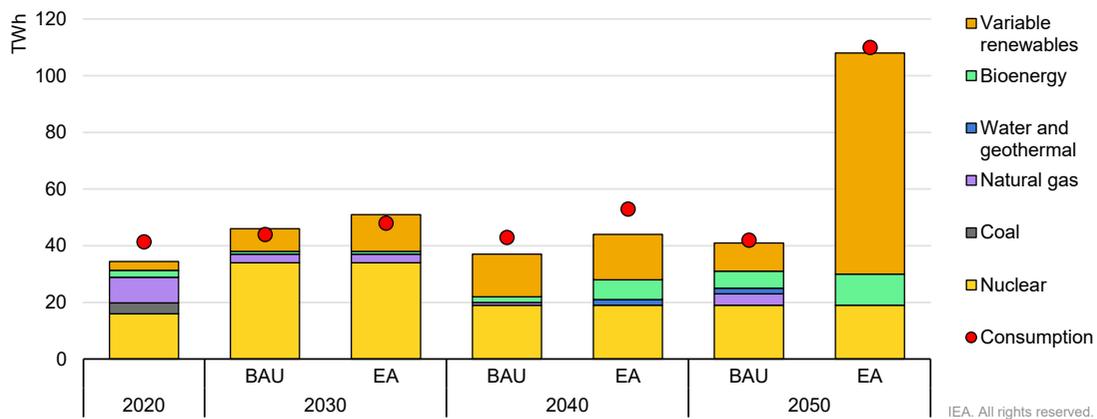
Notes: Tax information is not available for the United States exclusively. Industry price data are not available for Australia, Greece or Mexico; household price data are not available for Greece or Mexico. Source: IEA (2021).

Electricity security

The future of the power mix

The NES 2030 sets out a specific objective to reach 90% of electricity generation from “carbon-free” sources by 2030. Currently, 62% of electricity generation is derived from nuclear and renewables combined. The majority of Hungary’s new “carbon-free” electricity generation by 2030 is expected to be met by nuclear energy, with the Paks II new build. Existing Paks I with its four reactors was built in the 1980s and recently completed a lifetime extension beyond the initial 30 years for another 20 years. After that, existing units of the Paks NPP will be decommissioned, resulting in an increasingly heavy reliance on renewables, and in particular, on solar PV technology.

Figure 7.9 Hungary's electricity generation mix, electricity demand and scenarios for 2030, 2040 and 2050



Notes: BAU = business as usual; EA = early action.

Source: Hungary (2021).

The government's target is to increase PV capacity to 6.5 GW by 2030 and to 12 GW by 2040. The NCDS' early action scenario relies on solar power for baseload. While in the 2020s, Hungary has invested in gas-fired electricity generation as an important source of system flexibility, for 2030, the NCDS does not include gas-fired generation as a key enabling source for the integration of variable renewables. In fact, there is no objective to increase gas-fired electricity generation capacity beyond 2030.

Coal-fired electricity generation, meanwhile, is expected to be phased out by 2030 or even earlier, by 2025, when the Mátra lignite-fired plant will be converted to a gas-fired and renewable installation. A detailed road map for phasing out the Mátra Power Plant's lignite blocks has yet to be finalised, however. It is also yet to be decided whether the planned Mátra gas-fired plant will be compatible with the use of hydrogen co-firing, using CCS.

In 2050, following the phase-out of the existing units at the Paks I NPP, Hungary's generation mix will become heavily reliant on the realisation of plans to significantly increase installed renewables capacity, and in particular on solar PV capacity installation, as shown in the early action scenario in Figure 7.9.

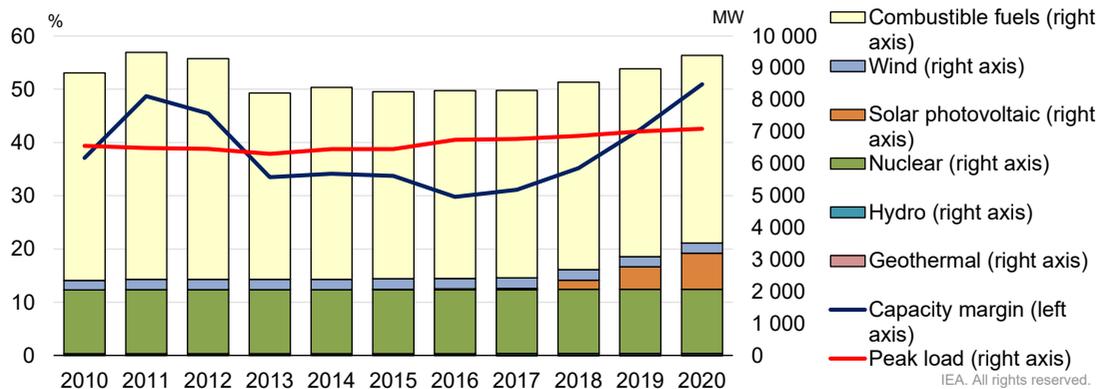
Electricity adequacy

Hungary does not face immediate generation adequacy concerns. With total installed capacity standing at 10 200 MW in 2022, well above the record peak load of more than 7 GW in 2022, the country as a whole enjoys a comfortable capacity margin (Figure 7.10). Rising investment in new capacity, notably solar PV but also new gas-fired power plants, have greatly improved the capacity margins.

An increase in peak loads has been noticeable in the past years. The overall record peak load was reached in January 2022 at 7 396 MW, while a record summer peak load of 6 940 MW was registered in June 2021.

However, electricity demand has increased by 18% since 2009 and MAVIR expects daily gross load to reach 8 250 MW in 2030. Given that demand is projected to grow further, investments in generation, transmission and distribution will be required in the medium to long term.

Figure 7.10 Historic evolution of the capacity margin in Hungary, 2010-2020



Source: IEA (2022a).

Hungary's future generation adequacy will be dependent on the timely completion of the Paks II nuclear project and the Mátra gas-fired plant, in the light of the phase-out of coal-fired electricity generation by 2030 or earlier. If the construction of the Paks II plant does not come forward, Hungary will need to firm up plans and investment for the system integration of very high shares of variable renewables.

System integration of variable renewables

Since the introduction of the new renewables support scheme (METÁR) in 2017, Hungary has already seen a significant expansion of solar capacity. In 2020, solar PV accounted for 7% of Hungary's electricity mix. Due to the government's plans to increase PV capacity, the system integration of solar power will become an increasingly pressing concern around 2030. This will likely require additional investments in the grid, balancing capacities and storage facilities, alongside more electricity imports from increased cross-border transmission capacity.

Investments in networks will be required alongside generation plans. To realise these projects, the Ten-Year Network Development Plan 2020-2030 of the TSO MAVIR was approved by the HEA in February 2021. It includes projects at the transmission level, and DSO projects at 132 kV voltage level until 2035. Hungary's NES 2030 anticipates that around HUF 500 billion (USD 1.6 billion) will be required for strengthening the domestic distribution network by 2030 to facilitate increased consumer demand due to expected electrification and solar energy production.

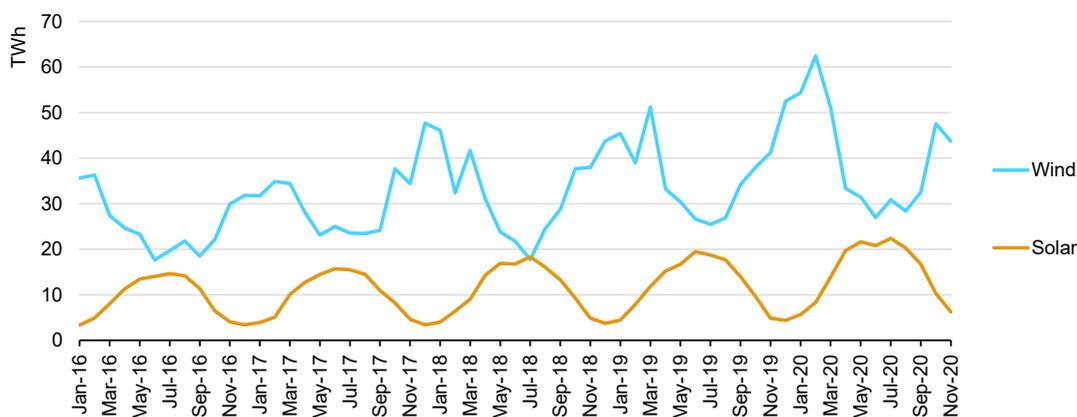
Hungary has access to electricity imports from a range of interconnections thanks to new capacity commissioned with neighbouring Austria and the Slovak Republic, and with Slovenia in 2022. MAVIR envisages improving renewable system integration through regional co-ordination of interconnected control areas of four of the TSOs of Central-Southern Europe. The growing share of renewable electricity units has drastically reduced

the running hours of conventional fossil fuel plants. They are increasingly used to ensure balancing activities and congestion relief through redispatching. The FutureFlow project allows the TSOs to work together on the future balancing and network security challenges.

The significant increase in solar production capacity at distribution levels will also require investment in smart meters, grids and network upgrades. MVM Group signed a new loan agreement with the European Investment Bank for EUR 120 million for the modernisation, digitisation and expansion of the capacity of the electricity distribution network in south-eastern Hungary (such as smart metering, renewable energy sources integration, bird protection, etc.). In October 2020, MVM Group concluded a EUR 100 million loan agreement with the International Investment Bank for investments in the electricity sector, such as smart metering and smart city projects. Under Hungary's National Recovery and Resilience Plan, an investment of EUR 32 million is planned for classic and intelligent network developments of the TSO and the DSOs.

Dispatchable capacity (nuclear, gas, hydropower, geothermal) alongside demand response and energy storage can help smooth the “duck curve” of solar production. Wind power generation could complement solar PV production (Figure 7.9). There are no pumped storage plants in Hungary. In 2021, there were four large-scale commercial battery storage plants (21 MW capacity in total). The first two are used by the TSO for the primary reserve (FCR: frequency containment reserve) and can participate in the secondary reserve market (aFRR: automatic frequency restoration reserve). Further large-scale projects are currently under preparation and construction with a total capacity of 10 MW/20 MWh.

Figure 7.11 Monthly solar and wind electricity generation in European OECD countries, 2016-2020



Source: IEA (2022c).

With regard to demand response, Hungary's regulator had 26 aggregators registered with a total capacity of 820 MW by the end of 2021. Demand response has been enabled in principle since 1 January 2021, but the regulations allowing its implementation are under development. The government aims to increase energy storage capacity to at least 1000 MW by 2026 (from today's 20 MW) and to add 100 MW capacity of demand-side response by 2030.

As an enabler of demand-side response, a target has been set to install 1 million smart meters by 2030, compared to 100 000 currently (or just over 1% of low-voltage connection points). Around 500 000 households, with an annual electricity consumption of over 5 000 kWh, will be obliged to install smart meters, with installation costs covered by the DSOs. The others have to pay for their meter installation.

In 2020, the government created a legal regulatory framework for prosumers, energy communities and aggregators through an amendment to the 2007 Electricity Law (Act No. CLXXVI of 2020 amending Act LXXXVI of 2007 on Electricity) and Government Decree No. 721/2020 (XII.31) in implementation of Directive 2019/944/EU.

As of 1 January 2021, Hungary has rules in place for the market-based procurement of flexibility services. The framework regulation introduces new electricity market actors (active users, aggregators and energy communities), changes data management rules and co-operation rules between network operators. It strengthens consumer protection provisions and defines conditions for grid connection. The new rules aim to ensure sufficient and appropriate connection to the grid for new producers/consumers, including from growing demand for electromobility, industrial electrification and heating and cooling, managing system-level reserves, congestion management, frequency management, or voltage maintenance by applying new, innovative and sometimes more cost-effective solutions such as energy storage technology, demand-side management, aggregation and energy communities.

The new rules for regulating energy storage will facilitate market-based commercial storage investments and advanced technologies for electricity storage. The rules also clarify the relationship between aggregators and traders, the liability of aggregators for imbalance, technical issues related to metering, the aggregation of market participants from different balance groups (power plants, consumers and electricity storage). The 15th amendment of the Distribution Code in June 2021 introduced new rules on flexible connection contracts to enable the DSOs to handle the connection needs of the expected large number of solar plant developments. The rules include TSO-DSO relations and data exchange.

Reliability of electricity supplies

Hungary's electricity reliability is overall in line with OECD averages. In 2020, its system average interruption duration index (SAIDI) was 0.9, below the OECD average of 1.3, while its system average interruption frequency index (SAIFI) was 1.1, above the OECD average of 0.9.

Electricity risk preparedness

In January 2022, the HEA released a comprehensive risk preparedness plan for the security of electricity supply (HEA, 2021). The plan outlines measures to enhance electricity security and prevent the occurrence of crises. It provides details of the steps to be taken in the event of an electricity supply emergency, as well as the roles and responsibilities of all relevant stakeholders. The risk preparedness plan is to be updated every four years.

Power plants with a capacity of 50 MW or more are obliged to hold backup fuel stocks based on their average daily consumption level. The total stand-by capacity available must be at least equal to the capacity of the largest block in the national system (N-1), which is equal to one 500 MW block of the Paks NPP.

Total available stand-by black-start reserve capacity in 2021 equated to 526 MW, composed of four gas turbine power plants located across the country near grid nodes, to be quickly activated in the event of unexpected power outages.

Electricity emergency response

In the event of a major electricity supply emergency, the TSO would establish a Crisis Working Committee to act as the crisis co-ordinator. In accordance with Government Decree 280/2016 and the measures outlined in the latest electricity risk preparedness Plan, the TSO would first attempt to increase electricity imports, request international assistance and modify the export-import schedule.

When import capacities are insufficient to restore the balance, the TSO can instruct the use of Hungary's reserve capacities. If these measures do not resolve the situation, measures can be taken to reduce electricity demand. The plan stipulates that, where possible, no group of consumers should face more than three hours a year without supply, Hungary's loss of load expectation. A list of essential consumers, who would not be subject to supply losses, is updated regularly. Essential consumers include households, defence facilities, medical services and airports. Non-essential consumers, notably industry, are not typically offered the opportunity to enter into interruptible contracts, which could hinder efforts to curtail demand in an emergency situation.

Assessment

Electricity demand in Hungary has been rising since 2015, and will likely grow further in the coming decade to reach above 8 GW. At the same time, the Hungarian government aims to reach 90% of electricity generation from "carbon-free" sources by 2030, through the coal phase-out, the addition of two new nuclear reactors (2.4 GW) and a rapid expansion of solar PV to 6.5 GW by 2030.

With rising capacity margins in the past years, Hungary's electricity generation capacity will likely remain sufficient in the short term, although the installation of significant additional generation capacity will be required by 2030, given both increased electricity demand and the planned phase-out of existing capacity.

The planned phase-out of the Mátra lignite-fired plant will require the timely completion of both the Mátra gas-fired plant and the Paks II nuclear plant. However, it is currently unclear whether the Paks II project will be operational by 2030, while the configuration of the Mátra gas-fired plant has yet to be finalised. For the Mátra gas-fired plant to be compatible with Hungary's 2050 net zero target, the plant should be built ready for hydrogen or CCUS technology. There are also plans to install solar power at the location of the coal plant.

The government may need to prepare for a backup plan with larger shares of variable renewable energy. The investment plans for solar PV capacity of up to 12 GW by 2040 is significant in this context. Preparing the transmission and distribution networks and system

operation to meet the challenges posed by more decentralised and variable generation will be a major challenge for the Hungarian electricity sector, requiring significant investments in the flexibility of the grid through balancing and storage capacities.

Hungary's TSO has significantly strengthened interconnections and cross-border capacity, reaching 55% in 2020, well above the EU interconnection target for 2030 of 15%. Three new 400 kV interconnectors with the Slovak Republic were commissioned in 2021. The first interconnection with Slovenia was completed on the Hungarian side and should be commissioned in 2022 after completion on the Slovenian side by July 2022. A new 400 kV interconnection with Romania is also planned for 2030.

While Hungary's ambitions with regards to solar power are commendable, it should also consider additional options to increase renewable energies, in particular wind energy. While increasing wind generation capacity is not a government objective, more wind installations are feasible, particularly in north-western Hungary, and will be helpful as wind complements solar PV generation. Geothermal energy also has untapped potential in Hungary, mainly for district heating, but also for electricity generation (for 2020, Hungary targeted 57 megawatts electrical [MW_e] of power production). This could serve as a dispatchable source to balance variable renewables, alongside power imports and greater demand response and energy storage.

A strong legal framework is needed to facilitate increased penetration of variable renewables. The government amended the Electricity Law in 2021, which provided a legal framework to regulate prosumers, energy communities and aggregators. However, detailed rules still need to be developed and implemented to make these new market players functional. Hungary's existing legislative framework for regulating energy storage is also incomplete; measures are needed to facilitate market-based commercial storage investments with advanced technologies.

Hungary plans to implement demand-side measures to control electricity consumption, including installing 1 million smart meters by 2030, with half of them being installed by the DSOs. The active use of demand response through smart meters could be hindered by the current regulated end-user electricity prices, which are also an obstacle for investments in energy efficiency in residential buildings. Different tariffs for different periods of the day and/or the introduction of dynamic retail pricing could incentivise consumers to install smart meters and shift their electricity consumption away from peak load periods.

In line with the National Energy Strategy 2030, the government should revise the Universal Service Scheme towards dynamic pricing to incentivise a shift of electricity demand to off-peak hours. Moreover, shifting electric vehicle load to midday (via a combination of dynamic tariffs and workplace charging incentives/regulations) can help increase the integration of solar PV, given Hungary's high solar potential. It would also help reduce ramp rates (duck curve).

Amid skyrocketing electricity prices at the European wholesale spot exchanges, a significant financial burden will be placed on electricity utilities, with regulated capped electricity retail prices under the Universal Service Scheme. Owing to unbundling rules imposed by EU legislation, compensation for the losses incurred in the universal service segment may also entail a financial risk on the state budget, which needs to increase state aid to its companies. Hungary should seek to define what constitutes a vulnerable consumer and review support to this consumer segment.

With regard to emergency preparedness, Hungary has developed a clear set of response measures to be taken in the event of an electricity supply emergency. These measures are outlined in the January 2022 Electricity Risk Preparedness Plan and include measures to increase supply and tap into reserve capacities if required.

Future preparedness for electricity supply emergencies should be bolstered by taking into account how different scenarios for renewables penetration will impact emergency response measures, while consideration should be given to ways to avoid electricity export cuts to neighbouring countries and increasing reserve capacities, notably black-start reserve capacity amid power plant closures around 2030 and 2040 (coal, existing nuclear reactors).

Recommendations

The government of Hungary should:

Electricity markets and security

- To respond to possible delays in the development of new nuclear and address the decommissioning of the existing plants, review renewable energy system integration plans and identify investment needs in the grid, balancing and storage capacities.
- Prepare for the long-term electrification of the economy by evaluating investment needs in generation, transmission and distribution capacities, and related system balancing. Model the consequences of the electrification, drawing upon concepts for sector integration of transport, industry and buildings, as well as storage opportunities such as batteries and hydrogen.
- Review the end-user electricity price regulation and further develop the tariff structure and design, in accordance with the National Energy Strategy 2030 and applicable EU legislation, to focus on vulnerable household customers only with support provided outside of the electricity market. This would enable a broader roll-out of smart meters and alignment of electricity consumption with different daily shift tariffs.
- Complete the regulatory framework for prosumers, energy communities and aggregators, so generation and electricity demand from households and small-scale installations can be pooled.

Electricity emergency response

- Prepare scenarios for renewables penetration and test system operations for very high shares of renewable electricity.
- Consider increasing the amount of black-start reserve capacity given Hungary's status as a major electricity net importer, supply risks in neighbouring countries and increasing production from solar energy.

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8. Nuclear

Key data (2020)

Number of power reactors: 4 reactors at the Paks Nuclear Power Plant

Installed capacity: 1 916 MW (net)

Electricity generation: 16.1 TWh, +2% since 2010

Share of nuclear: 16.1% of TES, 48.0% of electricity generation

Overview

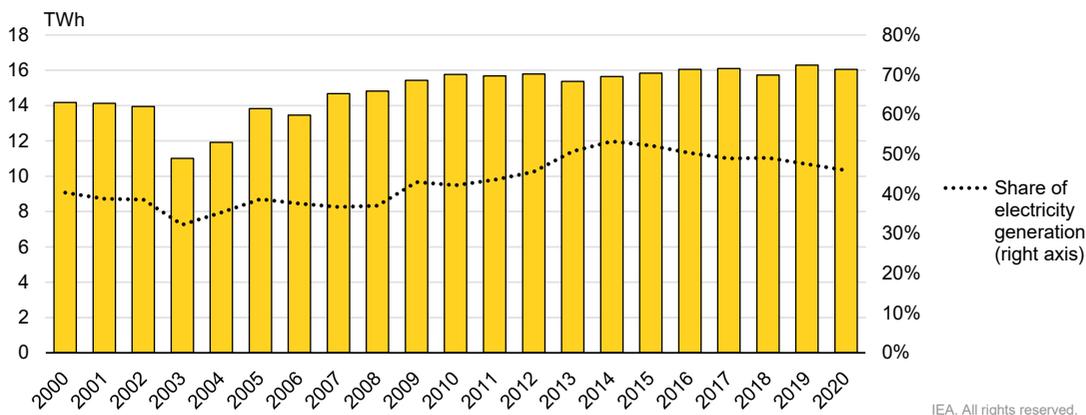
Nuclear energy has been a major source of electricity generation in Hungary ever since the commissioning of the Paks NPP in the 1980s. The Paks NPP, the country's only nuclear power plant, has four reactors with a total capacity of 2.0 GW (gross). In 2020, it provided 48% of Hungary's electricity generation, the third-highest share among IEA member countries, after France and the Slovak Republic, accounting for 16% of Hungary's total energy supply. Electricity generation from nuclear power in Hungary has been steady at around 16 TWh since 2010 (Figure 8.1).

According to the NES 2030, nuclear power will continue to be an important part of the domestic energy sector, contributing to security of supply while keeping carbon emissions in check.

The share of nuclear power in the electricity mix is ensured through the recently completed lifetime extension of the existing units at the Paks NPP beyond the initial 30 years for another 20 years and by the planned construction of 2 additional units at the Paks site (Paks II).

At EUR 12.5 billion, the Paks II project is the largest investment in the Hungarian energy sector for decades and considered a flagship project by the government, under direct responsibility of the Prime Minister's Office. An intergovernmental agreement between Hungary and the Russian Federation was signed in 2014 for the construction of two 1 200 MW_e units at the Paks site. In 2020, the construction licence application was submitted to the nuclear regulator for review and authorised in August 2022. Construction is expected to start in 2022 for commissioning by 2030.

Figure 8.1 Nuclear power generation and its share in total electricity generation, 2000-2020



IEA. All rights reserved.

The Paks Nuclear Power Plant provides 48% of Hungary's electricity generation.

Source: IEA (2021).

Nuclear strategy

Nuclear energy is a pillar of the net zero emissions pathways under Hungary's NCDS, presented in May 2021, and is central to reaching climate neutrality under Hungary's Climate Protection Law.

Maintaining the role of nuclear energy in the coming decades remains a key goal of the new NES and the NECP 2030, adopted in 2020, based on three strategic pillars: clean, smart and affordable energy.

The NES includes more than 40 measures and foresees a 95% reduction in GHG emissions by 2050 compared to 1990 levels. Hungary has set the very ambitious goal of reaching a power mix with 90% of carbon-neutral sources already by 2030.

To achieve this goal, Hungary targets investment in all low-carbon energy sources, including nuclear, with view to meet the growing demand for reliable, affordable and clean electricity. In 2050, as set out in the NCDS, the electricity generation system would be based on solar PV, nuclear and biomass. There is clear understanding that in Hungary the climate-neutral economy cannot be established without nuclear energy.

Maintaining nuclear generation capacity by replacing existing units at the Paks NPP, which are nearing the end of their lifetimes in the 2030s, is one of the key measures in this regard. Emissions may go up when existing nuclear plants are decommissioned and their replacement with Paks II is a key target for maintaining a low-carbon electricity mix.

Plant upgrades, lifetime extension

The construction of the first two units at the Paks NPP started in 1974 followed by two more units in 1979. The four VVER 440-213 pressurised water reactors were commissioned in 1982, 1984, 1986 and 1987, respectively (Table 8.1). Each unit had an

installed capacity of 440 MW_e by design, allowing the Paks NPP to produce around 14 TWh per year. Between 2009 and 2019, a major upgrade was made in two phases to increase the power output of the plant. In 2009, a thermal power uprate brought the capacity of each unit to 500 MW. The most recent power upgrade was completed in 2019, further increasing the capacity of each unit to 506 MW (gross). After the introduction of 15-month refuelling outage intervals and the modernisation of high-pressure turbines, the plant operated at an average capacity factor of 90.81%, and electricity generation exceeded 16 TWh in 2020.

By the end of 2020, the total amount of electricity produced by the Paks NPP since the first connection to the power grid exceeded 509.6 TWh.

The extension of the original design lifetime of 30 years for Units 1-4 of the Paks NPP was declared a strategic goal in 2001, following a feasibility study, taking into account the technical, economic and environmental aspects as well as human resources and electrical grid connections. The results of the feasibility study assured the fitness for service of operating equipment for subsequent licence renewal, proving that installed components allow operation beyond 50 years.

At the end of 2008, the Paks NPP submitted a lifetime extension programme to the Hungarian Atomic Energy Authority (HAEA) to justify the establishment of the operating conditions and safe operation beyond the designed lifetime. The HAEA granted an operating licence for all units for an additional 20 years, subject to periodic safety assessments of the units (Table 8.1).

Table 8.1 Operating details of Hungary's nuclear power reactors

Reactor name	Reactor type	Net capacity (MW _e)	Construction start	Grid connection	End of licence (extended)	Unit capability factor (2019)
Paks 1	PWR	479	Aug 1974	Dec 1982	Dec 2032	99.7
Paks 2	PWR	477	Aug 1974	Sep 1984	Dec 2034	92.0
Paks 3	PWR	473	Oct 1979	Sep 1986	Dec 2036	92.4
Paks 4	PWR	473	Oct 1979	Aug 1987	Dec 2037	82.8

Note: PWR = pressurised water reactor.

Source: IAEA (2021).

The four units of the Paks NPP also supply heat through a nuclear-based district heating system in Paks. Two new units will also be able to supply heat to this system and its current and future consumers of heat. Plans exist for the construction of a new district heating branch to reach the city of Szekszárd, 30 km to the south of Paks, and to provide heat to greenhouses in the area of Paks.

New build at the Paks site

The existing four Paks units are planned to close in sequence between 2032 and 2037, after 50 years of operation. To ensure the timely replacement by new nuclear units, in 2009 the parliament authorised the start of preparatory works for two new Paks units. In January 2014, Hungary signed an intergovernmental agreement with Russia for the construction and technical support of two units of 1 200 MW_e at the Paks site. In March 2014, Hungary

and Russia signed a financial agreement providing for a EUR 10 billion credit line (maximum) from Russia to cover 80% of the expenditures. The Hungarian government will finance the remaining 20%.

Under intergovernmental agreements, three contractual implementation agreements were signed in December 2014 between MVM Paks II Ltd on the Hungarian side and JSC NIAEP⁹ on the Russian side: the engineering, procurement and construction agreement, the fuel supply agreement, and the operation and maintenance support agreement. Under the terms of the engineering, procurement and construction agreement, the Paks II project has a fixed price,¹⁰ fixed deadlines and a turnkey contract, for which the Russian party bears the full contractual responsibility until the start of commercial operation.

The MVM Paks II Ltd is under direct state ownership and the shareholder's rights and obligations are exercised by the Prime Minister's Office. In 2014, the company was fully separated from the incumbent MVM Group that includes the joint stock company MVM Paks NPP Ltd, established in 1992, which is operating the existing Paks units. A government commissioner has also been nominated to oversee the Paks II project.

Since the start of the project, more than 500 licences and permits have been obtained, including the environmental licence, the site licence and the implementation licence granted by the HAEA. A number of infitlon fora were held in Paks and the surrounding areas, and nine international hearings in seven neighbouring countries were concluded in November 2015.

In 2015, the EC issued a positive opinion on the Paks II project under the Euratom Article 41 Investment Declaration procedure. The Euratom Supply Agency also analysed the impact of the Paks II fuel supply contract. After negotiations, ensuring that the aspects of security of supply for Euratom were respected, the fuel supply contract was signed in April 2015.

The pre-construction phase of the project involves mostly design and licencing work. The basic design of the new units has already been approved by the Hungarian project company. Several non-nuclear safety-related buildings are being constructed and the preparation works at the future construction site are being carried out.

In June 2020, the project company submitted the construction licence application to the Hungarian nuclear regulator. In September 2021, the HAEA announced that it needs more time to fully verify all the requirements to get final clearance on the licence. The Hungarian Atomic Energy Authority granted the construction licence in August 2022.

⁹ In 2016, by decision of the special meeting of the shareholders of NIAEP JSC, the Joint-Stock Nizhny Novgorod Engineering Company "Atomenergoprojekt" was renamed ASE Joint Stock Engineering Company (ASE JSC EC). ASE Group of Companies was formed as a part of engineering division of Rosatom State Corporation.

¹⁰ Total investment costs amount to EUR 12.5 billion for 2.4 GW of capacity, which implies EUR 5 200/kW. The levelised cost of energy is estimated to be in the range of EUR 50.5-57.4/MWh (2013 real) while a mid-point case assumption for long-term market prices is EUR 86/MWh (2013 real).

Institutions and regulation

Act CXVI of 1996 on Atomic Energy provides for the independence of the nuclear safety authority, both organisationally and financially. Nuclear safety, safeguards and security are supervised by the HAEA, an independent central public administration body having its own competences and administrative acts. Since 2022, HAEA is now working under the sole legal supervision of the National Assembly. The president of the HAEA is nominated by the prime minister and the deputy by the president of the HAEA. These two positions have nine-year mandates. The HAEA reports annually to parliament. The HAEA has the power to take regulatory decisions and issue presidential decrees concerning nuclear safety, security and safeguards in line with the requirements and recommendations of the EU and the International Atomic Energy Agency.

Provisions of Act VII of 2015 on the investment for maintaining the capacity of the Paks NPP and the amendment to certain corresponding acts entered into force on 1 January 2016. In particular, the HAEA started performing tasks related to the radiation protection of employees and the public. The HAEA co-operates with other institutes and organisations by involving experts to support its decisions. The objective of transferring competences to the HAEA was to ensure that a single authority oversees nuclear safety, radiation protection and security of the peaceful use of atomic energy.

As a new task, from 1 January 2016, the HAEA proceeds as the general construction authority for non-specific types of buildings affected by the safety area of nuclear facilities and radioactive waste repositories.

As of 1 August 2016, the HAEA is also tasked to examine and register civil engineering professionals with regard to the design, implementation and inspection of nuclear facilities and radioactive waste repositories. This provision is based on Government Decree 184/2016 (VII. 13.) concerning the verification of skills and registration of civil engineering-technical experts, civil engineering designers, technical building inspectors and responsible construction supervisors of buildings and structures under the scope of the Act on Atomic Energy.

With these new regulations, the integrated regulatory system was set up, in line with the recommendation of the international nuclear community (IRRS mission in 2015).

A review of the regulations related to the status of the HAEA entered into force in January 2022. Presidential decrees entered into force from 1 May 2022 onward. The aim of the review was to further strengthen the HAEA's legal, organisational and financial independence and allow it to more efficiently perform its tasks. HAEA is now responsible to the National Assembly.

The Public Limited Company for Radioactive Waste Management (PURAM), established in 1998, is responsible for the management of radioactive waste in Hungary and is 100% state owned. In accordance with the Act on Atomic Energy, PURAM is responsible for the design and execution of radioactive waste management in a safe manner. Its tasks include the final disposal of radioactive waste, the interim storage of spent fuels, closure of the nuclear fuel cycle and the decommissioning of nuclear installations.

Nuclear safety

Following the accident at the Fukushima Daiichi Nuclear Power Plant in 2011 and post-Fukushima EU stress tests, the HAEA developed a National Action Plan with all actions decided during the self-assessment of the Paks NPP and international reviews. The action plan was positively evaluated during the European Nuclear Safety Regulators Group peer review organised by the EC. In 2016, the HAEA reviewed the implementation of the action plan, to be able to report under the International Atomic Energy Agency (IAEA) Convention on Nuclear Safety.

The National Action Plan, published in December 2012, contains 46 safety improvement actions for the Paks NPP that were supposed to be implemented by the end of 2018. The actions covered technical and administrative areas; the HAEA continuously monitored their implementation. By the end of 2018, 40 of the 46 tasks had been realised. Six tasks could not be implemented by the deadline, and the deadline was extended to 31 December 2022. The licensee has justified that the safety risk associated with the remaining tasks is acceptable and the delay of the implementation of these tasks does not considerably increase the safety risk. Since then, two further tasks have been implemented.

As of the end of 2021, the following tasks were still in progress:

- backup command centre equivalent to a protected command centre shall be established
- wireless radio connection in the plant
- construction of a new Fire Brigade Barrack
- diesel generators for emergency cases.

Since 2015, the MVM Paks NPP started a number of major reconstruction projects to improve the safety, reliability and economy of the power plant. These projects included the construction of additional water pipelines for spent fuel ponds, the installation of diverse diesel generators, instrumentation and control modernisation of the Reactor Control and Protection System. A 15-month refuelling cycle was introduced to all units using a new type of fuel assembly with an average enrichment of 4.7%, thus reducing the volume of outage-related work, the total occupational exposure to radiation of power plant personnel, the number of unit shutdowns and restarts, and the volume of low- and medium-level radioactive waste produced.

Nuclear fuel supply

Hungary currently has no nuclear fuel production infrastructure (uranium mining, refining, conversion, and enrichment or fuel fabrication facilities) and no reprocessing facilities. Nuclear fuel is purchased exclusively from Russia and a strategic reserve of two years of fuel supply is maintained at the NPP. For the new units, a fuel purchase contract for the first ten years has been signed with Rosatom. The Hungarian regulatory framework ensures the possibility of diversifying nuclear fuels.

Nuclear waste management and decommissioning

In accordance with Council Directive 2011/70/Euratom of 19 July 2011, the Hungarian government has elaborated its National Policy and National Programme on spent fuel and radioactive waste management. The National Policy on Radioactive Management was approved by parliament in April 2015 and is in line with the relevant international recommendations, EU requirements, as well as national laws and regulatory procedures on spent fuel and radioactive waste. In line with the requirements of the Act on Atomic Energy, the National Policy has been reviewed and its updated version was approved by the Hungarian parliament in December 2020.

The related National Programme contains the practical and specific technical solutions for implementing the goals and principles laid out in the National Policy. The National Programme's strategic environmental assessment was completed in August 2016. PURAM is responsible for radioactive waste management in Hungary (NEA, 2017).

Low- and intermediate-level radioactive waste generated during the operation and decommissioning of the existing Paks units will be disposed of in the Bataapati National Radioactive Waste Repository. The facility was commissioned in two phases. In 2008, the surface buildings were put into operation providing technological storage capacity for the NPP-origin waste. In the second phase of the construction, the first two disposal galleries were commissioned in 2012. The first gallery is full, and the disposal of waste in the second gallery started by the end of 2021.

Until 1998, spent nuclear fuel from the existing Paks units was sent back to Russia for reprocessing. Since 1997, an interim spent fuel dry storage facility is in operation next to the Paks site. The facility is expanded over time in line with the needs of the continued long-term operation of the plant. Spent nuclear fuel is currently not considered as waste in Hungary.

In parallel with the process of expanding the Interim Spent Fuel Storage Facility, the preparation of the future decision on the back-end of the fuel cycle is of prime importance. Parliament approved the updated National Policy on spent fuel and radioactive waste management in 2020; a decision on the back-end option is expected by mid-2040, based on the technical, safety and socio-economic assessments, in time for the country's decommissioning needs.

While the final back-end option has not yet been selected, the annual payment of the Paks NPP to the Central Nuclear Financial Fund is determined by assuming direct geological disposal of spent nuclear fuel (without reprocessing) as the reference scenario. Hungary has run a geological investigation programme for many years, aiming at a site selection for an underground research laboratory by the mid-2030s, leading to the start of construction of a deep geological repository by 2055 and the start of operation in 2064.

Decommissioning and radioactive waste management activities are financed by the entities operating the nuclear facilities and generating the waste (polluter-pays principle). In 1998, the Act on Atomic Energy established the Central Nuclear Financial Fund to finance these activities. Payments to the fund come from tax-like instalments made by the waste generators. The fund is managed by the MIT and is to be used only for the purposes specified in the Act on Atomic Energy. The government is bound by law to use the fund only for waste management activities defined in the act.

The fund is authorised to finance only those tasks pertaining to the final disposal of radioactive waste, interim storage of spent nuclear fuel, back-end fuel cycle processes (disposal of either spent fuel or high-level waste after reprocessing) and the decommissioning of nuclear facilities. The largest contributor to the fund is the Paks NPP. Annual payments are made during the operational lifetime of the plants. At the end of 2020, EUR 1 113 million had accumulated in the fund. Expenditures from the fund in 2020 to finance ongoing radioactive waste and spent fuel management amounted to EUR 44 million.

R&D and training infrastructure

The research reactor at the Energy Research Centre of the Hungarian Academy of Sciences (Budapest research reactor) and the training reactor at the Institute of Nuclear Technology of the Budapest University of Technology and Economics (training reactor) serve important research and educational purposes.

The Budapest research reactor was commissioned in 1959 (with an initial 2 MW of thermal power). The first upgrade took place in 1967, when the power was increased from 2 MW to 5 MW, using a new type of fuel and a beryllium reflector. Between 1986 and 1992, a full reconstruction was carried out. After the conversion (a thermal power upgrade to 10 MW), the new reactor was granted a 30-year operating licence, which is valid until 2023; it can be renewed upon technical conditions set by the HAEA.

The training reactor operated by Institute of Nuclear Technology of the Budapest University of Technology and Economics was started up in 1971 and the expected operating time has not yet been defined. The parts and components of relevance to the service life are interchangeable or renewable. The renewal of the facility's operating licence was initiated with the regulatory body by the licence holder in 2017. Based on the results of the periodical safety review conducted by the HAEA, the competent authority extended the operating licence of the training reactor for ten years until 2027.

The Budapest research reactor has been fully converted from HEU (highly enriched uranium) to LEU (low-enriched uranium). The first step of the repatriation process to Russia, initiated and financially supported by the US Department of Energy, was completed in 2008 in the framework of the International Atomic Energy Agency's RER/4/028 programme; all fuel used before 2005 was repatriated. The second step took place during October and November 2013, after which Hungary became HEU-free. The core of the NPPs now operates with low-enriched (19.75% ²³⁵U) fuel elements.

Assessment

According to Hungary's new National Energy Strategy 2030 and National Energy and Climate Plan, adopted in 2020, nuclear energy is one of the main pillars of a cost-effective, climate-friendly, safe and stable energy mix that helps to meet environmental goals, including the target of 90% of power generation in Hungary becoming carbon-neutral by 2030.

Nuclear safety, security and safeguards are supervised by the HAEA, an independent authority working under the sole legal supervision of the parliament. In 2015, the

Hungarian parliament adopted a legal act to strengthen the nuclear licencing and financial environment, including increasing the number of staff and the remuneration of the HAEA. A new review of the legal provisions relating to the status of the HAEA entered into force in January 2022 with the aim to strengthen both the organisational and financial capabilities of the HAEA, while at the same time reinforcing its independence.

To ensure the long-term role of nuclear power in the energy sector, not only with a view to security of supply but also as a key component of the energy transition, the Hungarian government plans to build two new units at the Paks site. An intergovernmental agreement between Hungary and Russia was signed in 2014 for co-operation in constructing two units with a capacity of 1 200 MW each. These new units will eventually replace the four units currently in operation. The agreement includes an engineering, procurement and construction contract, operation and maintenance support, and nuclear fuel supply.

In 2020, the project company, MVM Paks II, submitted the construction licence application to the HAEA. On 30 September 2021, the HAEA issued remedying deficiencies, pointing to some improvements needed to get final clearance on the licence, which was obtained in August 2022. The construction phase is expected to start in 2022/23 and the commissioning of the Paks II units is optimistically planned by 2030.

Meanwhile, the share of nuclear in the electricity mix will be maintained through a lifetime extension of the existing units of Paks NPP. Between 2012 and 2017, all four units of the Paks NPP were granted 20-year lifetime extension licences, on top of the 30-year original design lifetime, bringing their scheduled closure dates to 2032-37.

The Hungarian government places a special emphasis on establishing and maintaining a national framework for radioactive waste management that fulfils EU requirements and complies with international legal instruments, standards and best practices. Hungary complies with Council Directive 2011/70/EURATOM (establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste), and transposed its requirements into national law.

The Hungarian Act on Atomic Energy stipulates that the National Policy on spent fuel and radioactive waste management must be reviewed every five years. The first revision was successfully completed in 2020. During the review, the National Policy was amended to reflect minor changes in competencies and the new schedule for the operation of the facilities. No technical or scientific issues emerged during the review, and the review did not trigger new projects, as no significant changes to policies were required.

PURAM operates a low- and intermediate-level radioactive waste repository at Bataapáti – the national radioactive waste repository – that consists of two disposal galleries. The first one is full and operation of the second gallery started at the end of 2021. Processing, storage and disposal of institutional radioactive waste is performed at the Radioactive Waste Treatment and Disposal Facility at Püspökszilágy.

To ensure adequate financial resources for responsible radioactive waste management, the Central Nuclear Financial Fund, a special state fund managed by the Ministry for Innovation and Technology, has been created. The fund is replenished by nuclear entities (polluter-pays principle), with the Paks NPP being the main contributor. At the end of 2020, the fund contained EUR 1 113 million while expenditures of EUR 44 million were made in the same year to finance ongoing radioactive waste and spent fuel management activities.

A geological investigation programme is underway for the siting of a deep geological repository for the disposal of high-level waste and long-lived radioactive waste within Boda Claystone Formation in the south-west Mecsek Hills. PURAM intends to complete the site selection process for an underground research laboratory by 2030, leading to the construction of a deep geological repository starting in 2055 and the start of operation in 2064.

Recommendations

The government of Hungary should:

- ❑ Further pursue policies to strengthen and enhance the nuclear regulatory framework and the capabilities of the Hungarian Atomic Energy Authority.
- ❑ Bolster the building up of human resource capacity and provide support to nuclear education and training institutions and initiatives to meet research, industrial and regulatory needs and ensure the safe and sustainable development of nuclear power.
- ❑ Actively engage with the local communities on the siting of a deep geological repository and the framework for the responsible and safe management of spent nuclear fuel and radioactive waste management.
- ❑ Regularly review the cost estimates for decommissioning, spent fuel and waste management, including the diverse options for the back-end of the nuclear fuel cycle. Ensure that the adequate provision and proper management of the segregated Central Nuclear Financing Fund will be able to pay for all costs in time.

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9. Coal

Key data (2020)

Production: 0.9 Mtoe/6.1 Mt, -44% since 2010

Net imports: 0.7 Mtoe/1.3 Mt (0.93 Mtoe imports, 0.19 Mtoe exports)

Total coal supply (TES): 1.6 Mtoe/7.5 Mt (production + net imports + 0.02 Mtoe stock exchanges), -40% since 2010

Share of coal: 8% of energy production, 6% of TES, 11% of electricity generation, 7% of district heat and 1% (in 2019) of TFC

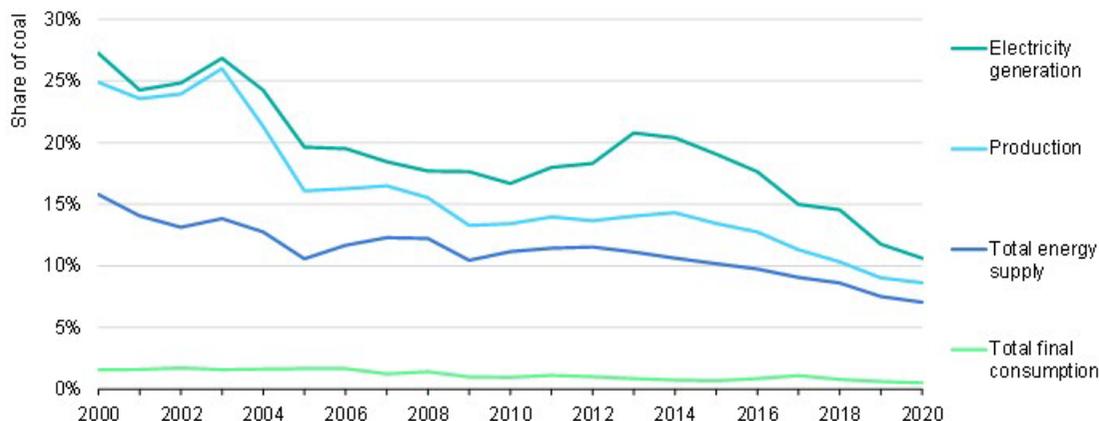
Consumption by sector: electricity and heat generation 60.7%, industry 46.3%, buildings 2.9%

Overview

Coal still plays an important but declining role in Hungary. In 2020, Hungary produced lignite (coal accounted for 8% of domestic energy production), mainly used in electricity generation (11% of electricity generation) and heating (7% of district heating) (Figure 9.1). There is little direct use of coal, about 1% of TFC. Coal use in industry remains important, with a 12% share of energy use.

The share of coal in Hungary's energy mix has significantly declined since 2010. Coal production decreased by 44% between 2010 and 2020, and coal supply declined by 40%, driven by changes in demand. The coal used in electricity generation declined by 37% between 2010 and 2020, driven by increased EU ETS carbon prices, leading to lower lignite production in Hungary. The use of coal in DH decreased even faster, by 53%, with the switch from coal to gas. The direct use of coal in TFC is small and fell by 41% from 2010 to 2019. Coal use by industry has remained stable over time, supporting the needs of the production of iron and steel, and paper and pulp in Hungary.

Under the NECP, Hungary has a target to phase out coal from its electricity mix by 2030. In 2021, Hungary joined the Powering Past Coal Alliance and announced its political objective to phase out coal use in power generation by 2030, and in case all financial support schemes are available, already by 2025. To support the decarbonisation of industry, for instance the production of green steel, coal use will need to be combined with CCS and hydrogen.

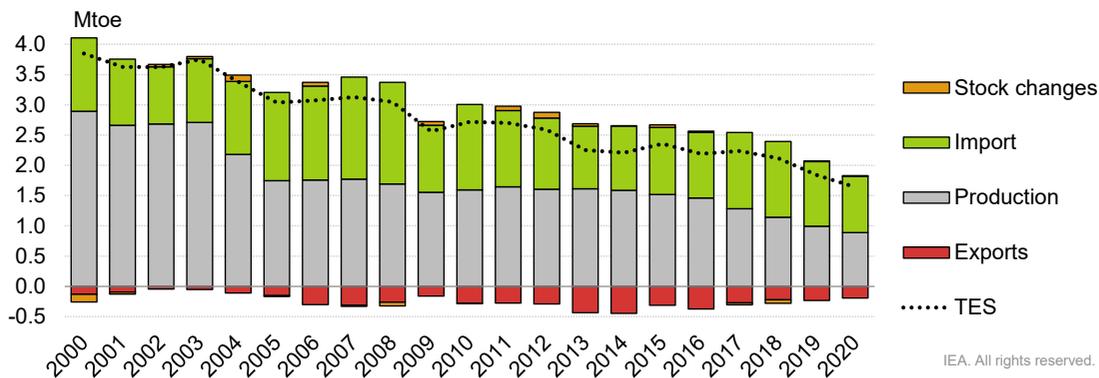
Figure 9.1 Share of coal in Hungary's energy system, 2000-2020

The share of coal in Hungary's energy mix has significantly declined since 2000.

Source: IEA (2022).

Supply and demand

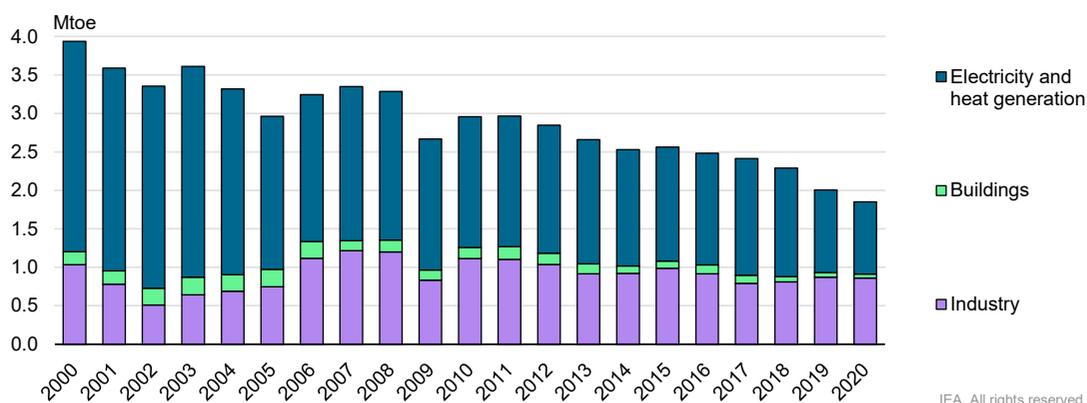
Hungary's coal supply was 1.6 Mtoe in 2020 (Figure 9.2). Half of the country's coal supply (51% in 2020) is composed of lignite, with the rest being hard coal, mostly coking coal (45%) and some thermal coal (3%). Hungary's coal production consisted of 0.9 Mtoe of lignite in 2020, and accounted for 54% of total coal supply (in energy terms) in 2020.

Figure 9.2 Coal supply in Hungary, 2000-2020

Coal supply has been decreasing, both in terms of production and in terms of imports.

Source: IEA (2022).

Coal demand in Hungary decreased by 25% between 2010 and 2020. Coal is mainly used for electricity and heat generation, which accounted for 51% of total coal consumption in 2020, followed by the industry sector (46%) and residential buildings (3%) (Figure 9.3). The largest industry consumer is the integrated iron and steel plant owned by ISD Dunafer Duna Vasmű Zrt., which operates in the city of Dunaújváros. The paper and pulp factory (Hamburger Hungária Erőmű Kft.), also located in Dunaújváros, uses coal for its production processes.

Figure 9.3 Coal demand by sector in Hungary, 2000-2020

Coal demand decreased by 25% between 2010 and 2020, driven by carbon pricing.

Source: IEA (2022).

Hungary is a net importer of coal, mainly of hard coal for iron and steel production. In 2020, net coal imports were 1.3 Mt, down from 1.8 Mt in 2010. Imports came largely from the United States (46%) and Russia (21%), followed by Poland (16%), the Czech Republic (15%), Germany (1%) and South Africa (1%). In 2020, exports accounted for 0.009 Mt of lignite, going to the Slovak Republic (89%) and Croatia (11%).

Coal mining

Hungary's total exploitable coal reserves accounted for almost 8.4 billion tonnes in January 2019. Over half of these reserves were lignite (4.2 million kt), and the remainder subbituminous coal (2.3 million kt) and bituminous coal (1.9 million kt).

Hungary produces mainly lignite, which accounts for 99% of all domestic production. Lignite production peaked in 2016 at 9.6 Mt and has since fallen, to 6.8 Mt in 2019 and further to 6.1 Mt in 2020, in line with reduced coal-fired electricity generation. Hard coal production in 2019 was negligible at only 6 000 t and 51 000 t respectively (MBFSZ, 2021).

In 2021, seven mines were operating in Hungary, all of which were open pit. Of these, two are lignite mines that supply the country's remaining coal-fired power plant, the Mátra plant. The mines and the Mátra plant are located in Visonta, in north-eastern Hungary. The Visonta lignite mine is adjacent to the Mátra Power Plant, while the Bükkábrány coal mine is some 50 km away and is connected to Visonta by rail.

Mátrai Erőmű Zrt. a formerly private company, owns the two lignite mines. Since March 2020, MVM, the government-owned dominant energy company in Hungary, is the sole owner of Mátrai Erőmű, after buying out the private shareholders. MVM also owns the Mátra Power Plant.

Since the IEA's last in-depth review in 2017, the number of companies engaged in coal mining has decreased notably in Hungary. While in 2015 there were nine active mining companies, the number fell to four in 2021, including the Mátrai Erőmű Zrt. Five mines have either suspended their operations or have stopped production entirely, in line with the reduced demand for coal.

Looking forward, the closure of the Mátra Power Plant and the related coal mines will pose social, economic and environmental challenges and the government is already preparing to address them (see the section below on the just transition).

Taxes and subsidies

There are no direct subsidies for coal mining and consumption in Hungary. However, a number of indirect support mechanisms are in place.

All electricity customers outside of the Universal Service Scheme (see Chapter 7), must pay a so-called “coal industry structure conversion fee”. The fee was first put in place in 2006 to support uneconomic coal mining. It was remodelled in 2011 and earmarked to support the affected workers following the closure of the Vértes coal-fired power plant and the subsequent closure of the Márkushegy mine, for the rehabilitation of mining areas and to address the ensuing social and economic issues in the concerned region. The fee was 0.05 HUF/kWh. In 2019, the energy regulator reduced the fee to zero as the mine closure was completed by the end of 2018.

The government is in discussions with the EC about a support scheme for phasing out the Mátra Power Plant and related mine closure. According to the OECD, in 2011, the support amounted to HUF 2-4 billion (OECD, 2011). In the context of the future transformation of the Mátra Power Plant, support of HUF 35 billion is foreseen for mine closures.

The government has also reduced the mining royalties payable by mining companies, although no specific information on the reduction scheme is available. Earlier, the mining royalty was calculated based on the market value of the unprocessed minerals (UN, 2008). However, in its 2014 annual report, MVM, the largest coal-mining company, included a receivable of HUF 4.4 million against the royalty reduction (MVM, 2015). The 2017 annual report noted that MVM has no outstanding receivables related to the reduced mining royalty (MVM, 2018). The royalty rate was 5% for open pit coal mines and 0% for underground coal mining until July 2019, when the rate was reduced to 0% across the board.

The role of coal in the energy transition

Under its NECP, Hungary is committed to phase out coal from the electricity mix by 2030. In 2017, the country’s only remaining coal power plant, the Mátra plant, with a total capacity of 950 MW, was responsible for about 14% of Hungary’s total domestic CO₂ emissions and 50% of energy sector emissions, and contributed about 10% of total domestic electricity production. The plant also generates heat.

Production of the Mátra plant is strongly impacted by the prices under the EU ETS and has been reduced in line with increasing prices. As the ETS prices are expected to continue to increase, production is expected to continue decreasing, which strengthens the arguments for a speedy decarbonisation of the plant. As a result of the increasing ETS prices, the Mátra plant has been loss-making every year since 2017.

Given the importance of the plant for electricity supply, the plant’s owner, MVM, plans to replace the five lignite-fired units of the plant with a total capacity of 884 MW with low-carbon energy sources.

A 500 MW combined-cycle gas turbine with an annual production of close to 4 TWh will be constructed and could save around 6% of Hungary's total annual CO₂ emissions (MVM, 2021). This will be complemented with the construction of two solar PV parks with a total capacity of 200 MW on recultivated mining areas, and the construction of a 38 MW biomass/communal waste-to-energy unit (MVM, 2021). MVM also plans to implement experimental electricity storage technologies for power-to-gas and for hydrogen production in line with Hungary's National Hydrogen Strategy. MVM already anticipates eventually using up to 30% of hydrogen in the new gas turbines to further reduce CO₂ emissions (MVM, 2021).

The Mátra plant complex today already includes two gas-fired units with 66 MW capacity, 36 MW of solar PV capacity constructed on recultivated former mining areas and co-fires around 400 000 t of biomass/refuse-derived fuel in its lignite units (MVM, 2021).

The government does not foresee the closure of the coal units of the Mátra plant until the new gas-fired units are fully operational and the Hungarian electricity transmission grid has been strengthened to accommodate the expected increase in solar production to ensure security of supply (see Chapter 7).

According to the NES 2030, coal would still account for 7% of heating and cooling and 12% of industry consumption in 2030. And it would still be part of the energy mix in 2050, at which date Hungary is committed to achieve carbon neutrality.

About 100 000 households, some 2.4% of total households in Hungary, use lignite for heating. Most of these are located in the vicinity of the coal mines and the coal plant. The Ministry of Interior regularly grants social aid to supply small settlements with coal during the heating season.

As households using coal for direct heating purposes tend to be economically weaker, the government is preparing support schemes for the transformation of the concerned households' heating sources (see section below and Chapter 4). This will also help address heavy local air pollution and associated health problems derived from the direct use of coal for heating. Coal accounted for only 0.2% of district heating production in 2020, compared to 11% in 2015.

Hungary's only integrated iron and steel plant that operates a blast furnace consumes about 1.2 Mt annually. The coking coal used in the plant is imported, but the coke is produced locally and the facility exports some of the coking by-products. Hungary's future coal imports will largely be impacted by the economic future of the integrated plant.

Smaller amounts of coal are used in the pulp and paper industry; mainly related to one company: Hamburger Hungária Erőmű Kft. Since 2016, the company operates its own small power plant to supply its electricity and heat. The power plant is designed to burn different fuels, including raw materials obtained from waste during production at the factory, and also some coal. According to government policies, after 2030, coal would still be used as feedstock in the industry sector, but no longer as an energy source.

Just transition

Beyond its critical role in the Hungarian power sector, the Mátra plant also plays a significant role for the local economy. About 2 000 people are directly employed by the Mátra plant and the coal mines, and there are another 4 700 indirect jobs linked to the coal

sector in the concerned regions. Not all of these employees will lose their jobs, as MVM plans to convert the Mátra plant to a lower carbon hydrogen-ready combined-cycle gas turbine project. However, around one-quarter of direct jobs will be lost and support for retraining needs to be provided. In addition, about 1 000 companies are related to the plant and the mines, either through direct supply chains or other businesses. The plant and the mines also generate important tax revenues for 11 municipalities in the concerned region.

The two counties in which the two lignite mines and the Mátra Power Plant are located (Heves and Borsod-Abaúj-Zemplén) can benefit from the EU's Just Transition Fund. A third county (Baranya) is also eligible for funding under the JTF as it is home to already closed coal mines and suffers from a high carbon intensity.

To support the transition, the Hungarian government, in partnership with the Eszterházy Károly Catholic University – in the framework of the LIFE-IP North-HU-Trans project – created a national Coal Commission (with a secretary and six technical committees) in March 2021 as the first permanent consultative platform for the different stakeholders affected by coal phase-out. Apart from the JTF, Hungary receives funding for coal transition purposes from the above project – co-financed by the EU LIFE programme and the Hungarian government – as well (see below for more details).

LIFE-IP North-HU-Trans project

The LIFE-IP North-HU-Trans will support the low-carbon transition of the single largest coal region in Hungary over the period 2020-29 through the implementation of “territorial just transition plans” that were developed by the government in partnership with the project (in the case of Heves and Borsod-Abaúj-Zemplén territorial plans) in 2021, and currently are under discussion with the EC. The total project budget is EUR 14.87 million, of which the EU is financing 60%. To complement the project, Hungary also plans to make use of other EU funds, such as the JTF, the Modernisation Fund and operational programmes, and of domestic programmes such as the new support scheme for renewables to advance the just transition.

The LIFE-IP project is being implemented with the co-ordination of the MIT in partnership with 21 organisations at the central, local and municipal levels and involves stakeholders from trade unions, industry, civil society and universities. The project is based on four pillars. The first focuses on decarbonisation and emissions reductions while the second assesses the socio-economic progress and ensures a just transition for affected workers and businesses. The third pillar will create better governance structures and offer capacity building for the transition while the fourth aims to share best practices and replicate them at national and EU level.

The project scope in each pillar is wide and covers aspects such as promoting energy efficiency and greening transport, training for at least 500 workers and mentoring for 250 supply chain companies linked to the lignite sector, awareness-raising activities, and addressing the legal and institutional barriers to ensure the creation of a favourable regulatory environment for new business models and technologies. One such model aims to create energy communities while simultaneously improving the energy efficiency of residential buildings to reduce energy poverty and replace residential use of lignite for heating. An important component of the project is the recultivation of the post-mining sites by, for example, establishing innovative businesses, solar parks or creating tourism facilities on the recultivated land. The Mátra Power Plant is also the anchor of a vibrant

industrial park that was created around it and that is a major contributor to the regional economy. Several initiatives are being considered to ensure that the industrial park remains an important economic entity in the region, and to help businesses to become low-carbon, innovative ones.

Carbon capture, utilisation and storage

Coal will continue to be part of the energy mix until 2050, albeit with the lowest share of all energy sources. CCUS is considered by the government to become a major abatement technology as of 2030. In all three of the scenarios developed for the preparation of Hungary's NCDS 2021-2050, CCUS is a key technology for reaching net zero by 2050. The early action and the late action scenarios both assume that CCUS will become commercially viable after 2030. And in the early action scenario, some 25% of the emissions reductions by 2050 are expected to come from CCUS (see Chapter 2).

While the government has high expectations for the contribution of CCUS to the decarbonisation of the energy and industry sectors, specifically for the steel mill, there are no specific policies or strategies being developed regarding CCUS. The government also does not specifically support RDI for CCUS. Still, the NCDS recognises that more research is needed to ensure the application of CCUS and related technologies in the energy sector and high emitting industrial facilities. But the NCDS falls short of quantifying targets for annual stored and/or utilised CO₂.

The industry has, however, launched some initiatives. For example, MVM is planning the implementation of a pilot CCUS project with a special focus on the capture of CO₂ from the flue gas of the gas turbines at Mátra (MVM, 2021).

Assessment

Hungary has set a target to phase out coal from its electricity mix by 2030. In 2020, coal accounted for 8% of domestic energy production, 11% of electricity generation and 0.2% of district heat. In the same year, coal accounted for 6% of Hungary's TES, and direct use of coal for 0.5% of TFC. Coal will still account for 7% of heating and cooling and 12% of industry consumption in 2030, according to the NES 2030.

The country's only remaining coal power plant, the Mátra plant, is responsible for about 14% of Hungary's total GHG emissions and 50% of the energy sector's CO₂ emissions, and contributes about 10% of total domestic electricity production. The government plans a low-carbon transformation of the plant by replacing, by 2030 at the latest, the five lignite-fired units with a total capacity of 884 MW with a 500 MW natural gas unit, a biomass/communal waste unit and solar PV generation at the same site.

Coal is also used at the country's integrated iron and steel plant. The coal and coke used at the plant is imported. Smaller amounts of coal are used by some 100 000 poor households for residential heating, and in the pulp and paper industry, which operates an autoproducing small power plant.

Hungary currently does not have any national programme to support research and development of CCUS, although coal and natural gas will continue to be part of the energy mix until 2050 and CCUS is assumed to be a major abatement technology after 2030; in the early action scenario, some 25% of the emissions reductions by 2050 have to come from CCUS.

There are no direct subsidies for the consumption of coal in Hungary. However, it is unclear whether the 100 000 households that still use coal directly for heating receive their supply at subsidised prices, or some even for free.

Two domestic coal mines supply the Mátra plant with feedstock. The mines and the plant are located in the north-eastern part of Hungary and form a significant part of the local economy. There are also some smaller coal-mining companies in Hungary, though their number has decreased over the years with the declining role of coal in the energy sector. Of Hungary's seven operating coal mines that together account for 57 kt annually, two are open pit lignite mines that produce around 9 Mt annually.

The plant and the mines also generate important tax revenues for the local governments. The two counties in which the two lignite mines are located can benefit from the EU's Just Transition Fund. A third county is also eligible for funding under the Just Transition Fund, as it is home to already closed coal mines and suffers from a high carbon intensity. Hungary is in the process of developing "territorial just transition plans" for the concerned regions.

To support the transition, the Hungarian government created a Coal Committee in 2021 as the first permanent platform for the coal phase-out. The committee is established as part of the LIFE-IP North Hungary transition project that is under a larger EC initiative that will also provide financial support to the affected regions. The Coal Commission was established to support regional stakeholders by providing technical support, fundraising and best practice sharing and to help local and regional partners to identify projects.

Recommendations

The government of Hungary should:

- ❑ Set a target year for the phase-out of direct coal use in district and residential heating, and provide financial and technical assistance to the concerned companies and households to shift to sustainable heating systems.
- ❑ Ensure the timely completion of the development of the territorial just transition plans to allow Hungary to access the EU Just Transition Fund to redevelop the affected regions.
- ❑ Support research and pilot projects for industry sectors, including carbon capture, utilisation and storage technology for hard to decarbonise industry sectors, in particular steel production.

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10. Natural gas

Key data (2020)

Domestic production: 1.7 bcm, -42% since 2010

Net imports: 7.9 bcm (12.2 bcm imports, 4.3 bcm exports), -16% since 2010

Share of gas: 33% of total energy supply, 26% of electricity generation, 31% of total final consumption, 12% of energy production

Consumption by sector: residential buildings 34%, industry 29%, power generation 25%, service sector buildings 12%, transport 1%

Overview

Natural gas consumption in Hungary has been on a downward trend since 2005 and has remained relatively flat since 2015. With a total demand of 9-10 billion cubic metres per year (bcm/y) since the mid-2010s, natural gas remains the most significant source of TES, accounting for 33% of TES in 2020. Natural gas consumption is likely to rise by 2030, when the Mátra lignite-fired plant will be closed and replaced with a 500 MW gas-fired power plant.

With limited domestic production, Hungary relies on imports, primarily from Russia, for the vast majority of its natural gas demand. Major infrastructure developments and market coupling in 2012 in south-east Europe supported market integration, shifted gas trade and increased liquidity for Hungary, which is becoming a natural gas hub. Traditional gas exports from Hungary to Croatia and Serbia have declined due to a reconfiguration of flows from south to north. Since 2021, Hungary can also import gas via the Krk LNG terminal in Croatia. Flows through the Serbia-Hungary interconnector arriving from the TurkStream pipeline in Serbia commenced in October 2021. While Hungary will be able to avail of more interconnections in the future, Russia will remain the ultimate source of much of the natural gas delivered to Hungary. Supply agreements were renewed with Russia in 2021.

The Hungarian natural gas market is liberalised, but state-owned companies dominate the market. MOL accounted for 80% of total domestic natural gas production in 2020. MVM holds a dominant supply position with 60% of the market as the main importer, wholesaler and distributor/retailer of natural gas. Most small-scale consumers are able to avail of regulated retail prices under a Universal Service Scheme. Amid skyrocketing gas prices in Europe, Hungary's gas import prices increased substantially in 2021, creating potential solvency issues for wholesalers as retail gas prices remain regulated.

Gas supply and trade

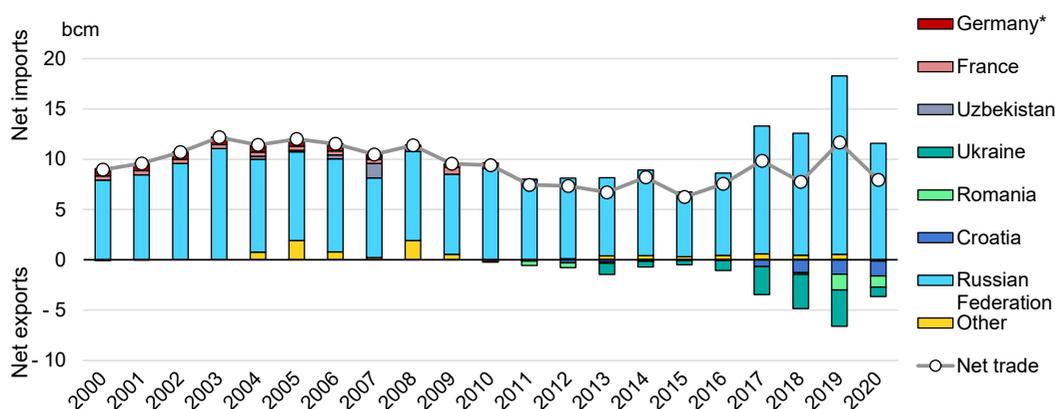
Domestic gas production

Hungary is a relatively small natural gas producer, with total domestic production of 1.7 bcm in 2019 and 2020. Natural gas production declined by 41% from 2009 to 2015, but has been relatively stable since. Indigenous production represented 15% the country's total gas consumption in 2020. Hungary's National Energy and Climate Plan and new Energy Strategy for 2030 foresees natural gas production reaching 2.4 bcm by 2030, but it is unclear precisely how this increase will be achieved (Hungary, 2020). Attempts to tap unconventional gas resources have been largely unsuccessful.

Gas trade

A significant majority of the natural gas consumed in Hungary is imported. In 2020, Hungary's net imports of natural gas stood at 7.9 bcm (Figure 10.1). Hungary is heavily reliant on natural gas imports from Russia; in 2020, 95% of the country's total gas imports came from Russia. Hungary's MVM CEEnergy holds two direct 15-year contracts with Russia's Gazprom, totalling 4.5 bcm/y of gas supplies. Recent infrastructure improvements could theoretically facilitate greater diversification of natural gas supply sources in the future. Going forward, increased volumes of Russian gas will be transported to Hungary from the TurkStream and Balkan Stream pipelines, resulting in lower volumes transiting Ukraine to Hungary. Besides, in 2022, discussions are under way to increase Russian gas supplies to Hungary by 1 bcm/y.

Figure 10.1 Hungary's natural gas trade per country, 2000-2020



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Hungary is heavily reliant on natural gas imports from Russia, which account for 95% of its total natural gas imports.

* Data for Germany are not visible at this scale, less than 1 bcm.

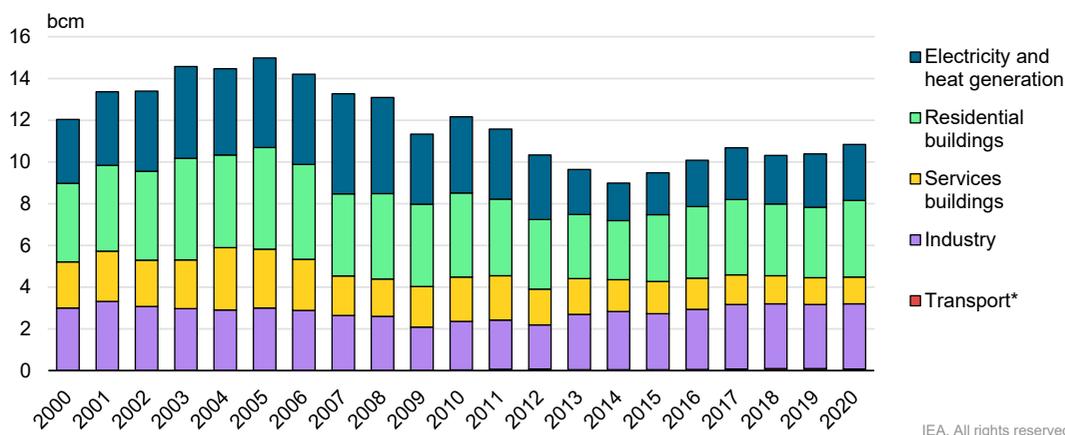
Source: IEA (2022a).

Prior to 2020, gas exports from Hungary had been increasing to Croatia and Romania, as were reverse flows to Ukraine. Reverse flows from Hungary to Ukraine grew strongly following the rising interest of Ukrainian suppliers to acquire gas from the EU. In December 2021, the Hungarian and Ukrainian TSOs signed an agreement to introduce firm capacity of the Ukraine-Hungary interconnection in the direction of Ukraine from January 2022. Since 2017, Gazprom has started delivering gas to Croatia via Hungary, instead of via Austria and Slovenia, following contractual and tariff revisions. Flows from Hungary to Romania increased in 2019 due to more favourable price spreads. As a result of a thorough market test and consultation between the Austrian and Hungarian authorities and TSOs, the Austrian-Hungarian interconnector can be used in reverse mode in the case of an emergency situation in the direction of Austria.

Gas demand

Natural gas consumption has been generally stable in Hungary since 2015, and prior to that had been on a downward trend since the mid-2000s (Figure 10.2). Natural gas consumption reached 11 bcm in 2020 and remains the most significant energy source in the country, accounting for 33% of TES in 2020. The most significant gas-consuming sector is residential buildings (3.7 bcm, 34% of total consumption in 2019) followed by industry (3.1 bcm, 29%), electricity and heat generation (2.7 bcm, 25%), services buildings (1.3 bcm, 12%), and transport (0.1 bcm, less than 1%).

Figure 10.2 Natural gas consumption by sector in Hungary, 2000-2020



Natural gas consumption has declined from the peak reached in the mid-2000s, but the overall consumption level remains substantial.

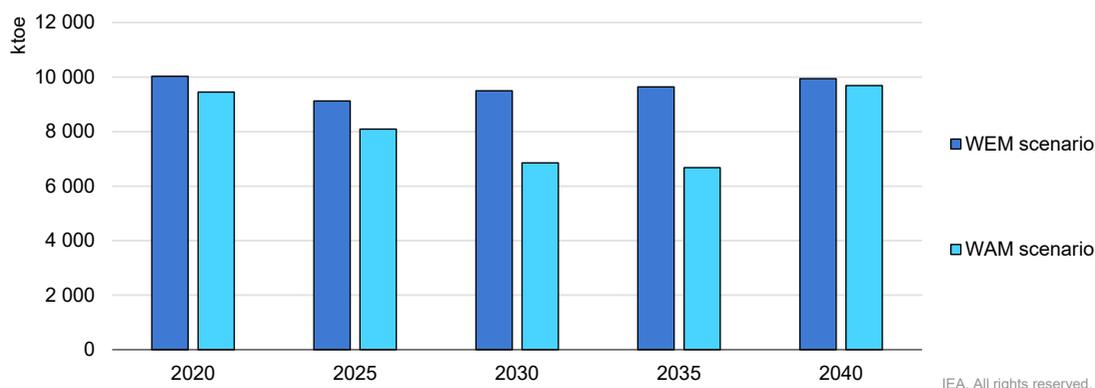
* Transport sector data are barely visible on this scale, representing less than 0.1 bcm.
Source: IEA (2022a).

The future role of natural gas in the energy mix

Under the base case scenario of Hungary's NECP – the “with existing measures” scenario – natural gas consumption is projected to decrease in the short term, before increasing towards the end of the decade when the Mátra lignite-fired plant will be closed

and replaced with a 500 MW gas-fired plant (plus a solar array and other smaller generation units) (Figure 10.3, Hungary, 2020). In the longer term, the “with existing measures” scenario projects that natural gas consumption will continue to increase mildly with consumption growth being partially offset by increased renewables penetration in power generation, heating and other uses.

Figure 10.3 Projections for natural gas consumption in Hungary’s National Energy and Climate Plan



Despite the stated goal to reduce gas import dependence, consumption is not forecasted to decline in the long term under the base case scenario outlined in Hungary’s NECP.

Notes: WEM = With existing measures; WAM = With additional measures.

Source: Hungary (2020).

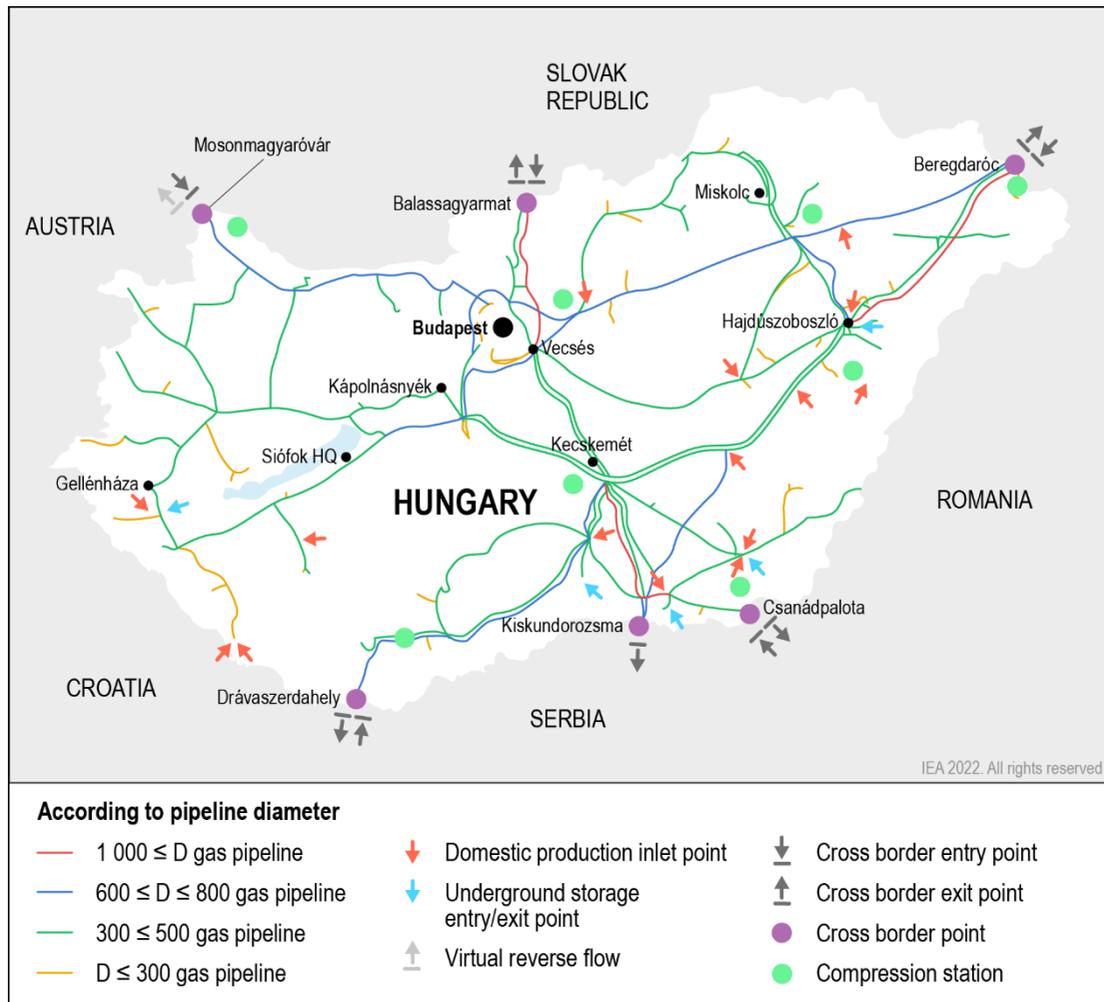
The NES 2030 foresees Russia continuing to be a major import source of natural gas for Hungary, but highlights that Hungary’s ability to source supplies from the new Krk LNG terminal provides it with access to global markets while also improving the liquidity of regional natural gas markets. The NES 2030 provides general support for greater integration of the Hungarian and Croatian natural gas markets. It mentions that the expected development of natural gas fields in the Romanian Black Sea will further boost Hungary’s efforts to diversify natural gas import sources and points to the ability to source natural gas from western European markets through an interconnection point at Mosonmagyaróvár in the north-west of the country (Figure 10.4 and Table 10.1).

Table 10.1 Hungary’s natural gas interconnection points and imports in 2021

Entry/exit points	Bordering country	Maximum daily technical entry capacity (mcm/d, 0°C)	Import volumes (bcm, 0°C)	Export volumes (bcm, 0°C)
Bregdaróc	Ukraine	71.3	0	0.004
Mosonmagyaróvár	Austria	14.4 (13.85)	1.2	0.05
Drávaszerdahely	Croatia	19.2 (18.7)	0.04	0.4
Csanádpalota	Romania	4.8 (4.6)	0.7	0.1
Kiskundorozsma	Serbia	(22.2)	4.2	0.2
Balassagyarmat	Slovak Republic	12 (11.7)	3.4	0

Source: HEA, https://fgsz.hu/file/documents/2/2063/a_magyar_foldgazrendszer_2020_evi_adatai.pdf

Figure 10.4 Hungary's gas infrastructure



Gas infrastructure

Gas network

Hungary's gas transmission network consists of 5 873 km of high-pressure pipelines with 400 gas delivery points. The network includes six compressor stations with a total installed capacity of 234 MW. Hungary has six gas interconnection points. The most significant interconnection point has been Beregdaróc, on the Ukrainian border, which was the source of more than 70% of Hungary's natural gas imports in 2020. However, the importance of this interconnection is declining as increasing quantities of gas are being imported through the Kiskundorozsma interconnection with Serbia. Today, increasing quantities of natural gas are exported through Hungary to Ukraine via Beregdaróc. There are additional interconnectors at Mosonmagyaróvár, near the border with Austria, and at Balassagyarmat, on the Slovakian border, each of which supplied about 15% of Hungary's gas imports in 2020. Aside from 2020, import volumes through the Balassagyarmat interconnection have been low, however.

Recent gas network developments

Since the beginning of 2021, relatively small quantities of natural gas have been imported from the Drávaszerdahely interconnection point; these volumes originate from the Krk LNG terminal in neighbouring Croatia, which has provided an opportunity for traders to book capacity with a view to transporting global LNG cargoes to Hungary. In June 2020, MVM signed a seven-year deal for the import of 1 bcm/y from the Krk LNG facility, and reportedly imported some volumes from Krk in 2021. This access to global gas markets broadens Hungary's diversification of supply sources.

Interconnections at Kiskundorozsma, bordering Serbia, and Csanádpalota, bordering Romania, have historically been used to transport natural gas out of Hungary. However, recently both have been upgraded to allow imports into Hungary. In September 2021, the Hungarian government agreed a 15-year deal in principle with Gazprom to supply 4.5 bcm of natural gas to Hungary annually, the majority of which is to be supplied through the Serbian interconnection via TurkStream. A new compressor station commissioned at Csanádpalota on the Romanian border, completed in 2019, opens the possibility of Black Sea offshore gas production being transported to Hungary; however, volumes transported from Romania will depend on the future development of these offshore sources. Several additional projects could see increased flows of natural gas to both the Hungarian market and to neighbouring markets transiting through Hungary in the near future. These include a proposed interconnector between Slovenia and Hungary, and as a result of a series of consultations between the Austrian and Hungarian authorities and TSOs, the Austrian-Hungarian interconnector can be used bidirectionally in the case of an emergency situation in the direction of Austria as well.

Storage

Hungary has five commercial gas storage facilities, with a total working capacity of 5.01 bcm and a maximum withdrawal capacity of 58.6 mcm/d. All allow third-party access. There is also an underground strategic storage facility located in Szőreg, in southern Hungary. This facility is owned by a subsidiary of the Hungarian Hydrocarbon Stockpiling Association (HUSA), Hexum Natural Gas. In October 2021, the volume of strategic natural gas stocks held was 1.14 bcm while the level of natural gas stocks across all storage terminals was 4.8 bcm. The total stock level in October 2021 is equivalent to around 165 days of average annual natural gas demand in 2020, or around 100 days of average winter demand; the volume of strategic stocks held in October 2021 was equivalent to 50 days of average annual demand in 2020.

Table 10.2 Gas storages in Hungary

Name of UGS Facility	Type	Commissioned	Working gas capacity (mcm)	Peak withdrawal rate (mcm/d)	Peak injection rate (mcm/d)
Hajdúszoboszló	Depleted field	1980	1640	16	10.3
Kardoskút	Depleted field	1978	280.0	2.9	2
Puszaederics	Depleted field	1979	340	2.9	2.9
Zsana	Depleted field	1996	2170.0	28.0	17
Szoreg-1	Depleted field	2009	1905	25	12.7

Sources: MFTG, <https://mftg.hu/hu-HU/Tevekenysegek/Gaztarolok>; GIE, <https://agsi.gie.eu/#>.

Gas policy

There remains an element of uncertainty around Hungary's overall strategy regarding the future of natural gas, and therefore how natural gas consumption will evolve. On the one hand, the NES 2030 outlines a clear objective to reduce the current dependence on imported natural gas as well as the level of total gas consumption. However, the government's intentions to make a significant investment in the Mátra gas plant and other gas infrastructure will inevitably provide support for gas consumption in the long term.

Hydrogen and biomethane

Hungary's NES 2030 projects that natural gas consumption will also be partially tempered by blending hydrogen (up to 2%) and small amounts of biomethane (up to 1%) into the natural gas network by 2030.

The NES 2030 calls for sections of the gas distribution network with an annual utilisation rate below 10% to be phased out and repurposed to allow for the future distribution of low-carbon hydrogen. Hungary's National Hydrogen Strategy, accepted by the government in May 2021, further supports future efforts to build out a hydrogen supply network based on Hungary's existing gas networks (Hungary, 2021). However, while the National Hydrogen Strategy signals the government's intention regarding increasing hydrogen penetration, a detailed plan for a hydrogen roll-out in Hungary has yet to be developed. The government acknowledges that work is required on new regulatory and chemical safety regimes to accommodate hydrogen and biomethane flows, and to balance these with plans to convert underutilised pipelines and use depleted gas reservoirs for sequestering CO₂.

Market structure

Institutions and market structure

Regulation of the Hungarian natural gas market is carried out by the HEA. The HEA awards permits for natural gas transmission, distribution and storage, and is involved in regulating prices. Although the HEA was created as an independent body, its president and vice presidents are direct political appointments.

The Hungarian natural gas market is liberalised, but prices are regulated for customers in the universal service segment (see section below) and state-owned MVM is the dominant player in the market. Either directly or through subsidiaries, MVM is a major DSO, the largest player in both the wholesale and retail sectors, and owns all commercial storage sites.

A number of suppliers (including companies owned by E.ON, ENI and GDF) ceased their operations in the universal service segment after the government reduced regulated prices from 2013, which resulted in these companies incurring losses.

Natural gas transmission is carried out by FGSZ Földgázszállító (FGSZ), a subsidiary of MOL Group. FGSZ became the sole TSO in Hungary in 2019 after acquiring MGT, which operated and managed the interconnector between the Slovak Republic and Hungary.

Ten companies hold licences to operate as DSOs in Hungary, but only four operate networks of significant magnitude. These are MVM, TIGÁZ (owned by OPUS Global, which is a publicly listed company on the Budapest Stock Exchange), and two companies owned by E.ON Hungária, a subsidiary of the German electric utility company.

Magyar Földgáztároló (MFGT), wholly owned by MVM, owns and operates all five commercial gas storage terminals in Hungary. The strategic storage terminal in Szőreg is owned by a subsidiary of HUSA, the national stockholding agency.

Upstream

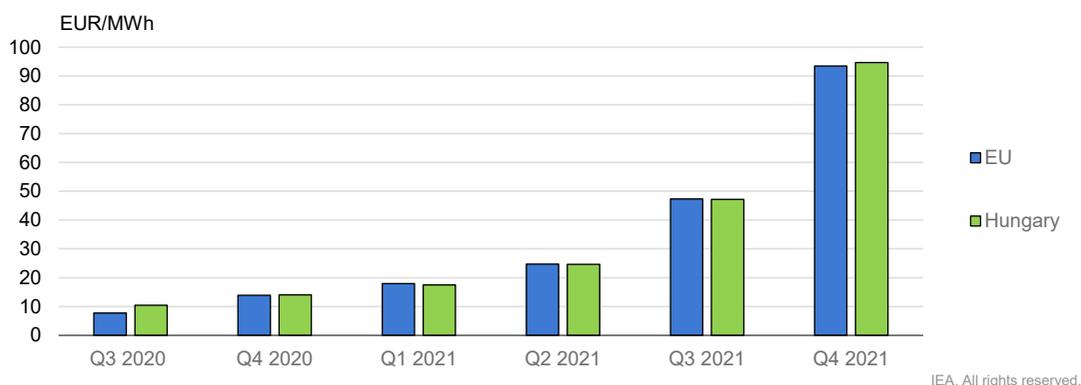
In 2013, Hungary introduced a concession system for natural gas production and exploration. There have been six rounds of concession auctions since 2013, with permits having been granted to MOL, Hungarian Horizon Energy (HHE), Vermilion, O&GD, and Panbridge. However, MOL is the dominant upstream player, accounting for about 80% of total domestic natural gas production in 2020. HHE is the second most significant producer with a production share of 15%.

Wholesale market

As of 2021, 81 companies held licences to trade or supply natural gas in the Hungarian market, of which 45 held a licence to supply end users. Magyar Földgázkereskedő (MFGK), another subsidiary of state-owned MVM, is the largest wholesale player, with an estimated market share of 40% in 2020. MVM is the contracting party for Gazprom's long-term natural gas supply contract with Hungary. PPD Hungária, a subsidiary of the Croatian gas supplier PPD, is the second most significant wholesale supplier, holding a market share of 20%. MET Group accounts for a 10% share of the market while the remaining market share is divided between a large number of companies which each hold relatively minor positions.

A growing quantity of natural gas is being traded on the Hungarian national gas exchange, CEEGEX (Central Eastern European Gas Exchange), which began operating in 2013. In 2020, the quantity of gas traded on CEEGEX equated to 30% of Hungary's total natural gas consumption. This has led to the EU Agency for the Cooperation of Energy Regulators (ACER) to consider that the Hungarian natural gas market is becoming more liquid; ACER noted in 2020 that the Hungarian gas market has moved from being "illiquid" to an "emerging hub" (ACER, 2020).

Figure 10.5 Wholesale gas prices, EU average and Hungary, Q3 2020-Q4 2021



Source: Based on data from EU Market Analysis Reports on European gas market, 2021 and 2020, https://energy.ec.europa.eu/data-and-analysis/market-analysis_en.

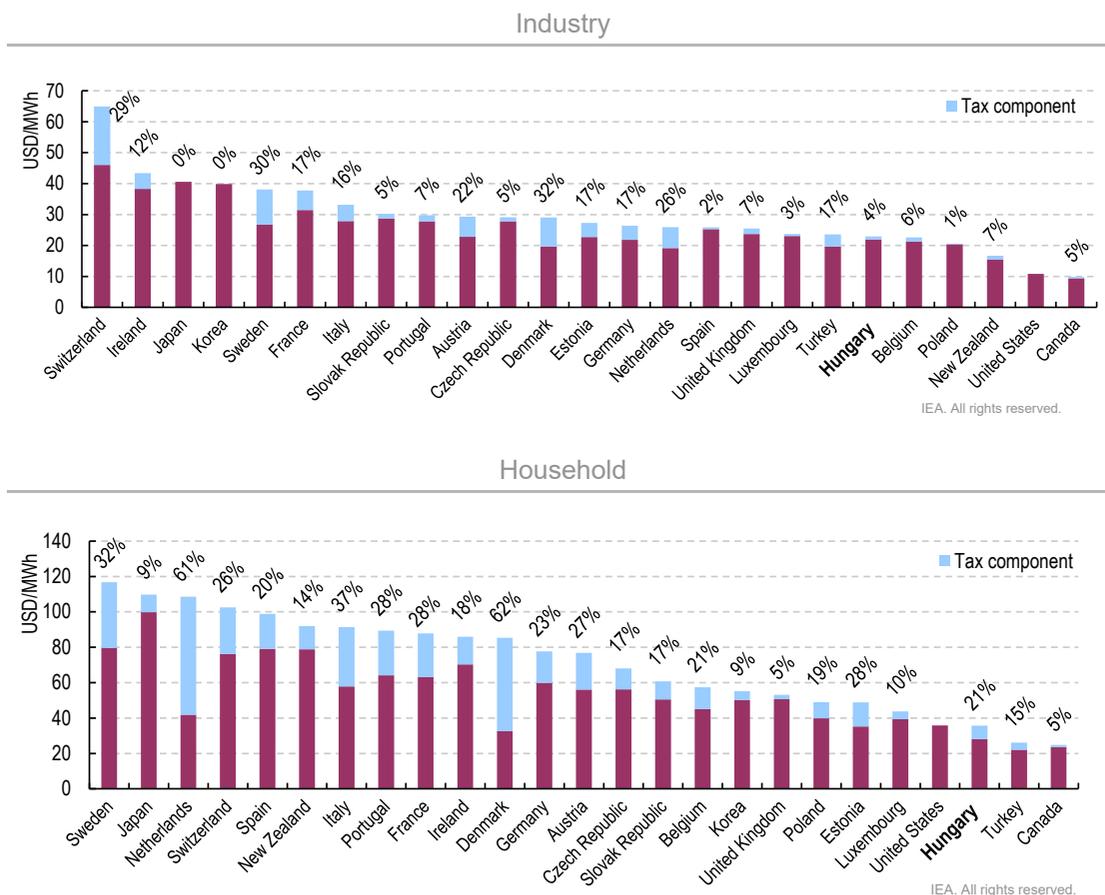
Retail market

State-owned MVM is the dominant supplier in the retail market with a 60% market share in 2020. MVM's retail market share has increased substantially since 2013 following the acquisition of a number of companies that departed the market. MVM is now the sole supplier in the universal service segment, and is therefore essentially the only natural gas supplier to households and other small-scale consumers. MET and E.ON each hold a 5% market share, with the remaining share of the retail market being comprised of small operators.

Retail prices and taxes

Hungary’s industry and household natural gas prices have followed trends similar to its neighbouring countries in recent years, although Hungarian natural gas prices are, on average, lower than in most of its neighbouring countries. In 2020, the price for industry was 23.0 USD/MWh, higher only than Poland (20.6 USD/MWh) among neighbouring countries (Figure 10.6). Household natural gas prices (35.7 USD/MWh) in Hungary were the lowest among its immediate neighbours (Figure 10.7).

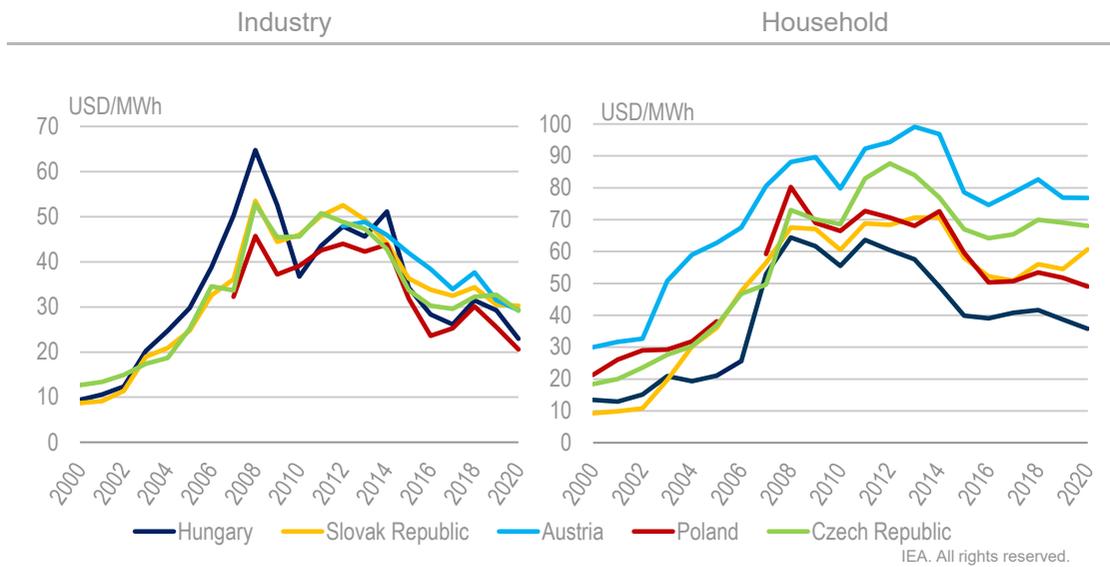
Figure 10.6 Industrial and household gas prices in IEA countries, 2020



Natural gas prices in Hungary are low compared to other IEA countries. Household gas prices are regulated by the government under the Universal Service Scheme.

Notes: 2020 prices are not available for Australia, Finland, Greece, Norway or Mexico. The United States’ tax rate is unavailable. Household prices are inclusive of a supplier margin, transmission costs, storage costs and distribution. Source: IEA (2022b).

Figure 10.7 Industrial and household gas prices in selected IEA countries, 2000-2020



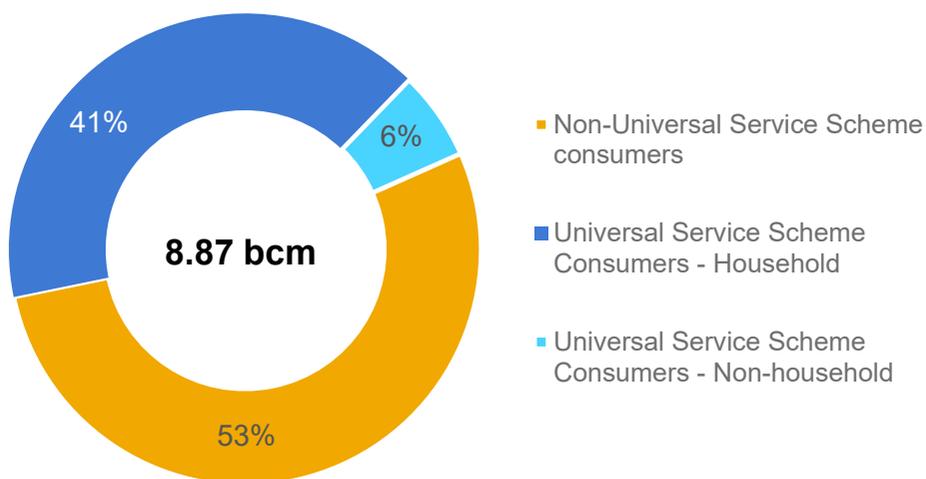
Industry gas prices in Hungary are the lowest among all its regional peers, except Poland. Household gas prices are the lowest in the region by a significant margin.

Note: Industry price data are unavailable for Austria from 2000 to 2011, for Poland from 2000 to 2006; household price data are unavailable for Poland for 2006.
Source: IEA (2022b).

Universal Service Scheme

Hungary has regulated prices under a Universal Service Scheme for natural gas supply, which is aimed at ensuring the affordability of energy for household consumers.

Figure 10.8 Natural gas consumption by consumer type in Hungary, 2020



Six per cent of Hungarian natural gas consumption relates to non-household consumers that are able to avail of regulated prices under the Universal Service Scheme.

Source: Hungarian Ministry for Innovation and Technology.

Under the scheme, end users with less than 20 cm³/h metering capacity are entitled to purchase gas from universal suppliers at regulated prices. Besides households, the relatively high metering capacity threshold allows a significant number of non-household consumers to avail of regulated gas prices (Figure 10.8). In 2020, 13% of the natural gas supplied under the Universal Service Scheme was for non-household consumers, which equated to over 6% of Hungary's total natural gas consumption. As a whole, universal service consumers accounted for 47% of Hungarian natural gas consumption in 2020.

The NES 2030 suggests that the Universal Service Scheme could be revised at some point before 2030, proposing that socio-economic indicators be used as eligibility criteria to access the scheme instead of it being offered to all small-scale consumers, regardless of income.

Gas security and emergency response

Hungary's natural gas security rests on well-developed supply infrastructure, including robust storage capacity and diverse supply routes. Hungary's N-1 indicator, an industry indicator used to gauge the security of natural gas supply, has been above 100% for several years. The N-1 level was calculated at 157%¹¹ in 2021, based on the disruption of the largest natural gas import source, the Ukraine-Hungary interconnector. While Hungary has several alternative supply routes, a significant majority of the natural gas supplied through Hungary's interconnectors originates in Russia, leaving the country potentially vulnerable to any reduction in Russian gas supply to Central and Eastern Europe.

Emergency response measures

The Minister for Innovation and Technology has overarching responsibility for natural gas emergency response policy in Hungary and, in the event of a natural gas supply emergency, would lead Hungary's natural gas National Emergency Strategy Organisation (NESO). Hungary's gas NESO is also comprised of the HEA; HUSA; the gas and electricity TSOs; gas DSOs; major wholesale and retail suppliers; and the gas exchange, CEEGEX.

In the event of a supply emergency, the Hungarian Natural Gas Law provides for clear duties and responsibilities for the Minister for Innovation and Technology, the HEA and other key stakeholders. The decision on whether or not to release emergency stocks or take demand restraint measures would be taken by decree by the minister after consultation with the gas NESO. Throughout the course of an emergency situation, the minister would continue to consult and take NESO's advice.

If the minister decided to impose demand restrictions, the HEA would assess the maximum level of demand that could be withdrawn from various consumer groups. To assist with this assessment, gas traders are obliged to report consumption data by type of consumer to the relevant DSOs or to the TSO each year. Once implemented, the TSO, FGSZ, would monitor the impact of the demand restrictions.

¹¹ The highest daily consumption in the last 20 years was 89.5 mcm in 2005. Removing the largest import source, the Ukraine-Hungary interconnector, leaves Hungary with 140.8 mcm maximum daily import and withdrawal capacity.

Assessment

Natural gas remains a critical energy source in Hungary, accounting for 33% of total energy supply in 2020, the vast majority of which is imported via pipeline. The administration has outlined an objective to reduce Hungary's gas import dependency by increasing production and reducing demand. However, a significant increase in natural gas production is unlikely in the foreseeable future and current policies do not align with an objective to reduce gas consumption in the medium term, with plans to construct the Mátra gas-fired power plant. Therefore, Hungary is likely to remain heavily, and increasingly, reliant on natural gas imports through 2030, and beyond.

The Universal Service Scheme for natural gas supply, which allows households and small industrial users to purchase gas at regulated prices, sustains natural gas consumption. The scheme can also result in suppliers incurring losses if wholesale gas prices are higher than the regulated price which, in turn, disincentivises suppliers from participating in the retail gas market. For state-owned companies, the government will be asked to cover such losses, and has to do so in line with EU state aid rules. The NES 2030 suggests revising the Universal Service Scheme by 2030, proposing that socio-economic indicators be used as eligibility criteria to access the scheme instead of it being offered to all small-scale consumers, regardless of income and other socio-economic indicators. However, the government has shown no immediate desire to pursue a reform process of the Universal Service Scheme. The revision of the scheme is also a major tool to reduce households' reliance on Russian gas, and thus incentivise boiler upgrades or the installation of heat pumps through subsidy support instead of price support.

Targets have been set to increase the blending of hydrogen (up to 2%) and small amounts of biomethane (up to 1%) into the natural gas network by 2030. To support the uptake of hydrogen, the government has developed a National Hydrogen Strategy, which outlines an objective to develop a hydrogen supply network based on Hungary's existing gas networks. However, the government's plans for both hydrogen and biomethane uptake are underdeveloped, requiring significant work to meet the government's targets, including the development of new regulatory and chemical safety regimes.

Although Hungary's natural gas import sources are concentrated, recent infrastructure developments have provided Hungary with the opportunity to procure natural gas from a wider variety of sources. The construction of the Krk LNG terminal in neighbouring Croatia has given Hungarian natural gas suppliers the opportunity to source global LNG cargoes which can be transported to Hungary via the Drávaszerdahely interconnection, and upgrades at the Kiskundorozsma and Csanádpalota interconnections have facilitated flows into Hungary via Serbia and Romania, respectively. Since October 2021, quantities of natural gas imports have arrived through the Kiskundorozsm interconnection (on the Serbian border), in particular following the September 2021 supply agreement between the Hungarian government and Gazprom regarding the supply of gas via the TurkStream pipeline system. These developments, in addition to future plans to construct an interconnector at the Slovenian border and to introduce bi-directional capacity between Hungary and Austria, will potentially serve to improve Hungary's gas security in the future.

Russia will remain the ultimate source of much of the natural gas delivered to Hungary. Therefore, a widespread disruption in Russian natural gas supply could result in a significant reduction in natural gas flows; this scenario should be taken into account in contingency planning and a coherent action plan for natural gas developed.

Recommendations

The government of Hungary should:

- Develop a coherent action plan for natural gas that both aligns with Hungary's decarbonisation objectives and maintains energy security, notably by enacting reverse flows and reduction of gas demand, thus avoiding single supplier dependency and stranded assets.
- Develop a clear and transparent programme for the implementation of full retail gas market liberalisation, including the elimination of administratively determined end-user prices. Protection measures for vulnerable customers and less well-off households should form part of a social policy rather than of energy policy.
- Develop a robust implementation plan to support the ambitions in the National Hydrogen Strategy, including instigating technical studies to investigate the possibility of using Hungary's existing natural gas infrastructure to accommodate hydrogen, biomethane and other low-carbon gases.

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11. Oil

Key data (2020)

Domestic crude oil production: 17 kb/d, +14% since 2010

Net imports of crude oil:^{*} 123 kb/d, +1% since 2010

Domestic oil products production: 153 kb/d, +12% since 2010

Net imports of oil products: 12.4 kb/d, (2.8 kb/d net exports in 2010), of which 70.8 kb/d total imports and 58.4 kb/d total exports

Share of oil: 27% total supply (TES plus international bunker fuels)**, 35% TFC, 10% in energy production and 0.1% in electricity generation

Oil consumption by sector: 163 kb/d (transport 55%, industry 42%, international bunkering 1%, residential 1%, electricity generation 0%)

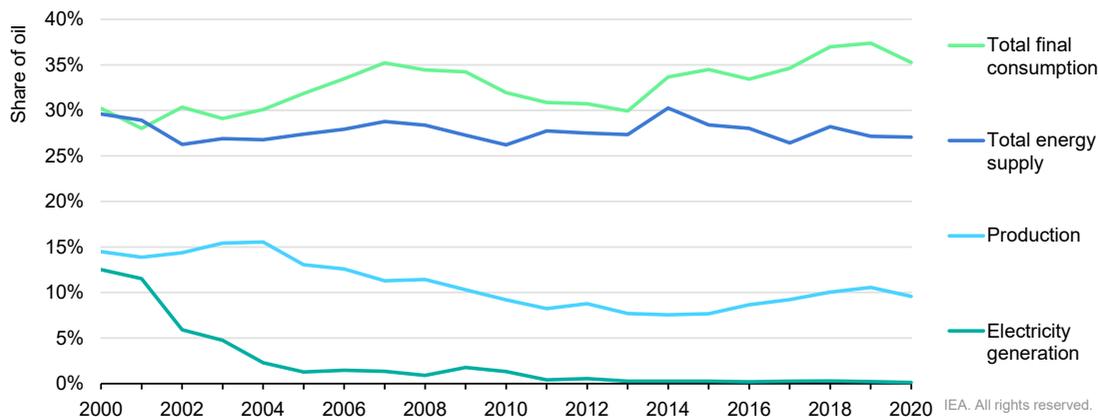
^{*} Imports of crude oil includes crude oil, natural gas liquids and feedstock.

^{**} Total energy supply does not include oil used for international bunkering.

Overview

Oil plays a significant and growing role in Hungary's energy system. The share of oil in TFC has increased in recent years, rising from 30% in 2013 to 35% in 2020, largely driven by growing demand from the transport sector (Figure 11.1).

Figure 11.1 Share of oil in Hungary's energy system, 2000-2020



The share of oil in total final consumption has grown, giving oil a major position in the mix.

Source: IEA (2022a).

Oil consumption is heavily concentrated in the transport and industry sectors; consumption in electricity generation is negligible. The petrochemicals sector is a significant oil consumer and is expected to account for a growing share of total oil consumption in the future. Hungary produces a small amount of crude oil, and has one major refinery, but the country is nonetheless a net importer of both crude and oil products.

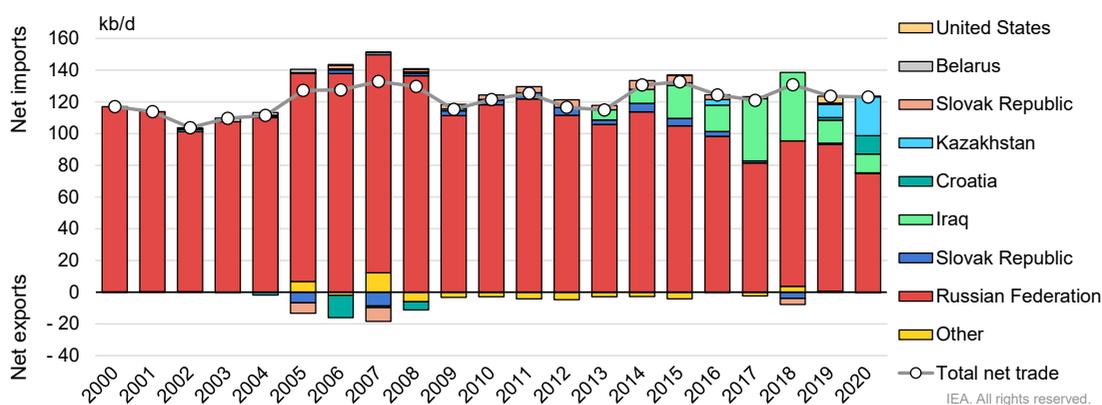
Hungary's NES 2030 stipulates that efforts should be made to curtail oil demand, particularly by supporting the uptake of alternative fuels in the transport sector (Hungary, 2020). However, the government has not set a target to reduce the total level of oil consumption in Hungary, with today's ambitions focusing on limiting oil consumption growth in the transport sector by 2030 to 10% above 2016 levels.

Crude oil trade

Hungary is a relatively small crude oil producer, but local production has increased following the discovery of reserves in the south-west of the country in 2017. In 2020, crude production stood at 17 thousand barrels per day (kb/d), around 35% higher than in 2015. Further significant increases in local crude output are not anticipated, however, and efforts to tap unconventional resources have been largely abandoned. Local production accounted for just 12% of Hungary's total crude oil needs in 2020.

Net imports of crude oil stood at 123 kb/d in 2020 (Figure 11.2). Hungary remains heavily reliant on crude oil imports from Russia, but the extent of its dependence on Russian crude has progressively decreased since 2012. In 2020, Russian crude accounted for 64% of Hungary's total crude imports, compared to 80% in 2015 and 97% in 2010. Most of the country's remaining crude imports come from Iraq and Kazakhstan.

Figure 11.2 Hungary's net trade in crude oil, natural gas liquids and refinery feedstocks, by country, 2000-2020



Hungary is a significant net importer of crude oil. Russia remains the most important import source, but reliance on Russian crude has decreased substantially since 2010.

Source: IEA (2022a).

Oil products production

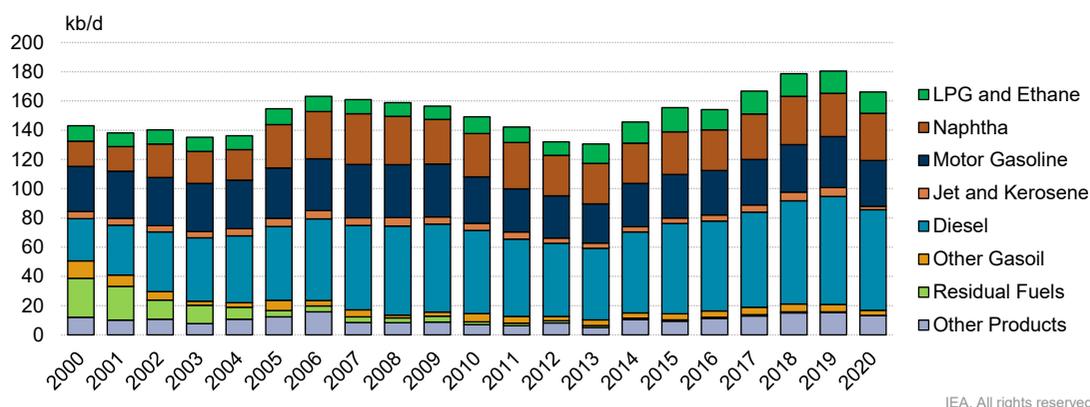
Total oil products production in Hungary amounted to 153 kb/d in 2020, the vast majority of which relates to production at the country's only large-scale refinery, the Duna refinery (also known as the Danube refinery) in Százhalombatta, owned and operated by MOL. Production levels have remained relatively steady in recent years. Diesel represents the largest share of oil product output, accounting for a 41% yield of total production, while gasoline and naphtha accounted for a 17% and 16% share of production, respectively. MOL intends to invest USD 4.5 billion in its downstream operations as part of its "MOL 2030" strategy, which includes an objective to increase the output of petrochemicals feedstocks at the Duna refinery.

Oil products consumption

Total oil products consumption in Hungary had been rising prior to 2020, reaching 176 kb/d in 2019, representing a 16% increase on the 2015 level (Figure 11.3). Oil products demand fell in 2020 by an estimated 8%, due to the impact of Covid-related restrictions on mobility and economic activity.

However, Hungarian oil products consumption has bounced back strongly, with total consumption recorded at 176 kb/d in Q2 2021, 11% higher than in Q2 2020. In the longer term, the government expects that consumption growth will be curtailed somewhat by both fuel switching and efficiency gains, but it nonetheless expects demand to continue to grow at least through 2030.

Figure 11.3 Oil products demand in Hungary, 2000-2020



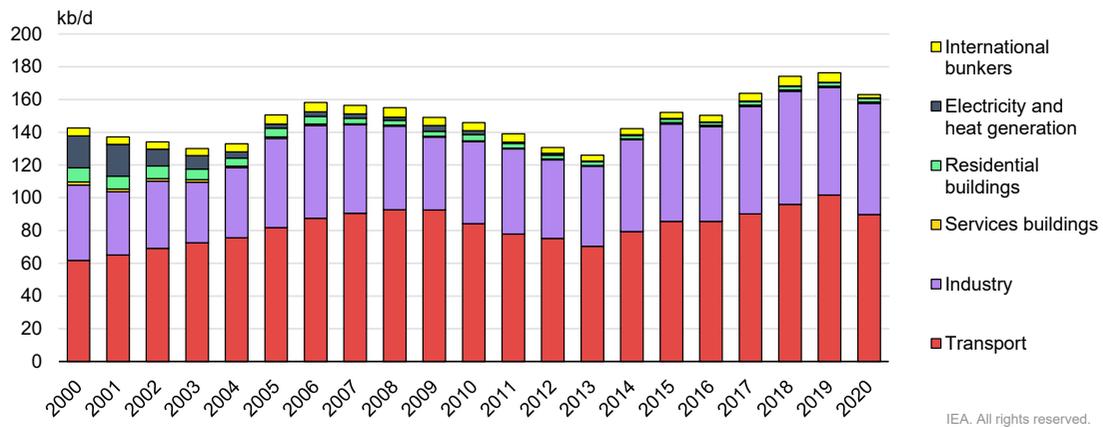
Oil products demand grew fairly strongly for several years before 2020, primarily driven by increased consumption of motor fuels.

Source: IEA (2022a).

Oil products consumption has become increasingly concentrated in the transport sector (accounting for 55% of total oil product consumption in 2020) (Figure 11.4). Demand for motor fuels has been the principal driver of oil product consumption growth in Hungary since 2013. The industrial sector is also a major consumer of oil products (accounting for

42% of total consumption in 2020), with naphtha consumption being notably large due to the substantial petrochemicals industry in Hungary. Oil consumption in electricity and heat generation has become negligible.

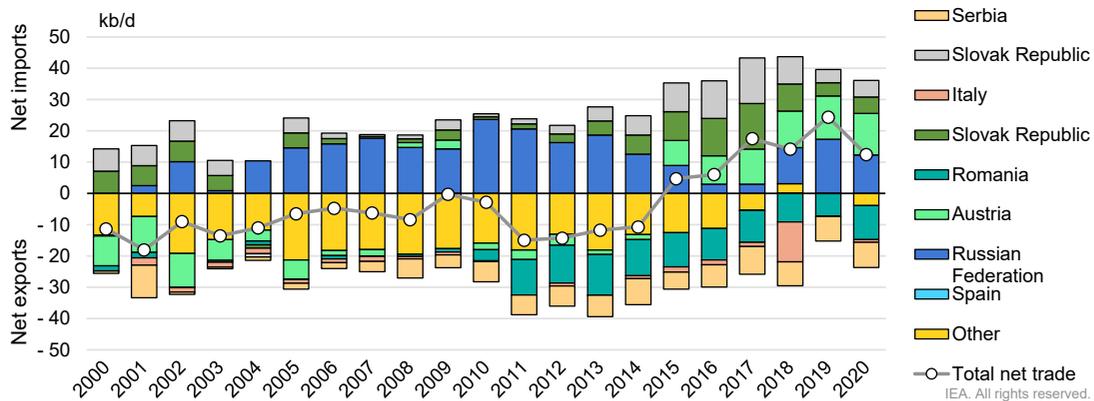
Figure 11.4 Oil demand by sector in Hungary, 2000-2020



Oil demand has become increasingly concentrated in the transport sector, while industry demand remains strong due to Hungary's substantial petrochemicals sector

Note: Service sector buildings' oil consumption is not visible on this scale.
Source: IEA (2022a).

Figure 11.5 Hungary's oil products net trade by country, 2000-2020



Hungary has been a net importer of oil products since 2015, most of which come from Austria, Russia and the Slovak Republic.

Source: IEA (2022a).

Oil products net trade

While Hungary was a net oil product exporter until the mid-2010s, it is currently a net importer of oil products, with net imports amounting to 9.7 kb/d in 2020. The impact of Covid-related restrictions resulted in net oil product imports declining sharply in 2020 (by 60%) versus 2019 (24.4 kb/d) (Figure 11.5). However, Hungary's import needs had been increasing strongly in the years preceding 2020, due to rising demand for diesel and

gasoline. In 2020, Hungary was a net importer of diesel/gasoil, gasoline, LPG/ethane and naphtha. Oil product imports came predominantly from Austria, Russia and the Slovak Republic, while some products were exported, notably to Romania and Serbia.

With no significant increase in production and oil demand set to grow until at least 2030, Hungary is expected to remain an oil product net importer for the foreseeable future.

Oil policy

Hungary's Ministry for Technology and Industry is responsible for determining the country's broad oil sector policy agenda. The ministry sets targets for the oil sector which are outlined in the NES 2030 and NECP (Hungary, 2020a). The NES and NECP highlight the importance of maintaining the security of oil supply. It notes that despite Hungary's high import dependency, security of supply is currently assured by the country's existing oil sector policies, multiple potential import sources and its stockholding system.

Promoting the potential development of the Hungarian upstream sector is also supported in the NES 2030, with importance placed on maintaining the existing concession system to incentivise additional exploration and production. The NES 2030 stipulates that oil consumption growth should be contained, and outlines a number of goals and objectives for curtailing oil demand. The strategy suggests that oil consumption in the transport sector should not rise by more than 10% by 2030 compared to 2016 levels, but stops short of setting a target to reduce oil consumption levels. It suggests that this target should be achieved by promoting the use of public transport and alternatively fuelled vehicles in public transport services as well as increasing the use of biofuels. The NES 2030 also stipulates that there should be incentives for using privately owned, alternatively fuelled vehicles. Various incentives, including some tax breaks and free parking for EVs, have already been implemented.

Biofuels

Hungary has sought to promote the uptake of alternative fuels in transport by increasing the mandated biofuels blending rate in motor fuels. The overall renewable energy share for gasoline and diesel combined was increased to 8.2% in 2020; there is a separate obligation for gasoline 95 of 6.1%. According to the EU's RED II Directive, the share of second-generation biofuels (produced from non-crop based feedstocks) in total energy consumption within the transport sector must be at least 0.2% by 2022, increasing to at least 1% by 2025 and 3.5% by 2030.

RED II also stipulates that the share of first-generation biofuels should be capped at 7% of FEC in the transport sector or the 2020 consumption level +1% (whichever is lower) by 2030. To comply with this mandate, there is a clear need for Hungary to prioritise the production and consumption of second-generation biofuels. Hungary is a major exporter of bioethanol from its two production plants. Feedstock of the production is almost exclusively first generation, i.e. crop-based. There is also a biodiesel (FAME) production unit in Hungary which processes both first-generation and waste-based – used cooking oil and tallow oil – biofuels.

Market structure

The Hungarian oil sector is fully liberalised with limited regulatory obstacles to market entry and no price controls. However, the vertically integrated oil company, MOL, is dominant across the oil value chain and enjoys a considerable competitive advantage over its rivals in the wholesale and retail sectors given that it is the only market participant with a refining asset in Hungary. No notable market reforms are planned.

MOL is the largest crude producer in Hungary and has also acquired the majority of the exploration rights on offer under Hungary's concession programme. Horizon Energy, a Hungary-based affiliate of the US-based Aspect Holding, is the country's second-largest upstream player, with its share of total production estimated to have increased from 20% in 2018 to 30-40% by 2020, following discoveries in the south-west of Hungary. A number of small North American exploration and production companies have also acquired exploration rights in Hungary.

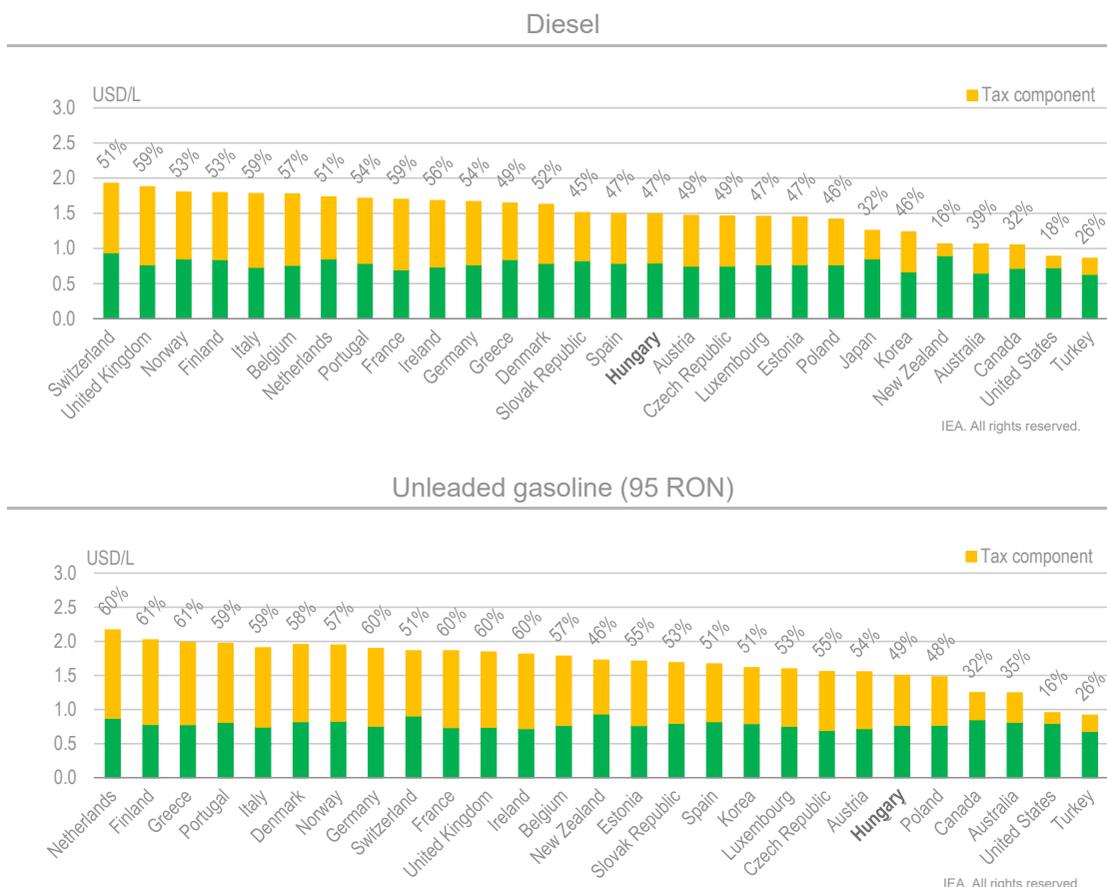
MOL is by far the most significant operator in the retail sector, but several other regional and international companies are also present, including Shell, OMV and Lukoil. There is a fairly significant proportion of small, independent retailers (accounting for around a third of all retail stations), while an increasing number of supermarkets are also offering refuelling services. The number of retail stations in Hungary has grown mildly in recent years, reaching in excess of 2 000 stations by 2020. Barriers to entry are considered fairly low in the retail sector. Most of the major players in the retail sector also operate in the wholesale sector, but the wholesale sector is again dominated by MOL.

Prices and taxes

The government does not regulate prices at the wholesale or retail levels, leaving fuel prices fully liberalised until November 2021. In November 2021, the government capped retail fuel prices of both gasoline and diesel at HUF 480 (USD 1.53) per litre as a temporary measure. The price cap was scheduled to be lifted in February 2022, but was extended first until 15 May then until 1 July 2022.

The price for automotive diesel in Q3 2021 was 1.5 USD/L, inclusive of a 47% tax share (Figure 11.6). The diesel price ranked 16th among IEA countries (data are not available for Mexico and Sweden). The price of premium unleaded gasoline was the sixth-lowest among IEA countries, at 1.5 USD/L, with a 49% tax share.

Figure 11.6 Price comparison for automotive diesel and gasoline in the IEA, Q3 2021



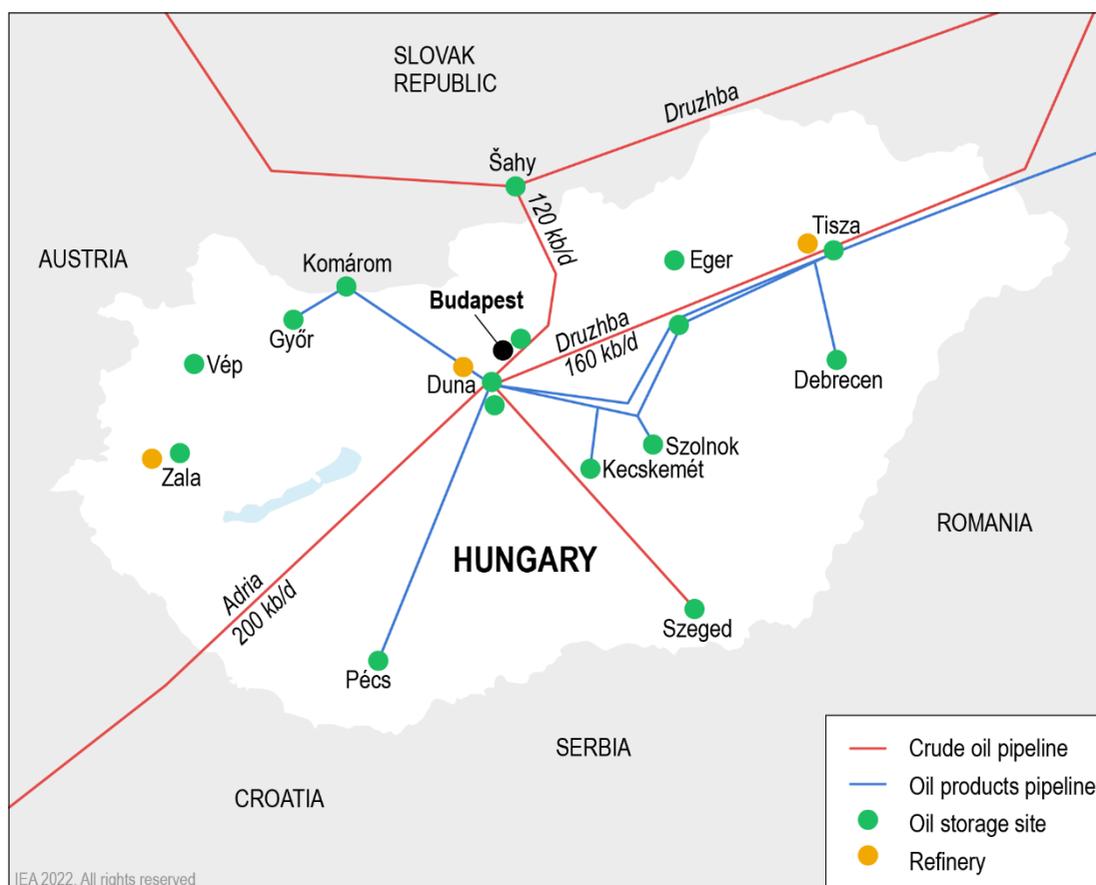
Diesel prices in Hungary trend around the IEA average while gasoline 95 prices are the sixth-lowest among IEA countries due to a relatively low tax component.

Notes: Automotive fuel 2021 prices are not available for Mexico and Sweden. Premium unleaded gasoline (95 RON) 2021 prices are not available for Japan, Mexico or Sweden.
Source: IEA (2022b).

Oil infrastructure

Refining

There is one major refinery in Hungary, the 162 kb/d Duna site in Százhalombatta, owned and operated by MOL. MOL operates the Duna refinery in co-ordination with another of its refineries, the 122 kb/d Bratislava refinery in neighbouring Slovak Republic, with a significant amount of intermediate products being exchanged between the two plants. There is also a bitumen production plant in Zalaegerszeg which receives feedstock from both the Duna and Bratislava refineries.

Figure 11.7 Oil infrastructure in Hungary

Transport

As a landlocked country, Hungary relies on pipelines and a barge system to transport crude and oil products. Most crude oil processed in Hungary arrives through the Druzhba pipeline system. The Duna refinery receives feedstock from Hungary's northern border with the Slovak Republic through the Druzhba I pipeline and from its eastern border with Ukraine through the Druzhba II pipeline. Increasing quantities of Middle Eastern crude are also being transported to Hungary from the Croatian port of Omišalj via the Adria pipeline system.

A number of oil product pipelines link the Duna refinery with demand centres, as well as with the Tiszaújváros and Zalaegerszeg refineries. Hungary is also linked to the Eastern oil product pipeline that transports products from Russia's refining centres via Ukraine; this system has been primarily used by MOL as a means of purchasing gasoil feedstocks for further processing. In addition to the pipeline connections, products can be exported, imported and transported internally via barge on the Danube from Komárom and Százhalombatta.

Oil storage

Total storage capacity for crude and oil products in Hungary amounts to 15.79 million barrels (mb; 8.2 mb of which is crude oil). There are three main storage operators in the country: MOL, Hexum Tank Storage (formerly known as OPAL) and Product Storage (also known as Terméktároló).

Crude oil is stored by MOL at the Duna refinery site (2.8 mb) as well as at Fényeslitke (0.4 mb) and Tiszaújváros (2.2 mb). Hexum Tank Storage also has two storage facilities for crude oil at Százhalombatta (1.9 mb) and Tiszaújváros (0.9 mb).

In addition to its crude terminals, Hexum Tank Storage operates three oil product terminals within the country with a combined capacity of 2.87 mb. Product Storage has oil product tank farms within MOL terminals with a combined capacity of 2 mb. MOL also operates a number of smaller storage facilities for oil products at various locations with a total capacity of 2.72 mb.

Oil emergency policies

Hungary's oil emergency policy is under the responsibility of the Minister for Innovation and Technology, and codified in the Stockpiling Act of 2013 (Act No. XXIII). The use of publicly held stocks by the dedicated national stockholding agency is the central element of Hungary's oil emergency response strategy.

Emergency stocks can, if necessary, be complemented by demand restraint measures. The Minister for Innovation and Technology has the power to decree demand restraint measures to restrict oil consumption in the event of a major supply emergency. Hungary developed a set of demand restraint measures in 2015, but the projected savings that could be made through their implementation has not been updated since.

Oil emergency organisation and decision making

The decision on whether or not to release public stocks or implement demand restraint measures would be taken by the Minister for Innovation and Technology. The minister would take its decision after consultation with Hungary's NESO and the national stockholding agency, the Hungarian Hydrocarbon Stockpiling Association.

Hungary's NESO is chaired by the Minister for Innovation and Technology, while other key ministries, HUSA and the oil industry are also represented. The NESO secretariat is comprised of staff from the MIT; it is responsible for maintaining relations with the IEA and the EU on matters pertaining to oil emergency policy, as well as organising emergency training exercises. NESO meetings and training exercises are held on an *ad hoc* basis with no fixed schedule.

The procedures to be taken in the event of an oil supply disruption are detailed in the government's *Manual on the Emergency Measures in the Supply of Crude Oil and Petroleum Products*. The document summarises the steps to be taken in a supply emergency and defines the roles and responsibilities of various stakeholders. However, the document was last updated in 2015.

Any disruption of Russian oil supply via the Druzhba pipeline, as was the case in 2019 due to contaminated crude, strongly affects Hungary, the Czech Republic and the Slovak Republic, which would likely have to draw on emergency oil stocks and seek alternative supplies of crude, notably seaborne crude via the terminals of Omišalj and Trieste.

Hungary is heavily dependent on the southern branch of the Druzhba pipeline for its crude oil imports. The government cited this reliance as a reason for requesting an exemption from the EU embargo on Russian oil imports, as decided by the European Council on 30-31 May 2022 and to be implemented by the end of 2022. Therefore, the EU embargo includes a temporary exemption for crude oil imports by pipeline, allowing Hungary to import crude oil via the Druzhba pipeline.

Stockholding

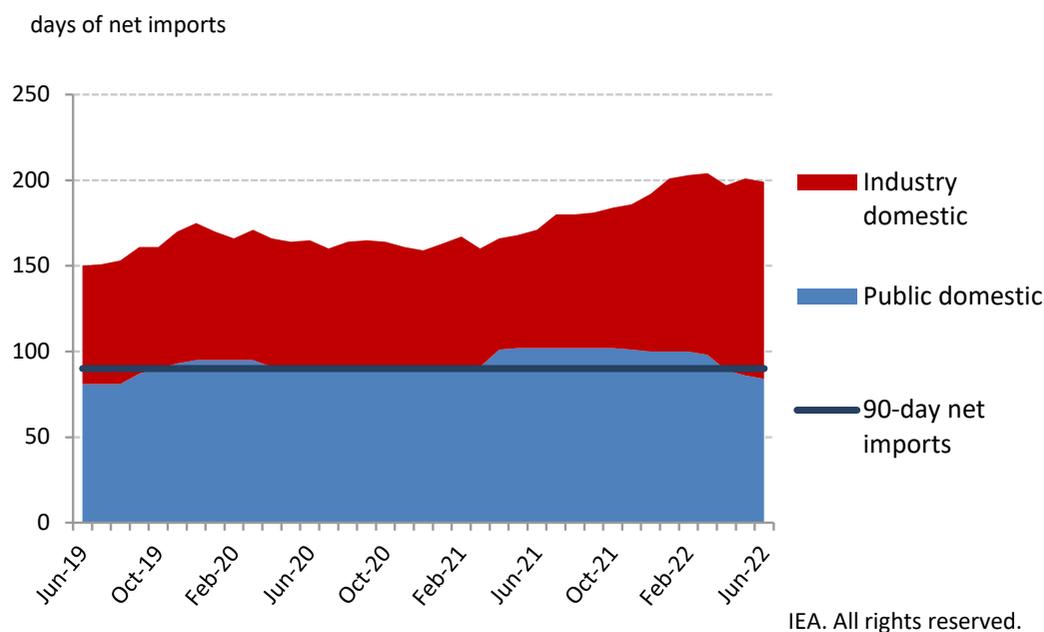
All of Hungary's public emergency stocks are owned by the national stockholding agency, HUSA, and stored within Hungary in dedicated tanks at commercial storage terminals, separated from commercial stocks. HUSA is an independent, non-profit organisation financed by compulsory membership levies imposed upon the 49 companies involved in the import and/or internal distribution of oil products in Hungary. Contribution fees are collected directly by HUSA. Aside from their obligations to HUSA, Hungary does not impose any stockholding obligations on the oil industry.

Hungary's Stockpiling Act obliges HUSA to hold oil stocks at a level equivalent to at least 90 days of net imports, with at least one-third of that quantity in the form of oil products. The precise breakdown of emergency stocks into crude oil and specific oil products is determined by HUSA on an annual basis following a market assessment.

Hungary has been consistently compliant with its IEA minimum stockholding obligation, with total oil stocks covering well beyond the 90-day net import level. As of June 2022, total oil stocks in Hungary equated to 199 days of net imports (Figure 11.8), including including 115 days of industry stocks and 84 days of public emergency stocks. Additionally, Hungary holds 2.37 mb of oil stocks¹² under bilateral agreements for the benefit of other countries; all the stocks held in Hungary under tickets are stored at facilities owned by MOL.

¹² As of August 2021.

Figure 11.8 Hungary's compliance with the IEA 90-day stockholding obligation, end-June 2022



Hungary holds oil stocks well beyond its minimum IEA stockholding obligations; the majority of stocks are publicly held by the national stockholding agency.

Source: IEA (2022c).

Assessment

Accounting for a 35% share of TFC in 2020, oil plays a significant role in Hungary's energy system, and despite a drop in 2020, oil consumption has been on a clear upward trajectory since the mid-2010s. Consumption growth has been driven by the transport sector, and to a lesser degree by the petrochemicals sector.

Although the government has introduced some measures to curtail oil consumption in the transport sector, including some tax breaks and free parking for EVs, the government's ambitions to reduce oil consumption are fairly limited. The National Energy Strategy 2030 suggests that oil consumption in the transport sector should not rise by more than 10% by 2030 compared to 2016 levels, but stops short of setting a target to reduce overall oil consumption levels.

Under current government policies, oil will remain a significant part of Hungary's energy mix through 2030, and well beyond. Further consumption growth is highly likely in the medium term, potentially resulting in a misalignment with Hungary's decarbonisation objectives and broader climate policy agenda. Stronger measures to support alternative fuels and deter the uptake of internal combustion engine vehicles would be required to significantly reduce oil consumption in transport.

Despite the government's continuing support for the upstream oil sector, growth in oil consumption is unlikely to be met by increased domestic production, meaning that Hungary's substantial reliance on oil imports will grow. Hungary's oil import needs had already been increasing strongly in the years preceding 2020, primarily due to rising demand for diesel and gasoline.

Hungary has made clear efforts to increase biofuels consumption in the road transport sector by increasing the mandated biofuels blending rate of diesel from 6.4% to 8.2%, and of gasoline 95 from 4.9% to 6.1% in 2020. Hungary is now also a sizeable biofuels producer. However, virtually all biofuels consumption and production in Hungary consists of first-generation biofuels, produced from crop-based feedstocks, leaving a clear need for Hungary to prioritise the production and consumption of second-generation biofuels if it is to comply with the EU's RED II Directive.

While there is a strong emphasis on electrification of the transport sector, Hungary has a high degree of second-hand cars from western European countries that could impede the uptake of EVs. Furthermore, the vehicle ownership rate is below the European average, leaving significant room for growth of the national vehicle fleet and potentially resulting in further growth in demand for motor fuels.

The Hungarian government does not regulate oil prices at the wholesale or retail levels, leaving prices fully liberalised. However, given that Hungary's gasoline prices are below average compared to other IEA countries (1.49 USD/L), and that diesel prices were around the IEA average (1.5 USD/L) as of Q3 2021, there is room to increase taxation for both fuels. Implementing taxation on motor fuels could help future ambitions to limit oil consumption growth in the transport sector.

With oil set to remain a significant part of Hungary's energy mix for the foreseeable future, oil security will remain a significant priority for Hungary in the long term. The strong likelihood of future oil consumption growth means Hungary will be subject to a growing minimum IEA stockholding obligation in volume terms, and could leave the country increasingly vulnerable to the impacts of any future oil supply disruptions.

On the whole, however, Hungary has a solid oil stockholding system exemplified by a competent national stockholding agency that is legally obliged to hold oil stocks within Hungarian territory at a level equivalent to at least 90 days of net imports.

Hungary's overall oil emergency response strategy is well developed, but in need of some revision to align with changing demand trends. The broad measures to be taken in a supply crisis and the roles and responsibilities of various stakeholders are stipulated in the Stockpiling Act, while further details on the practicalities of the emergency response strategy are outlined in the *Manual on the Emergency Measures in the Supply of Crude Oil and Petroleum Products*. However, the manual was last updated in 2015 and is now outdated in a number of areas.

In May 2022, the Hungarian government requested an exemption from the EU embargo on Russian oil imports, stating its high dependence on the southern branch of the Druzhba pipeline for its crude oil imports. In the light of Russia's invasion of Ukraine, the government

needs to urgently review options to reduce this dependency of pipeline imports from Russia and strengthen the diversification of its oil imports, together with its regional neighbours.

Recommendations

The government of Hungary should:

- ❑ Re-evaluate the alignment of the National Energy Strategy 2030's goal of limiting oil consumption growth in the transport sector to 10% in 2030 versus 2016 with Hungary's climate neutrality ambitions and consider introducing a target for reducing consumption.
- ❑ Consider more stringent measures to decarbonise the transport sector, including introducing higher taxation on gasoline and diesel, setting a date on banning the sale of new internal combustion engine vehicles, establishing a vehicle scrappage scheme, and creating stronger incentives for the uptake of electric vehicles and deeper investment in public charging infrastructure.
- ❑ Accelerate efforts to promote biofuels consumption in transport with a particular focus on second-generation biofuels to meet the biofuels mandate under the RED II Directive. Promote increased production of second-generation biofuels.

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ANNEX A: Institutions

The **Ministry for Technology and Industry (MTI)** is the central body responsible for energy policy. Its responsibilities cover oil, natural gas, coal, electricity and nuclear energy, along with renewables, climate policy and energy efficiency. Since 2022 it also prepares the general rules of environmental protection and monitors and encourages the development of environmental protection tools.

The **Deputy Secretary of State for Energy Policy** designs and implements the content and various measures of energy policy.

The **Deputy Secretary of State for Climate Policy** has responsibilities over climate policy. The Deputy Secretariat is organised in three departments: the Department for Decarbonisation, in charge of energy efficiency and renewable energy; the Department of Climate Policy, responsible for international and EU-level climate negotiations and domestic climate policy; and the National Climate Protection Authority, which administrates regulation on F-gases and the EU ETS, and is the National Administrator of the Registry.

The **Department for Strategic Planning and Programming** is responsible for hydrogen policy and the elaboration of energy-related strategic documents, such as the National Energy and Climate Plan and the Long-Term Strategy.

The **National Research, Development and Innovation Office** Ministry for Innovation and Technology co-ordinates research development and innovation policy across the government, ensures adequate RDI funding and transparent use of available resources. The Office works under the supervision of the Ministry for Culture and Innovation.

The **Energy Innovation Council (EIT)** was established in 2018 by the MTI and includes corporate entities, regulatory bodies and the Hungarian Academy of Sciences. The EIT prepared the chapter on Energy Innovation of the National Energy Strategy 2030.

The **Ministry of Foreign Affairs and Trade** manages international relations concerning energy security and is in charge of the planning, construction and commissioning of the two new units of the Paks Nuclear Power Plant.

The **Ministry of Agriculture** has responsibilities over forest and biomass management.

The **Hungarian Energy and Public Utility Regulatory Authority (HEA)** is an independent body that has oversight on electricity, natural gas, district heating, water utility and waste management. The HEA determines the electricity network usage, access charges and issues relevant permits. In the field of energy efficiency, the HEA manages energy auditing and the operation of the Energy Efficiency Obligation Scheme. It has its own budget and reports on annual basis to parliament. As the official statistical body, the HEA is also responsible for data reporting obligations to international bodies and organisations.

The **Hungarian Atomic Energy Agency** holds regulatory oversights of nuclear facilities.

ANNEXES

The **Mining and Geological Survey of Hungary** is a central governmental body acting jointly with the government in state activities related to mining and geology.

The **Hungarian Central Statistical Office** is an independent body responsible for official statistics in co-ordination with the **Official Statistical Service**. It publishes recommendations and guidelines relating to official statistical activities.

ANNEX B: Review team and supporting stakeholders

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 and preparation of the report

The in-depth review team visit took place virtually from 11 to 22 October 2021. 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 on the basis of the information obtained during these meetings, the team's preliminary assessment of Hungary's energy policy, the Hungarian 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 Elzo Molenberg, Netherlands (team leader)

Mr Conrad Buffier, Australia

Mr Jim Scheer, Ireland

Mr Balazs Jozsa, European Commission

Mr Linus Palmblad, Sweden

Mr Szymon Byliński, Poland

Mr Geoffrey Lyon, United States

Mr Kasper Sand Olsen, Denmark

OECD Nuclear Energy Agency

Mr Vladislav Sozoniuk, Nuclear Energy Analyst, Division of Nuclear Technology Development and Economics

International Energy Agency

Mr Aad van Bohemen, Head of Energy Policy and Security Division

Ms Dagmar Graczyk, Senior Energy Policy Analyst and in-depth review co-ordinator

Mr Ronan Graham, Energy Security Analyst

The team expresses its gratitude to Dr Márk Alföldy-Boruss, Deputy State Secretary for Energy Policy; Dr Barbara Botos, Deputy State Secretary for Climate Policy; Mr Viktor Horváth; Dr Anita Csiki; Dr Zsuzsa Béres; and their colleagues for their tireless efforts in supporting the review, their readiness to support the team with swift responses to the many requests and patience throughout the process.

The review was prepared under the guidance of Mr Keisuke Sadamori, Director, Energy Markets Directorate, IEA, and Mr Aad van Bohemen, Head of the Energy Policy and Security Division, IEA. Ms Dagmar Graczyk managed the review and prepared the chapters on coal and general energy policy. Ms Sylvia Beyer completed the drafting of the final report with support of Mr Alessio Scanziani, who led the chapters of energy efficiency and renewables. Mr Ronan Graham wrote the chapters on oil, natural gas and electricity security. Mr Vladislav Sozoniuk wrote the chapter on nuclear energy. Mr Alessio Scanziani, Ms Clémence Lizé, Ms Elisa Hittner and Ms Eunjin Choe prepared and drafted the sections relating to energy data contained in each chapter.

Helpful comments, chapter reviews and updates were provided by the following IEA staff: Mr Carlos Fernández Alvarez, Ms Ksenia Petrichenko, Mr Luis Lopez, Mr Francois Briens, Ms Ivana Capozza, Mr Gergely Molnar and Ms Toril Bosoni.

Special thanks to the IEA secretariat with regard to the data, publication and editing. Mr Alessio Scanziani and Ms Clémence Lizé ensured the preparation of the design of the report with figures, tables and maps. Mr Steve Gervais, Mr Arnau Risquez Martin and Ms Erica Robin from the Energy Data Centre participated in the data and statistics discussions during the visit. Mr Victor García Tapia, Ms Suzy Leprince, Mr Domenico Lattanzio, Mr Jungyu Park and Ms Roberta Quadrelli provided support on statistics and data. Ms Therese Walsh managed the editing process and Ms Astrid Dumond the production process. Ms Isabelle Nonain-Semelin finalised the production. Support for the maps was provided by Ms Tanya Dyhin. The report was edited by Ms Jennifer Allain.

Organisations visited

Alteo

Association of Climate-Friendly Municipalities (Klímbarád Települések Szövetsége)

BME Zéró Karbon Központ

Budapest University of Technology and Economics – Department of Environmental Economics

Centre for Energy Research (Nuclear)

Central Eastern European Gas Exchange (CEEGEX)

Coal Commission Secretariat (within Eszterházy Károly Catholic University)

E.ON

Energiaklub

FGSZ Ltd (natural gas transmission system operator)

Hungarian Atomic Energy Authority (HAEA)

Hungarian Biofuels Association (Magyar Bioüzemanyag Szövetség)

Hungarian Chamber of Commerce and Industry

Hungarian Chamber of Engineers

Hungarian Competition Authority

Hungarian Energy and Public Utility Regulatory Authority (HEA)
Hungarian Gas Storage Ltd
Hungarian Geothermal Association (Magyar Geotermális Egyesület)
Hungarian Hydrocarbon Stockpiling Agency (HUSA)
Hungarian Petroleum Association (Magyar Ásványolaj Szövetés)
Industrial Energy Consumers Forum
Institute of Nuclear Technologies – Budapest University of Technology and Economics
Institute of Climate Policy (Klímapolitikai Intézet)
Limited Company for Radioactive Waste Management (PURAM)
Lorand Research Network – Centre for Energy Research/Institute for Energy Security and Environmental Safety
Magyar Energiahatékonysági Intézet
MAHÖSZ (Hungarian Heat Pump Association)
MANAP (Hungarian Solar Industry Association)
MATÁSZSZ (Hungarian Association of District Heating Providers)
MAVIR (electricity transmission system operator)
MEHI Magyar Energiahatékonysági Intézet MET
Mining and Geological Survey of Hungary
Ministry for Innovation and Technology (MIT)
Ministry of Agriculture
Ministry of Finance
Ministry of Foreign Affairs and Trade
MOL Group
MVM Group
MVM Mátra Energia Zrt.
National Climate Protection Authority
National Hydrogen Technology Association
National Research, Development and Innovation Office
National Society of Conservationists (Magyar Természetvédők Szövetsége)
Nuclear Safety Research Institute (NUBIKI)
OPUS TIGÁZ Gázhálózati Zrt./Opus Global Nyrt
Paksi Atomerőmű Zrt. (Paks Nuclear Power Plant Ltd, MVM)
Prime Minister's Office
Veolia Energia Magyarország Zrt
Women in Nuclear Hungary

ANNEX C: Statistical notes and energy balances

		Unit: Mtoe						
SUPPLY		1973	1990	2000	2010	2018	2019	2020
TOTAL PRODUCTION		12.70	14.69	11.62	11.87	11.05	11.01	10.79
Coal		6.05	4.22	2.89	1.59	1.14	0.99	0.93
Peat		-	-	-	-	-	-	-
Oil		2.02	2.27	1.68	1.09	1.11	1.16	1.03
Natural gas		4.03	3.81	2.48	2.23	1.47	1.33	1.32
Biofuels and waste ¹		0.59	0.70	0.76	2.67	2.86	2.80	2.78
Nuclear		-	3.58	3.71	4.12	4.11	4.26	4.20
Hydro		0.01	0.02	0.02	0.02	0.02	0.02	0.02
Wind		-	-	-	0.05	0.05	0.06	0.06
Geothermal		-	0.09	0.09	0.10	0.14	0.16	0.15
Solar/other		-	-	-	0.01	0.14	0.22	0.30
TOTAL NET IMPORTS²		8.60	14.00	13.64	14.88	15.24	18.33	14.71
Coal Exports		0.11	0.00	0.13	0.28	0.22	0.23	0.19
Coal Imports		1.74	1.63	1.21	1.41	1.25	1.07	0.92
Coal Net imports		1.63	1.63	1.08	1.13	1.03	0.83	0.74
Oil Exports		0.91	1.50	1.78	2.78	3.86	3.37	3.02
Oil Imports		7.38	7.93	6.99	8.56	10.81	10.45	9.53
Oil Int'l marine and aviation bunkers		-0.05	-0.16	-0.23	-0.24	-0.27	-0.28	-0.10
Oil Net imports		6.42	6.27	4.98	5.54	6.67	6.80	6.41
Natural gas Exports		0.01	0.02	0.06	0.19	4.17	5.83	3.56
Natural gas Imports		0.17	5.19	7.35	7.91	10.62	15.58	10.19
Natural gas Net imports		0.15	5.17	7.28	7.73	6.45	9.75	6.63
Electricity Exports		0.09	0.19	0.52	0.40	0.37	0.63	0.64
Electricity Imports		0.49	1.14	0.82	0.85	1.60	1.71	1.65
Electricity Net imports		0.40	0.96	0.30	0.45	1.23	1.08	1.00
TOTAL STOCK CHANGES		-0.02	0.10	-0.25	-0.24	0.30	-2.69	0.75
TOTAL SUPPLY (TES)³		21.28	28.78	25.00	26.51	26.58	26.65	26.25
Coal		7.91	6.23	3.85	2.72	2.12	1.84	1.68
Peat		-	-	-	-	-	-	-
Oil		8.15	8.35	6.63	6.55	7.79	7.89	7.37
Natural gas		4.17	8.91	9.66	9.82	8.27	8.46	8.76
Biofuels and waste ¹		0.64	0.66	0.76	2.70	2.70	2.65	2.71
Nuclear		-	3.58	3.71	4.12	4.11	4.26	4.20
Hydro		0.01	0.02	0.02	0.02	0.02	0.02	0.02
Wind		-	-	-	0.05	0.05	0.06	0.06
Geothermal		-	0.09	0.09	0.10	0.14	0.16	0.15
Solar/other		-	-	-	0.01	0.14	0.22	0.30
Electricity trade ⁴		0.40	0.96	0.30	0.45	1.23	1.08	1.00
Shares in TES (%)								
Coal		37.2	21.6	15.4	10.3	8.0	6.9	6.4
Peat		-	-	-	-	-	-	-
Oil		38.3	29.0	26.5	24.7	29.3	29.6	28.1
Natural gas		19.6	31.0	38.6	37.0	31.1	31.8	33.4
Biofuels and waste ¹		3.0	2.3	3.0	10.2	10.2	9.9	10.3
Nuclear		-	12.4	14.8	15.5	15.5	16.0	16.0
Hydro		0.0	0.1	0.1	0.1	0.1	0.1	0.1
Wind		-	-	-	0.2	0.2	0.2	0.2
Geothermal		-	0.3	0.3	0.4	0.5	0.6	0.6
Solar/other		-	-	-	0.0	0.5	0.8	1.1
Electricity trade ⁴		1.9	3.3	1.2	1.7	4.6	4.1	3.8

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: Mtoe						
DEMAND							
FINAL CONSUMPTION	1973	1990	2000	2010	2018	2019	2020
TFC	16.53	20.69	17.22	18.97	20.10	20.13	19.89
Coal	4.08	2.36	0.58	0.41	0.26	0.24	0.20
Peat	-	-	-	-	-	-	-
Oil	6.46	7.12	5.20	6.06	7.43	7.53	7.01
Natural gas	2.80	6.20	6.69	6.46	6.06	5.98	6.24
Biofuels and waste ¹	0.62	0.62	0.69	1.91	1.90	1.87	1.94
Geothermal	-	0.09	0.08	0.09	0.07	0.07	0.06
Solar/other	-	-	-	0.01	0.01	0.01	0.02
Electricity	1.51	2.72	2.53	2.94	3.39	3.46	3.43
Heat	1.06	1.59	1.45	1.09	0.98	0.98	0.99
Shares in TFC (%)							
Coal	24.7	11.4	3.4	2.2	1.3	1.2	1.0
Peat	-	-	-	-	-	-	-
Oil	39.1	34.4	30.2	32.0	37.0	37.4	35.3
Natural gas	17.0	30.0	38.9	34.1	30.1	29.7	31.4
Biofuels and waste ¹	3.7	3.0	4.0	10.1	9.4	9.3	9.8
Geothermal	-	0.4	0.5	0.5	0.3	0.3	0.3
Solar/other	-	-	-	0.0	0.1	0.1	0.1
Electricity	9.1	13.1	14.7	15.5	16.9	17.2	17.3
Heat	6.4	7.7	8.4	5.7	4.9	4.8	5.0
TOTAL INDUSTRY⁵	7.42	7.82	4.89	4.66	6.74	6.66	6.76
Coal	1.57	0.57	0.33	0.26	0.16	0.17	0.14
Peat	-	-	-	-	-	-	-
Oil	2.22	2.08	1.53	1.81	2.52	2.35	2.48
Natural gas	2.22	3.76	1.70	1.33	1.92	1.90	1.93
Biofuels and waste ¹	0.02	0.00	0.06	0.12	0.31	0.36	0.35
Geothermal	-	-	-	0.00	0.00	0.00	0.00
Solar/other	-	-	-	-	-	-	-
Electricity	0.92	1.18	0.76	0.84	1.48	1.53	1.51
Heat	0.46	0.23	0.52	0.30	0.34	0.36	0.35
Shares in total industry (%)							
Coal	21.2	7.2	6.8	5.6	2.4	2.6	2.0
Peat	-	-	-	-	-	-	-
Oil	29.9	26.6	31.2	38.8	37.4	35.3	36.6
Natural gas	30.0	48.0	34.7	28.6	28.5	28.5	28.5
Biofuels and waste ¹	0.3	-	1.2	2.5	4.6	5.3	5.2
Geothermal	-	-	-	-	-	-	-
Solar/other	-	-	-	-	-	-	-
Electricity	12.5	15.1	15.5	18.1	22.0	22.9	22.3
Heat	6.2	2.9	10.6	6.4	5.1	5.3	5.2
TRANSPORT⁴	2.28	2.93	3.04	4.12	4.77	5.05	4.44
OTHER⁶	6.83	9.94	9.30	10.19	8.59	8.42	8.69
Coal	2.13	1.79	0.25	0.15	0.10	0.07	0.06
Peat	-	-	-	-	-	-	-
Oil	2.41	2.20	0.73	0.43	0.52	0.51	0.54
Natural gas	0.58	2.44	4.99	5.10	4.06	4.00	4.25
Biofuels and waste ¹	0.60	0.61	0.63	1.62	1.40	1.31	1.31
Geothermal	-	0.09	0.08	0.09	0.06	0.07	0.06
Solar/other	-	-	-	0.01	0.01	0.01	0.02
Electricity	0.52	1.43	1.69	2.00	1.80	1.83	1.82
Heat	0.60	1.36	0.93	0.79	0.64	0.62	0.63
Shares in other (%)							
Coal	31.2	18.0	2.7	1.5	1.1	0.9	0.7
Peat	-	-	-	-	-	-	-
Oil	35.2	22.2	7.8	4.2	6.0	6.1	6.2
Natural gas	8.5	24.6	53.7	50.1	47.3	47.5	48.9
Biofuels and waste ¹	8.7	6.2	6.8	15.9	16.3	15.6	15.1
Geothermal	-	0.9	0.9	0.9	0.7	0.8	0.7
Solar/other	-	-	-	0.1	0.1	0.2	0.2
Electricity	7.6	14.4	18.1	19.7	21.0	21.7	21.0
Heat	8.7	13.7	10.0	7.7	7.4	7.4	7.3

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: Mtoe						
DEMAND							
ENERGY TRANSFORMATION AND LOSSES	1973	1990	2000	2010	2018	2019	2020
ELECTRICITY GENERATION⁷							
Input (Mtoe)	6.36	9.62	10.18	9.88	8.97	8.66	8.41
Output (Mtoe)	1.52	2.45	3.03	3.21	2.76	2.95	3.00
Output (TWh)	17.64	28.44	35.19	37.37	32.07	34.29	34.93
Output shares (%)							
Coal	66.0	30.5	27.6	17.0	15.1	12.2	11.0
Peat	-	-	-	-	-	-	-
Oil	17.2	4.8	12.5	1.3	0.3	0.2	0.1
Natural gas	16.2	15.7	18.8	31.0	22.7	25.4	26.0
Biofuels and waste ¹	-	0.1	0.3	6.6	7.9	7.2	6.9
Nuclear	-	48.3	40.3	42.2	49.1	47.5	46.0
Hydro	0.6	0.6	0.5	0.5	0.7	0.6	0.7
Wind	-	-	-	1.4	1.9	2.1	1.9
Geothermal	-	-	-	-	-	0.1	-
Solar/other	-	-	-	-	2.4	4.7	7.4
TOTAL LOSSES	5.40	7.78	7.77	7.52	7.34	6.82	6.51
of which:							
Electricity and heat generation ⁸	3.65	5.41	5.50	5.40	5.17	4.77	4.54
Other transformation	0.72	0.29	0.29	0.54	0.50	0.45	0.41
Own use and transmission/distribution losses	1.03	2.08	1.97	1.58	1.66	1.61	1.57
Statistical differences	-0.65	0.31	0.01	0.02	-0.85	-0.30	-0.15
INDICATORS	1973	1990	2000	2010	2018	2019	2020
GDP (billion 2015 USD)	58.66	88.49	91.61	112.93	140.53	147.05	139.76
Population (millions)	10.43	10.37	10.21	10.00	9.78	9.77	9.75
TES/GDP (toe/1000 USD) ⁹	0.36	0.33	0.27	0.23	0.19	0.18	0.19
Energy production/TES	0.60	0.51	0.46	0.45	0.42	0.41	0.41
Per capita TES (toe/capita)	2.04	2.78	2.45	2.65	2.72	2.73	2.69
Oil supply/GDP (toe/1000 USD) ⁹	0.14	0.09	0.07	0.06	0.06	0.05	0.05
TFC/GDP (toe/1000 USD) ¹⁰	0.28	0.23	0.19	0.17	0.14	0.14	0.14
Per capita TFC (toe/capita)	1.59	2.00	1.69	1.90	2.06	2.06	2.04
CO ₂ emissions from fuel combustion (MtCO ₂) ¹⁰	66.4	65.7	53.3	47.2	48.3	46.2	43.8
CO ₂ emissions from bunkers (MtCO ₂) ¹⁰	0.2	0.5	0.7	0.7	0.8	0.8	0.3
GROWTH RATES (% per year)	73-90	90-00	00-10	10-17	17-18	18-19	19-20
TES	1.8	-1.4	0.6	0.1	-0.2	0.3	-1.5
Coal	-1.4	-4.7	-3.4	-2.7	-5.4	-13.1	-8.5
Peat	-	-	-	-	-	-	-
Oil	0.1	-2.3	-0.1	1.6	6.2	1.4	-6.6
Natural gas	4.6	0.8	0.2	-2.0	-3.1	2.3	3.5
Biofuels and waste ¹	0.2	1.4	13.5	0.9	-5.8	-1.9	2.0
Nuclear	-	0.4	1.1	0.3	-2.3	3.5	-1.5
Hydro	3.4	-	0.6	2.2	1.1	-1.6	11.7
Wind	-	-	-	5.1	-19.9	20.1	-10.2
Geothermal	-	-	1.4	4.4	7.4	10.1	-5.1
Solar/other	-	-	-	54.0	28.0	58.7	34.0
TFC	1.3	-1.8	1.0	0.8	-0.1	0.2	-1.2
Electricity consumption	3.5	-0.7	1.5	1.7	2.4	2.0	-0.7
Energy production	0.9	-2.3	0.2	-0.7	-2.6	-0.3	-2.0
Net oil imports	-0.1	-2.3	1.1	2.0	5.1	1.9	-5.8
GDP	2.4	0.3	2.1	2.4	5.4	4.6	-5.0
TES/GDP	-0.6	-1.7	-1.5	-2.3	-5.3	-4.2	3.6
TFC/GDP	-1.1	-2.2	-1.1	-1.5	-5.2	-4.3	3.9

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

- 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 and waste.
- 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, CHP 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 and wind.
- ⁹ Toe per thousand US dollars at 2015 prices and exchange rates.
- ¹⁰ "CO₂ 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.

Statistical notes

- Unless otherwise noted, all GDP data are in USD 2015 prices and purchasing power parity (PPP).
- *Total energy supply (TES)* comprises production + imports – exports – international marine and aviation bunkers ± stock changes. This equals the total supply of energy that is consumed domestically, either in transformation (e.g. power generation and refining) or in final use.
- *Total final consumption (TFC)* is the final consumption of energy (electricity, heat and fuels, such as natural gas and oil products) by end users, not including the transformation sector (e.g. power generation and refining).
- *Total final energy consumption (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 countries' renewable energy targets.
- The primary energy equivalent of nuclear electricity is calculated from the gross generation by assuming a 33% conversion efficiency. The calculation to be carried out is the following: gross electricity generation in TWh x 0.086/0.33 = primary energy equivalent in Mtoe.
- *Bioenergy* refers to solid and liquid biofuels, renewable waste, and biogas and excludes non-renewable waste.
- *Buildings* includes the energy use of the residential sector (residential buildings) and commercial and public service sectors (service sector buildings).
- *Transport* excludes international aviation and navigation.
- *Industry* includes both energy and non-energy use of the industry sector, agriculture, forestry and fishing.
- *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.
- *IEA30* is the equivalent of a weighted average of 30 IEA member countries.
- *CO₂ 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: International Energy Agency “Shared Goals”

The member countries* of the International Energy Agency (IEA) seek to create conditions in which the energy sectors of their economies can make the fullest possible contribution to sustainable economic development and to the well-being of their people and of the environment. In formulating energy policies, the establishment of free and open markets is a fundamental point of departure, though energy security and environmental protection need to be given particular emphasis by governments. IEA countries recognise the significance of increasing global interdependence in energy. They therefore seek to promote the effective operation of international energy markets and encourage dialogue with all participants. In order to secure their objectives, member countries therefore aim to create a policy framework consistent with the following goals:

1. Diversity, efficiency and flexibility within the energy sector are basic conditions for longer term energy security: the fuels used within and across sectors and the sources of those fuels should be as diverse as practicable. Non-fossil fuels, particularly nuclear and hydropower, make a substantial contribution to the energy supply diversity of IEA countries as a group.

2. Energy systems should have the ability to respond promptly and flexibly to energy emergencies. In some cases, this requires collective mechanisms and action: IEA countries co-operate through the Agency in responding jointly to oil supply emergencies.

3. The environmentally sustainable provision and use of energy are central to the achievement of these Shared Goals. Decision makers should seek to minimise the adverse environmental impacts of energy activities, just as environmental decisions should take account of the energy consequences. Government interventions should respect the polluter-pays principle where practicable.

4. More environmentally acceptable energy sources need to be encouraged and developed. Clean and efficient use of fossil fuels is essential. The development of economic non-fossil sources is also a priority. A number of IEA member countries wish to retain and improve the nuclear option for the future, at the highest available safety standards, because nuclear energy does not emit carbon dioxide. Renewable sources will also have an increasingly important contribution to make.

5. Improved energy efficiency can promote both environmental protection and energy security in a cost-effective manner. There are significant opportunities for greater energy efficiency at all stages of the energy cycle, from production to consumption. Strong efforts by governments and all energy users are needed to realise these opportunities.

6. Continued research, development and market deployment of new and improved energy technologies make a critical contribution to achieving the objectives outlined above. Energy technology policies should complement broader energy policies. International co-operation in the development and dissemination of energy technologies, including industry participation and co-operation with non-member countries, should be encouraged.

7. Undistorted energy prices enable markets to work efficiently. Energy prices should not be held artificially below the costs of supply to promote social or industrial goals. To the extent necessary and practicable, the environmental costs of energy production and use should be reflected in prices.

8. Free and open trade and a secure framework for investment contribute to efficient energy markets and energy security. Distortions to energy trade and investment should be avoided.

9. Co-operation among all energy market participants helps to improve information and understanding, and encourages the development of efficient, environmentally acceptable and flexible energy systems and markets worldwide. These are needed to help promote the investment, trade and confidence necessary to achieve global energy security and environmental objectives.

(The Shared Goals were adopted by IEA ministers at the meeting of 4 June 1993 in Paris, France.)

* Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, the Slovak Republic, Spain, Sweden, Switzerland, Türkiye, the United Kingdom and the United States.

ANNEX E: 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

CCS	carbon capture and storage
CCUS	carbon capture, utilisation and storage
CEEGEX	Central Eastern European Gas Exchange
CO ₂	carbon dioxide
DH	district heating
DSO	distribution system operator
EC	European Commission
EED	Energy Efficiency Directive
EEOS	Energy Efficiency Obligation Scheme
ESCO	energy service company
ETS	Emissions Trading System
EU	European Union
EV	electric vehicle
FEC	final energy consumption
GDP	gross domestic product
GHG	greenhouse gas
HAEA	Hungarian Atomic Energy Authority
HEA	Hungarian Energy Authority
HUF	Hungarian forint (currency)
HUPX	Hungarian Power Exchange
HUSA	Hungarian Hydrocarbon Stockpiling Agency
IEA	International Energy Agency
JTF	Just Transition Fund
LNG	liquefied natural gas
LPG	liquefied petroleum gas
LULUCF	land use, land-use change and forestry
MIT	Ministry for Innovation and Technology
NCCAP	National Climate Change Action Plan
NCDS	National Clean Development Strategy
NEA	Nuclear Energy Agency
NECP	National Energy and Climate Plan
NES	National Energy Strategy

10. OIL

NESO	National Emergency Strategy Organisation
NPP	nuclear power plant
NRDI	National Research, Development and Innovation
OECD	Organisation for Economic Co-operation and Development
PEC	primary energy consumption
PURAM	Public Limited Company for Radioactive Waste Management
PV	photovoltaics
R&D	research and development
RD&D	research, development and demonstration
RDI	research, development and innovation
RED	Renewable Energy Directive
RRF	Recovery and Resilience Facility
S3	Smart Specialisation Strategy
SAIDI	System average interruption duration index
SAIFI	System average interruption frequency index
SME	small and medium-sized enterprise
TES	total energy supply
TFC	total final consumption
TFEC	total final energy consumption
TSO	transmission system operator
USD	United States dollar (currency)
VAT	value-added tax
VVER	water-water energetic reactor

Units of measure

bcm	billion cubic metres
bcm/y	billion cubic metres per year
CO ₂ -eq	carbon dioxide equivalent
dw	dwelling
GJ	gigajoule
GW	gigawatt
GWh	gigawatt hour
kb/d	thousand barrels per day
kW	kilowatt
kWh	kilowatt hour
L	litre
mb	million barrels
mcm/d	million cubic metres per day
MJ	megajoule

Mt CO ₂	million tonnes carbon dioxide
Mt CO ₂ -eq	million tonnes of carbon dioxide equivalent
Mtoe	million tonnes of oil equivalent
MW	megawatt
MW _e	megawatt electric
MW _{th}	megawatt thermal
PJ	petajoule
pkm	passenger-kilometre
t	tonne
tkm	tonne-kilometre
TWh	terawatt hour
toe	tonne of oil equivalent

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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 IEA review in 2017, Hungary has increased its climate ambitions by legislating a carbon neutrality goal for 2050 and adopting a long-term vision with the National Clean Development Strategy, which guides energy policy decision making.

Hungary has a strong starting point with considerable low carbon generation thanks to a remarkable growth of solar photovoltaic (PV) and the lifetime extension of its nuclear reactors up to mid-2030s. The government has an ambitious target of 90% clean electricity by 2030, Hungary needs to maintain and increase its low carbon generation. Alongside nuclear energy, a diverse renewable energy portfolio and greater power system flexibility for the integration of high shares of solar PV are critical.

The country needs to reduce the high vulnerability and reliance on Russia for gas, oil and nuclear, through policies that lower fossil fuel consumption, increase energy efficiency and promote investments in clean energy technologies and human resources to deliver a just and inclusive transition. To decarbonise hard-to-abate sectors in the medium term, Hungary is shifting gear and is boosting its ambitions in hydrogen use in transport and industry.

In this report, the IEA provides energy policy recommendations to help Hungary effectively manage the transformation of its energy sector in line with its goals.