institute for environmental policy

Ministry of Environment of the Slovak Republic

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Impact analysis of the Fit for 55 package

March 2022

Economic analysis 12

Works led by:
Ján Dráb (IEP) jan.drab@enviro.gov.sk
Marek Engeľ (IEP) marek.engel@enviro.gov.sk
Katarína Nánásiová (IEP) katarina.nanasiova@enviro.gov.sk

In the preparation of the analysis, the following people collaborated:
Kamil Boros (CpHO MINISTRY OF ECONOMY OF THE SLOVAK REPUBLIC), Kristína Gardoňová (ISA), Ľubica Hamarová (Ministry of Investments, Regional Development and Informatization of the Slovak Republic), Ján Horváth (SLOVAK HYDROMETEOROLOGICAL INSTITUTE), Karin Hrnčiarová (IEP), Michal Hudec (REGULATORY OFFICE FOR NETWORK INDUSTRIES), Jana Jirsáková (IDP), Mário Juliny (IPP), Miroslav Kľúčik (IFP), Michal Kotrč (IEP), Zdenko Krajčír (ISP), Ivan Lichner (SLOVAK ACADEMY OF SCIENCES), Marek Macík (IEP), Ivana Marková (Ministry of Transport and Construction of the Slovak Republic), Tomáš Miklošovič (SLOVAK ACADEMY OF SCIENCES), Ján Mykhalchyk Hradický (VALUE FOR MONEY DEPARTMENT), Ján Šilan (IFP), Simona Šulíková (VALUE FOR MONEY DEPARTMENT), Kristína Tonhauzer (SLOVAK HYDROMETEOROLOGICAL INSTITUTE), Beáta Vitteková (ISP), Marcel Zemko (SLOVAK HYDROMETEOROLOGICAL INSTITUTE)

Comments, consultations and partial inputs were provided by:
Ivan Barka (NATIONAL FOREST CENTRE), Filip Bolčo (CpHO), Anton Cerman (MINISTRY OF ECONOMY OF THE SLOVAK REPUBLIC), Martin Gális (IEP), Dominik Hoppej (IEP), Miroslava Hricišínová (CpHO), Adrián Krajňák (MINISTRY OF ECONOMY OF THE SLOVAK REPUBLIC), Miroslav Mariáš (MINISTRY OF ECONOMY OF THE SLOVAK REPUBLIC), Kristína Mojzesová (IEP), Alena Ohradzanská (Ministry of Transport and Construction of the Slovak Republic) Pavel Pavlenda (NATIONAL FOREST CENTRE), Tibor Priwitzer (NATIONAL FOREST CENTRE), Dominik Susa (SARIO (SLOVAK INVESTMENT AND TRADE DEVELOPMENT AGENCY)), Ján Šebo (GOVERNMENT OFFICE OF THE SLOVAK REPUBLIC), Martin Šuster (GOVERNMENT OFFICE OF THE SLOVAK REPUBLIC), Michal Vančo (NATIONAL FOREST CENTRE), Milan Zvara (MINISTRY OF ENVIRONMENT OF THE SLOVAK REPUBLIC)

The material has not yet undergone peer review.

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Summary

Climate change will have major economic impacts. If climate change continues as it is and no new measures are taken to combat climate change, the costs associated with climate change could reduce GDP in the EU by almost 10% by 2100. To avoid extreme and irreversible climate change, it is important to keep global warming to no more than (but ideally below) 1.5 °C. Since the start of the Industrial Revolution, the Earth's average temperature has risen by between 0.8 °C and 1.2 °C.

Slovak territory is expecting more frequent occurrence of extreme weather events. Some of the climatic conditions that were projected to occur as late as 2030 have already occurred in Slovakia between 2001 and 2017. Climate change has led to increased evaporation of water from plants back into the atmosphere and a decrease in soil moisture, gradually leading to desiccation, especially in the southern regions of the Slovak Republic. The number of regional and flash floods has increased rapidly since 1994. Increased variability in precipitation is expected in warmer periods, with storms intensifying during the warmer parts of the year and increased occurrence of stronger winds, storms and tornadoes.

The Fit for 55 proposal aims to set the EU on the path to climate neutrality, deliver transformational change in the economy, society and industry as quickly and fairly as possible, while strengthening competitiveness, creating jobs and effectively addressing the costs and impacts associated with this transformation. Specifically, it aims to achieve a 55% reduction in greenhouse gas emissions compared to 1990, followed by climate neutrality in 2050. The package strengthens 8 existing legislative acts and introduces 5 new initiatives in the areas of climate, energy and fuels, transport, the buildings sector, land use and forestry. **This is a complex package of measures, so it is important to assess what positive and negative impacts it will have, what costs will be necessary for its implementation and what are the limits of its implementation in practice.**

As a member of the Single Market, Economic and Monetary Union, Slovakia shares responsibility for achieving the objectives of the common policies. To achieve the goals of sustainable transformation, the country has the resources to make investments. The targets should reflect the economic level of the Member States to ensure solidarity throughout the process. In addition to the costs, we should also bear the benefits of a sustainable transformation, such as energy savings, conservation and sustainable use of natural resources and pollution reduction.

The Fit for 55 package aims to increase energy efficiency and the share of RES, as well as reducing fuel consumption, which improves the energy security of EU countries. It was not possible to model all measures, the modelled scenario from the Fit for 55 package includes the extension of the ETS to the household and transport sectors and stricter emission standards in transport. Therefore, the overall package is expected to have an even greater positive impact on these indicators. The modelled measures from the Fit for 55 package will improve energy security as follows:

- **In 2030, total energy consumption is expected to be more than 4% lower than in the baseline scenario.** Although total energy consumption in Slovakia should still grow, growth should be slower than in the baseline scenario.
- **The biggest difference is expected to be in imports, which are expected to be lower by up to 18% in 2030.** Meanwhile, the baseline scenario foresees import growth of up to more than 10% by 2030. The decrease in imports reduces dependence on the external environment and promotes energy production in Slovakia, which increases the energy security of the Slovak Republic. Primary energy production should be 15% higher compared to the baseline scenario.

- **Together with renewables, Slovakia could achieve almost 90% emission-free electricity generation,** and electricity generated from fossil fuels should account for 10-12% in 2030, which is half of the share in 2020. Slovakia could export more than 10% of the electricity it produces after the third and fourth units of the Mochovce nuclear power plant are connected.
- **Total fuel consumption in 2030 is expected to remain at about the same level as in 2020, but the share of individual fuels will change.** The share of renewables and electricity should grow significantly. On the contrary, oil consumption is expected to fall slightly and solid fuels and gas consumption to rise more significantly. **Without decarbonisation, total fuel consumption is projected to grow by 7%, driven mainly by growth in oil and gas.**

The increasing intensity of climate change impacts will force countries around the world to adopt climate policies that will be implemented more widely and earlier in the EU:

- **A carbon tax will increase the competitiveness of European businesses and stimulate innovation in low-carbon technologies.** Decarbonisation investments made in advance will thus pay off for European businesses in the shorter term. The introduction of a carbon tax will support important domestic industries. Steel production can be given a strong incentive for long-term sustainability as a result of known intentions and policies. Aluminium production will also be positively affected and could potentially grow by almost 3%. This could mitigate the risk of ending aluminium production in Slovakia.
- **In particular, industrial enterprises can be positively incentivised to invest in improving energy efficiency.** The specific investment intensity of energy saving projects in this sector is relatively lower than e.g. in the buildings or transport sectors. The increased incentive to invest in competitiveness also stems from the fact that the industry is not entitled to regulated energy prices, so it has to bear higher market prices in the short term.
- **The emission intensity of energy production will be further reduced, thereby mitigating negative climate impacts.** In the context of the overall strategy of shifting energy consumption towards electricity, the share of energy needs supplied by low-emission technologies will increase.
- **Slovak companies can expect a more stable but higher carbon price in the long term.** In the revision, the Commission proposes, after a one-off reduction in the overall cap of 117 million allowances, a more significant annual reduction of emissions by a linear reduction factor of 4.2% (instead of 2.2% per year under the current scheme). The Market Stabilisation Reserve (MSR), which was introduced in response to the long-term surplus of emission allowances during the Great Recession, is to be maintained under current parameters until the end of 2030.

Road transport is responsible for 16.9% of total CO_2 emissions in Slovakia, with up to 55% of emissions coming from passenger cars. Road transport emissions continue to rise year on year, putting the EU's future climate targets at risk. Heating of buildings and institutions is responsible for 11% of total CO_2 emissions in the Slovak Republic. **Therefore, the EC proposes to extend the ETS to the buildings and transport sectors:**

- **The intention is to achieve reductions in greenhouse gas emissions in these sectors as well,** with the road transport sector in particular being problematic due to the growth in transport intensity. The aim is also to encourage a transition to low-emission technologies. However, in terms of household or business needs, the elasticity of fuel demand is very low, which may suppress the decarbonisation effect of the measure. Burdening end-consumers through distributors also limits incentives for technological transition in both sectors, the entities could easily absorb price increases.
- **Decarbonisation with the extension of the ETS will significantly reduce greenhouse gas production in the transport and household sectors.** In 2030, emissions from the household sector should be reduced by over 480 $ktCO_2e$ per year, which is almost at the level of emissions from the Vojany coal-fired power plant. For transport, the difference in emissions in 2030 compared

to the baseline scenario should be almost 1.3 $MtCO_2e$, which represents more than 2.5% of all Slovak emissions today.

- **In the case of the extension of the ETS to the buildings sector, projections show the largest impacts in hard coal heating,** where price increases of up to 63% can be expected. For households in uninsulated houses, this can mean an increase in expenditure of between EUR 300 and EUR 500 per year, depending on the fuel. For apartment buildings using natural gas, the increase should be less than EUR 100 per year. However, around 50% of households living in apartment buildings are already under the EU ETS, so they will not be affected by the increase.
- **For transport, diesel and petrol will be affected comparably.** Fuel costs will increase by between EUR 80 and EUR 175 per year in passenger transport. Freight transport will be 7.5% more expensive per 1 tkm.
- Such an increase in fossil fuel prices will lead households to use more RES, electrification, increased energy efficiency, and a more rapid change of the car fleet to zero-emission vehicles.
- **The introduction of an ETS for fossil fuels in the transport sector would increase inflation by 1.1 to 1.5 p.p. in 2026,** depending on the initial price of emission allowances**.** Up to 70% of the increase would be accounted for by the price of natural gas. In the following years, the rise in quota prices would contribute between 0.05 and 0.08 p.p. per year to headline inflation. We expect the cumulative impact by 2035 to be between 1.8 and 2.1 p.p. The calculations are static, they do not consider a shift to electromobility or lower natural gas consumption after the renovation of buildings. **The ultimate impact on the price level in the long run may therefore be lower. A downside risk may be a higher than expected increase in the price of emission allowances.**
- **Decarbonisation and the extension of the ETS to road transport and heating of buildings will lead to an increase in GDP growth, real wages and employment after an initial slight decline.** This growth will be driven by investments in energy efficiency, which will create new jobs with a higher share of employment for the less skilled labour.
- **Decarbonisation and investment in energy efficiency will boost production, particularly in the iron, steel and building materials sectors, but will negatively affect refineries.** The decline in fossil fuels will hit refineries, whose output will be more than 7% lower in 2030. Refineries will also be negatively impacted by the replacement of internal combustion engine cars with electric vehicles. Increased investment in energy efficiency and decarbonisation, including building retrofits, is expected to increase output in the iron and steel sector by around 16% and in the non-metallic mineral products sector by more than 3% in 2030.
- Given the typical fuel mix and scenarios for the ETS price in the road transport sector, **annual public administration expenditure** could increase by EUR 2 to 6 million. The expenditure of the higher-territorial unit may increase by EUR 29.2 million. The annual impact on the largest cities can reach almost EUR 10 million. We assume that the increase in costs will be fully passed on to the customer of the transport services.
- **A Social and Climate Fund is proposed to mitigate the impacts of the extension of the ETS to these sectors.** Of the total allocation, Slovakia can apply for up to EUR 1.7 billion in period from 2025 to 2032, with Member States expected to contribute at least 50% of the total estimated costs. It will be most cost-effective for households that currently heat their unrestored homes with coal to insulate them and switch to wood heating. In the case of insulation, even households that heat with gas can significantly reduce their costs. In the area of transport, investment in the development of low-emission public transport can be envisaged, primarily in areas with low accessibility to these services and with a high potential for fuel poverty. However, the volume of resources is not sufficient and the scheme may be associated with implementation risks similar to the ESIF.
- **Particular attention will need to be paid to households in energy and fuel poverty.** These households often do not have the resources to invest in energy efficiency measures, do not have access to bank loans or guarantees, and do not have the social skills to access support schemes.

They are also particularly sensitive to changes in fuel prices and are characterised by low elasticity of demand as they simply have no alternative. In the period between the approval of the package and the launch of the Social and Climate Fund, data needs to be collected to help identify target households at risk of energy and fuel poverty.

The Fit for 55 package proposes meeting carbon neutrality for new vehicles from 2035, so from 2035 the sale of vehicles with internal combustion engines will not be allowed. Over the past year, sales of fully electric vehicles (BEVs) accounted for around 1.2% of all new vehicles, with sales of fully electric cars mainly driven by subsidies.

- Based on the trend of motorisation and decreasing prices of electric batteries, Slovakia can offer a way for Slovak households to **benefit from the reduction of transport emissions** if the right strategy is chosen. Higher market penetration of fully electric cars at the expense of plug-in hybrids and a sufficiently developed infrastructure that will lead to a preference for more cost-effective fully electric cars with shorter ranges appear to be key. The real dynamics of EV deployment will depend on the extent to which electric vehicles can be accelerated to meet the transport needs of both public and private sector organisations, where the marginal cost of building charging infrastructure is lower.
- **The financial benefits of buying electric vehicles grow with better infrastructure.** The eventual high share of plug-in hybrids on electric vehicles will mean higher household costs by 2035. With a slight reduction in the share of plug-in hybrids in electric vehicles, Slovak households could save up to EUR 65 million by 2035. **The price of batteries has a major impact on the competitiveness of electric vehicles and is expected to fall significantly.**
- **The transition to clean electric cars will threaten jobs in the European car industry less than expected.** Workers who manufacture internal combustion engines will be most affected by the transition to clean electric cars. Slovakia can expect to lose 1.6% of direct jobs in the transition to electric vehicles. **The Slovak Republic is gradually succeeding in removing several barriers to investment in the production of electric vehicles.**
- **The interest of battery cell manufacturers in Slovakia is both a positive and negative risk.** In the long term, such production will strengthen the sustainability and competitiveness of the automotive industry. However, the production of battery cells is extremely energy intensive. A typical gigafactory may require an installed capacity of 200 to 400 MW, which may also prevent the arrival of other major investors, as their energy needs could overload the transmission system. According to SARIO (Slovak Investment and Trade Development Agency), it is realistic that Slovakia will attract 1 to 2 battery cell manufacturers. **The location of investments may actually jeopardise the achievement of the energy efficiency target in industry, as there will be a significant increase in energy consumption.**

The Carbon Border Adjustment Mechanism (CBAM), a so-called "carbon tax", is due to be introduced in 2026. The aim is to prevent the Union's efforts to reduce emissions from being counteracted by an increase in emissions outside the EU as a result of relocation of production or an increase in imports of lower carbon intensity products. A carbon tax will encourage producers in non-EU countries to green their production processes. Once fully implemented, the CBAM is expected to raise around EUR 1 billion per year in carbon tariffs, which should be used to support decarbonisation in developing countries:

- **CBAM will introduce a levy on imports of cement, aluminium, fertilisers and iron and steel products into the EU.** The main criterion for the selection of goods was the cumulative GHG emissions of a particular sector, as well as the sector's exposure to carbon leakage risk. While CBAM will also apply to imported electricity, imports from third countries account for only about 3.4% of domestic electricity consumption.

- **The introduction of the CBAM will support domestic producers, but with the accelerated decline in the amount of free emission allowances, the costs of domestic production will also rise.** Between 2026 and 2035, the allocation of free allowances for CBAM products will be continuously reduced by ten percentage points each year. The highest prices can be expected in 2035, because in that year the amount of free allowances in the steel, aluminium, fertiliser and cement sectors will be zero.
- **The introduction of the carbon tax should have a positive impact on the real GDP of the Slovak Republic.** Compared to the baseline scenario, the EU economy could be about 0.03% smaller in 2035, while the Slovak economy could be 0.09% larger.
- **The largest change in output in Slovakia will be in the steel production sector, whose output will be almost 23% higher in 2035 compared to the baseline scenario.** Domestic firms in the steel, aluminium and cement sectors will respond to higher prices by increasing production. Compared to the baseline scenario, we assume that the production of non-ferrous metals (aluminium) and non-metallic mineral products (cement) should grow by 2.94% and 0.31%, respectively, in 2035. In the chemical sector, rubber and plastic products (fertilisers), we assume that the quantity produced will be about 2.31% lower in 2035 as a result of the increase in the prices of fertilisers.
- **The increase in the price of CBAM products together with the increase in the price of electricity may have a negative impact on the automotive industry in Slovakia.** As a result of the increase in input prices, we expect production in the motor vehicles and parts industry to fall by around 1% in 2035 compared to the baseline scenario. This is because steel represents a significant manufacturing input to the automotive industry. In the machinery and equipment manufacturing sector, we expect output to fall by around 2.3% compared to the scenario without the carbon tax.
- **The impact of the introduction of a carbon tax on real wages will be slightly positive for Slovakia due to higher output.** Higher productivity in manufacturing will put upward pressure on wages. Compared to the no-carbon-tax scenario, we estimate a 0.38% increase in real wages in 2035.
- **We expect the introduction of a carbon tax to increase exports from the Slovak Republic to the EU by roughly 0.45% in 2035** compared to a scenario without a carbon tax. Slovak exports are generally concentrated in the EU, where Slovakia exports about 80% of its production.
- **The modelling results are valid under the assumption that third countries do not impose retaliatory duties.**

Final energy consumption has been stagnant since the mid-1990s, but its structure is changing. While stagnation is observed in industry and households, energy consumption in transport is increasing and consumption in the tertiary sector is declining. The stagnation of energy consumption in the face of GDP growth has been achieved primarily through savings:

- **The potential for reducing final energy consumption beyond the NECP savings target for 2021-2030 is estimated at around 700 ktoe or 7,800 GWh.** The main risks to its fulfilment are continued rapid growth in the number of registered vehicles (which has increased by over 40% in the last 10 years) and new investment in energy-intensive industries (e.g. the production of batteries for electric cars).
- **The Fit for 55 target for an 8.7% reduction in final energy consumption against the EU REF2020 scenario is unrealistic.** This European Commission scenario foresees almost 12% lower final energy consumption in 2030 compared to the NECP. Including the additional 8.7% reduction, the need for energy savings would reach almost 20% by 2030.
- **Ambitious targets for reducing nominal energy consumption are only achievable with significant public support.** There is a gradual depletion of the potential for energy savings with short payback periods and a decline of economically stronger entities (households, firms) with

sufficient resources to invest in energy savings. For this reason, the energy intensity of the economy has been stagnating for several years, whereas previously it had been declining significantly.

- **The public resources needed to achieve the 8.7% reduction target in the NECP scenario by 2030 are estimated at EUR 5-20 billion.** Potential costs have a very wide variance due to the large number of input variables. The final cost to the state will depend on variables such as the evolution of final energy consumption, the savings potential, the specific investment intensity, the savings rate after insulation at the highest cost-effectiveness, the natural rate of investment, the amount of the necessary co-financing from the state, the weather, or the evolution of energy prices.
- **The cheapest are investments in energy efficiency in industry, on the contrary, the insulation of public buildings is the most expensive.** The estimated specific investment intensity per GWh saved between 2021 and 2030, after adjusting for inflation, is EUR 1.4 million. In other sectors, the estimated investment intensity is significantly higher (roughly EUR 3 to 5.5 million per GWh saved). Taking into account natural investments without the need for state intervention and the amount of estimated state support, these values fall in the range of EUR 0.7 to 2.4 million per GWh.

The use of renewables in individual areas is technologically relatively concentrated and the additional potential is partly limited. Slovakia has managed to exceed its target for the share of RES in gross final energy consumption for 2020 at the level of 14%, and it is growing in all areas. In terms of the share of RES in electricity generation, Slovakia is limited primarily by the stability of the transmission system, partly due to public hostility due to negative impacts on the environment or degradation of the landscape. **We estimate the potential for the share of RES in gross energy consumption by 2030 to be in the range of 23-24%:**

- **A potential of 100 ktoe (approx. 1,160 GWh) above the 2030 targets has been identified for the share of RES in heat generation.** For transport, the opportunities to increase the share of RES are minimal. The potential for RES deployment beyond the NECP was estimated at 166 ktoe (roughly 7% of RES deployment in 2030 under the NECP scenario). The total cost of the state in increasing the use of RES to its maximum potential is estimated at EUR 410 million in the medium scenario. The state's related costs necessary to implement investments in RES are dependent on energy prices.
- **From the point of view of public finances, it is more profitable to promote electricity from RES.** The estimated costs from public sources for the additional increase in RES energy production, expressed in million euros per ktoe, are the lowest for solar and wind (1.2 and 1.7, respectively). This is followed by heat production from biogas and heat pumps (2.2 and 2.4 respectively). The most expensive source is geothermal energy (3.7 for electricity and 5.8 for heat) - but there is an opportunity to make it cheaper, in the case of combined production of electricity and heat from geothermal energy (2.0).
- **A realistic estimate of the share of RES in gross energy consumption by 2030 is 23-24%.** More ambitious targets for electricity generation from RES would require higher electricity production from biomass and hydropower, with surplus electricity being exported. The main reason why Slovakia is lagging behind the EU in the use of RES is the high share of emission-free nuclear power generation.

Slovakia has one of the highest LULUCF targets in Europe, which is 85% higher than the EU average. The LULUCF sector can reduce GHG emissions through sequestering atmospheric CO_2 in vegetation, soil and wood, covering GHG emissions and removals from human activities in land use, land-use change and forestry. However, calculating capture rates from the three-year average introduces a large degree of uncertainty:

- **In order to achieve this goal, Slovakia will have to fundamentally rethink its current approach to forest management.** Without this change, it will be difficult to meet the targets, especially after 2030, when forestry actors are planning for more significant restoration. In order to achieve the target, it will be necessary to extend the non-intervention regime to 75% of the area of national parks by 2030, i.e. by an area of approximately 130 thousand ha compared to the current state. It will be necessary to reduce the volume of incidental logging from 5.5 million m^3 in 2020 to 4.4 million m^3 in 2030 and to increase the forest area in the range of 100 thousands ha by 2030.
- **There are risks to the achievement of the target, hence the need to continuously monitor the results achieved and potentially take additional measures.** The evolution of climate change and the occurrence of weather extremes may partially affect tree growth and reduce the accuracy of the modelled measures. The extension of the EU ETS to the buildings sector is likely to lead to a switch from coal to biomass heating in many households, which will increase the demand for wood.

Slovakia has so far failed to meet the emission reduction target for sectors under the Effort Sharing Regulation (ESR). The current target foresees a 12% reduction in CO_2 equivalent emissions in 2030 compared to 2005. Slovakia has increased this target to a 20% reduction in emissions in Envirostrategy 2030. Based on the projections of the business-as-usual scenario, emissions will increase by 7% in 2030. The proposed Fit for 55 target is a 22.7% reduction in emissions:

- **The most problematic sector under the ESR is transport, which accounts for more than 40% of total ESR emissions and is set to grow in the coming years.** The growth in emissions is driven by increasing mobility, rising car ownership and a very slow shift to alternative modes of transport. With additional measures, emissions should not fall below today's levels until around 2040. The subsequent decline could be rapid, with transport emissions reaching around 50% of today's emissions in 2050. The slow transition to electro-mobility, mainly due to an inadequate network of charging stations, is also contributing to rising emissions.
- **In the buildings sector, emissions are projected to decrease, primarily due to reducing losses and making household operations more efficient.** The energy sector accounts for 3.5% and the construction sector for almost 6% of total emissions, with emissions in both sectors growing slowly. In the case of the energy sector, emissions are expected to stabilise and then decline slowly, while the construction sector is expected to grow only slowly due to the rapid development of infrastructure and housing. **In other sectors, the trend is steady or declining.**
- **The scenario with the planned waste management measures leads to a 17.5% reduction in waste emissions by 2030 compared to 2005.** From 2023 it will only be possible to landfill waste that has undergone treatment, which is likely to lead to increased energy recovery of waste, which will be responsible for the bulk of emissions from waste. **In the scenario with additional measures, emissions would be reduced by up to 27.4%.** In addition to the planned measures, the scenario with additional measures quantifies the costs and benefits of introducing full-scale bulk collection, including electronic record-keeping in family houses, and more convenient collection of kitchen bio-waste by means of baskets in each household. The waste sector accounts for around 4% of greenhouse gas emissions, with emissions rising over the long term with rising living standards resulting in higher waste production.

Part of the Fit for 55 package focuses on decarbonisation and alternative fuels in the aviation sector. The aviation sector is expected to remain heavily dependent on fossil fuels for technical reasons, but the share of alternative fuels is expected to increase over time. Given the higher number of essential measures and their varying effectiveness, it would be appropriate to harmonise the different timetables in the interests of greater certainty in the sector.

- **Gradually, the free allocation of emission allowances will be phased out and the transition to auctions will take place.** The combination of this measure and the expansion of alternative fuels is intended to ensure a smooth decarbonisation of aviation.
- **The ReFuel Regulation aims to increase the share of RES in aviation.** Aviation fuel suppliers will be obliged to blend a sustainable fuel component into conventional aviation fuel in specified proportions. These fuel components can be made from e.g. vegetable oils, waste lipids or selected crops. Given that RES in the transport sector are mainly represented by bio-based fuels, more certainty needs to be given to aviation through a clear definition of sustainable fuels.
- **In aviation, the AFIR targets the expansion of electrification.** This will create an obligation within the European transport network to provide the necessary infrastructure. Slovakia will thus have to finance investments in the provision of electric charging at airports. The limited spatial possibilities of relatively small Slovak international airports may make these investments more expensive.

The Social and Climate Fund is not the only source of funding for measures to mitigate the negative impacts of Fit for 55, these investments can also be financed from the Recovery and Resilience Plan, the Slovakia Operational Programme, the Just Transition Fund, the Modernisation Fund or the Common Agricultural Policy.

Through targeted measures, we can meet the 55% greenhouse gas reduction target for as little as EUR 2.7 billion, which is up to EUR 5 billion cheaper than the Low Carbon Study's main decarbonisation scenario. This is estimated through the so-called Marginal Abatement Cost Curve (MACC), a tool that allows comparing decarbonisation options in terms of unit cost per tonne of CO_2 equivalent removed. Reducing emissions by 67% by 2030 would require more than EUR 4 billion over and above the measures already analysed.

- **This is a different approach to valuing emissions or cost benefits than the Fit for 55 partial measures,** so the values cannot be added together. The MACC approach focuses solely on GHG emissions without broader environmental targets. Due to implementation risks, it is recommended to aim for more ambitious targets.
- **The sectors with the highest gross costs are transport and industry.** Among industrial sectors, the steel industry requires the most resources, especially for the 67% reduction in emissions - almost EUR 1.5 billion, equivalent to more than a third of the total cost.
- **The heat and electricity generation sector also contributes significantly.** This sector includes measures addressing both point (improving the efficiency of district heating plants) and decentralised sources of emissions (insulation of buildings with district heating).

Some of the proposed measures have objective limits to their feasibility, therefore the following are recommended:

- **For households, the extension of the ETS to transport is less financially burdensome than the extension of the ETS to the buildings sector.** The estimated increased annual costs of coal heating are up to EUR 450 for an uninsulated house, while the increased fuel costs are less than EUR 175 even with high consumption. At the same time, the Social and Climate Fund can provide more targeted support to households affected by energy poverty when extending the ETS to the buildings sector than to transport, where targeted mitigation of social impacts for the most vulnerable households is difficult to achieve other than through subsidies.
- **Decarbonisation in non-ETS sectors needs to be focused on road transport.** In fact, transport is expected to increase greenhouse gas emissions by up to 4 $MtCO_2eq$/year due to increasing mobility, business development and still insufficient purchasing power to switch to electro-mobility. Although cost parity with internal combustion is expected to be achieved in the coming years,

barriers related to infrastructure availability and price competitiveness may remain. The state should support a sufficiently comfortable and efficient infrastructure network, as well as consider indirect instruments to support electro-mobility, for example through the tax system. It is necessary to increase the share of rail freight transport at the expense of road and public transport at the expense of individual car transport, for which the Social and Climate Fund, the ESIF and the Recovery Plan can also be used.

- **Taking into account the structure of the industry and the prospects for future economic development, the energy efficiency objective needs to be linked to the NECP and new support schemes need to be prepared.** If the EU REF2020 scenario were set as the baseline, this would require a reduction in final energy consumption by approximately one fifth by 2030. Given the national economic importance of energy-intensive industries, the declining rate of building renovation, the growth of energy consumption in transport, and the likelihood of the arrival of energy-intensive battery production for electric cars, such savings would be overly ambitious. As there is technically limited potential for energy savings in the industry, major companies would have to close down. In industry, building renovation and transport, there is a need to develop public support schemes for the implementation of investments generating energy savings in order to increase the motivation of households and businesses.
- **The target for the share of RES in final energy consumption needs to be adapted to national specificities and linked to emission-free sources.** We estimate a realistic share of RES in 2030 at a maximum of 25%. The high share of nuclear power in the electricity sector, which will increase in the coming years, objectively hinders the wider integration of new RES. Both the JRC Conclusions and the Taxonomy Regulation have highlighted the importance of nuclear energy in terms of long-term sustainable energy policy, so Member States should be able to take into account the share of zero-emission nuclear energy when setting the RES target.
- **Slovakia has one of the highest targets for carbon sequestration, so it will have to fundamentally change its approach to forest management.** Currently, the structure of the Slovak forest stock is characterised by a high stand age and is also facing the negative consequences of calamities and pests. For the near term, forestry actors are planning rejuvenation logging and replacement planting, but their carbon sequestration potential will only become apparent well in advance of the Fit for 55 targets. At the same time, the extension of the EU ETS to the buildings sector will lead to a switch from coal to biomass heating in many households, which will increase the demand for fuelwood.
- **The focus will need to be on finding cost-effective alternatives to gas and biomass heating.** The package does not provide system solutions for a cost-effective shift in domestic heating from gas and biomass. If all households living in houses with gas heating options took up this option, household consumption would increase by 11%, an overall increase of around 4%. To offset the increase in gas consumption, 11,500 gas-fired homes would need to be rehabilitated, which is consistent with the goal of the Recovery and Resiliency Plan. In Slovakia, 34,000 households still heat with coal. In the most pessimistic scenario in the context of the wood mass claim, namely if all these households switched to wood heating, an additional 411,000 m^3 of wood would need to be harvested, representing an increase in harvesting of 5.5%, which is associated, among other things, with local air pollution. The estimate is based on average building renewal rates, but it is likely that coal-fired households will have a higher renewal potential.
- **It is recommended to ensure a continuous evaluation of the benefits and costs of the measures from the package,** i.e. not only during the start-up of the measures, but also gradually complementing it with the effectiveness of the measures from the projects under the ESIF and the RRP. Ideally, private induced investment should also be included in the assessment.

Introduction

In response to the climate and biodiversity emergency, the European Commission has unveiled the Fit for 55 package, which aims to reduce greenhouse gas emissions by 55% compared to 1990 and then achieve climate neutrality in 2050. Since 1990 there has been a decoupling of CO_2 emissions growth and economic growth. While the European economy has grown by more than 62% since then, emissions have fallen by 24% (European Commission, 2021). However, meeting the 55% decline target will require a fundamental transformation of the economy.

Measures in this new climate package include reforms to the emissions trading scheme, including its significant extension, tightening CO_2 standards to move towards electro-mobility, introducing a "carbon tax" for selected commodities, and achieving carbon neutrality in the land use, forestry and agriculture sectors. These and other measures will require large investments, but the result should be a more resilient economy and leadership in low-carbon technologies. A Social and Climate Fund will be established to mitigate negative social impacts.

The aim of this study is to assess the benefits and impacts that the Fit for 55 package will represent for the Slovak economy both partially within its individual areas and cross-sectionally as a whole. This has been done using methods that look at estimating impacts "from the top", namely the macroeconomic CGE model and the CPS energy system model, as well as methods of estimating "from the bottom" via the marginal abatement cost curve, or other economic methods.

From an analytical point of view, the complex of measures in the Fit for 55 package represents a number of related and interrelated factors, which require sufficient time to analyse thoroughly. The present study provides a basic view of the expected impacts, the detailed examination of which, in their interdependence, requires lengthy analytical work to track the impact of changes over time and to improve the quality of the analytical outputs. This work was carried out collectively by a number of analytical units and government institutions and this submitted version did not manage to be subjected to peer review. Therefore, there are some margins in the results that require continued analytical work. However, the present study provides a basic outline of the impacts of the Fit for 55 package and should serve as a first basis for ongoing joint analytical work by a number of analytical units and institutions.

1 A common response to climate change

Since the start of the Industrial Revolution, the Earth's average temperature has risen by 0.8 °C to 1.2 °C. The scientific consensus is that human activities, particularly the release of heat-trapping greenhouse gas emissions, are responsible for global warming and other climate changes (Somerville & Hassol, 2011). Climate change is the result of the cumulative build-up of greenhouse gases in the atmosphere over time, not emissions in any particular year. Most of the warming has therefore occurred since 1975, at a rate of roughly 0.15 to 0.2 °C per decade (Allen, and others, 2018).

Current commitments to reduce greenhouse gas emissions are leading the planet towards an average temperature rise of 2.7°C by the end of this century. A 30% reduction in greenhouse gas emissions is needed to limit global warming to 2°C, and a minimum 55% reduction is needed to limit emissions to 1.5°C (United Nations Environment Programme, 2021). Keeping global warming to no more than (but ideally below) 1.5 °C is important to avoid extreme and irreversible climate change, which will result in more frequent and intense extreme weather events, loss of biodiversity, rising sea levels, melting glaciers and much more (IPCC, 2018).

A recent report from the IPCC warns that if global temperatures rise by more than 1.5°C above pre-industrial levels, some of the effects of climate change will be irreversible, as current emissions trends suggest. In particular, glacier melting and the 'cascade effect', where forest fires, dying trees, drying peatlands and thawing permafrost release additional emissions, amplifying climate change (IPCC, 2022). Climate change will have consequences in the form of flash floods, droughts and water scarcity. Ambitious and urgent action to adapt to climate change is essential to avoid increasing loss of life, biodiversity and infrastructure, while mitigation measures to reduce greenhouse gas emissions are also essential (IPCC, 2022).

1.1 Impacts of climate change

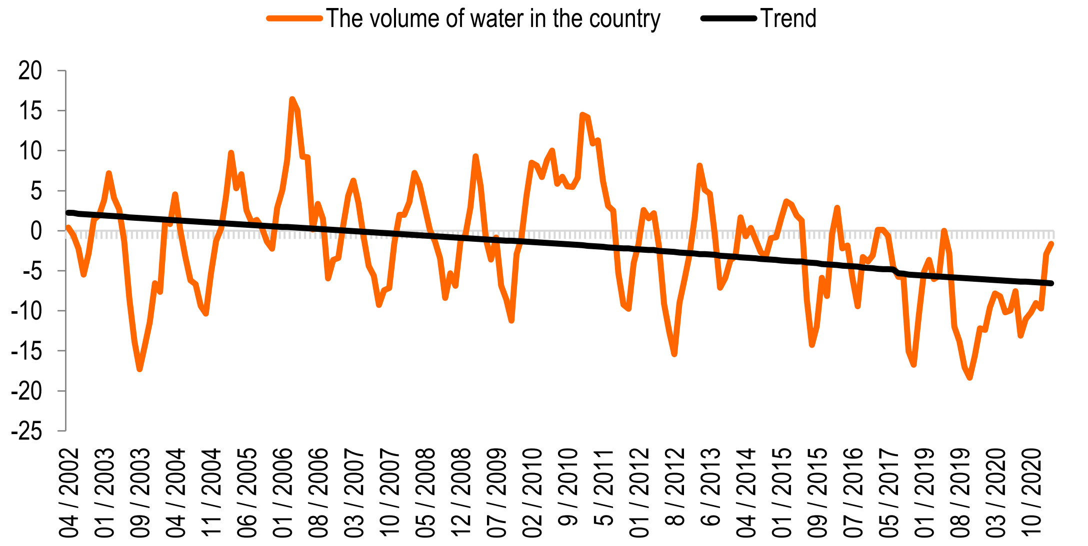
Climate change will have major economic impacts. If climate change continues as before and no new measures are taken to combat climate change, the costs of climate change could reduce GDP in the EU by almost 10% by 2100 **(Alogoskoufis, et al, 2021).** Climate change will have consequences in the form of flash floods, droughts and water scarcity. To date, nearly 17 million people in Europe have been exposed to river flooding and this number is set to increase. The cost of flooding is currently around EUR 9.5 billion per year. If the trend continues, they may increase up to EUR 75 billion by the year 2100 (median estimates). If no mitigation measures are taken, the estimates range up to EUR 225 billion (COACCH, 2019).

Agriculture is already fundamentally threatened by drought and water scarcity. Southern Europe is experiencing the adverse effects of climate change more acutely than northern Europe, and this trend is set to intensify in the future. Changes in daily temperature, precipitation, wind and relative humidity are expected to be the consequences of climate change. For example, wheat yields may fall by up to 49% (Hristov, et al, 2020). The economic cost of the adverse effects of climate change on agricultural producers is estimated at EUR 1.7 billion (median estimate) by the year 2050 (COACCH, 2019).

Specific estimates of the economic impacts of climate change on the Slovak economy are not available. Based on the total economic impact to be borne by the EU, it is not possible to determine Slovakia's expected share. The size of a country, its population and the size of its economy do not correspond to how the country will be affected by specific climate impacts. An aliquot share does not apply to public spending either, as climate policy measures are also developed at national or local government level. Given the high degree of interconnectedness of the Slovak economy with the European economy, our economy would in any case have to bear significant costs.

Some of the climatic conditions that were projected to occur as late as 2030 already occurred in Slovakia between 2001 and 2017. The Slovak territory experienced a significant increase in annual air temperature of 2.0 °C and a less pronounced trend in annual precipitation averaging about 1% compared to 1881. However, the trend of atmospheric precipitation is spatially different and more variable. Annual precipitation increased by up to 3% in the north, while in the southern parts of Slovakia it decreased by more than 10%. The south-west of Slovakia also recorded a relative decrease in humidity of 5%. The loss of snow cover was recorded mainly up to an altitude of 800 m above sea level, while at higher altitudes (above 1,000 m above sea level) we recorded a slight increase. Climate change is leading to increased evaporation of water from plants back into the atmosphere and a decrease in soil moisture, which is gradually leading to desiccation, especially in the southern regions of Slovakia. In Slovakia, the number of regional and flash floods has also increased rapidly since 1994 (Ministry of Environment of the Slovak Republic, 2017). Heating and cooling requirements are expressed in degree days. In the long term, there is a noticeable decrease in heating degree days and thus a slight decrease in heating demand. At the same time, however, the number of daily degrees of cold is increasing, requiring greater demands on air conditioning and refrigeration.

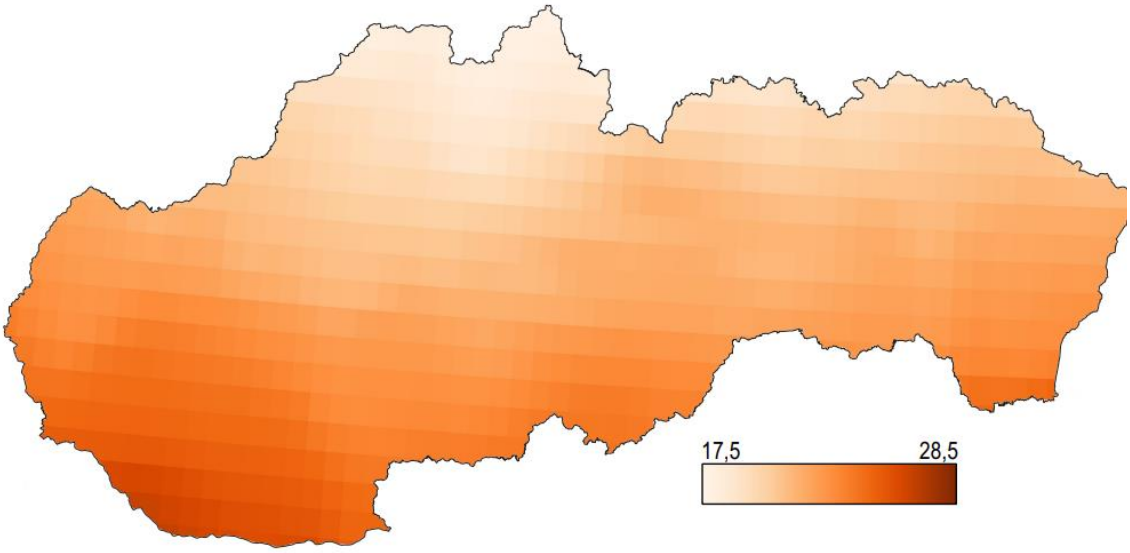
Graph 1: Decreasing water volumes in Slovakia due to evaporation (in cm)



Source: IEP according to NASA

A more frequent occurrence of extreme weather events is expected in the Slovak territory. Increased variability in rainfall is expected in warmer periods, i.e. dry periods will occur more frequently and at longer intervals; rainy periods will occur at shorter but more intense intervals. A significant decrease in soil moisture is also expected in southern Slovakia. In the growing season there will be an increase in potential evaporation of water back to the atmosphere of about 6% per 1 °C, with no increase in rainfall in the growing season predicted. Warmer temperatures in the winter months will result in erratic snow cover up to 900 m above sea level, and winter flooding will be a more frequent occurrence. The warmer parts of the year will see an increase in storms, which will mean the occurrence of stronger winds, gales and even tornadoes (Ministry of Environment of the Slovak Republic, 2018).

Map 1: Increase in heatwave days between 2020 and 2080



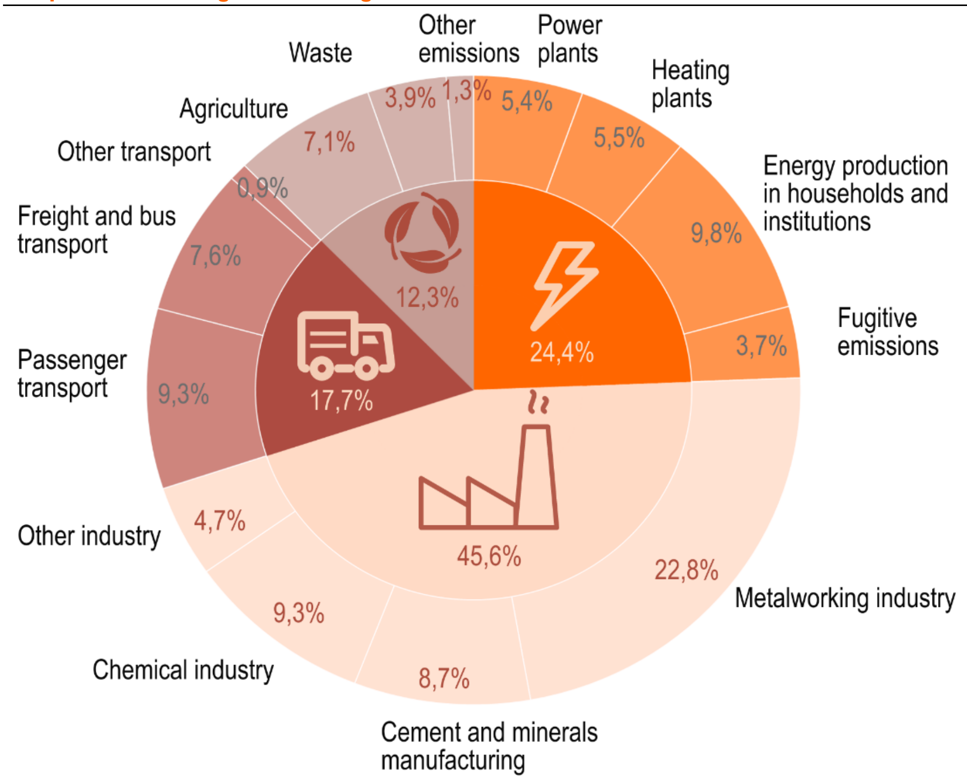
Source: IEP according to Copernicus

Preparing for the adverse effects of climate change with targeted adaptation measures is essential to future mitigation of their impacts. Despite our commitments to reduce greenhouse gas emissions to zero by 2050, the concentration of greenhouse gases in the atmosphere will increase in the coming decades and average global temperatures will rise. It is for this reason that it is imperative that humanity adapts and prepares for the irreversible negative impacts of climate change in order to reduce the damage caused. Adaptation measures may include, for example, planting trees to stabilise eroded soils and slopes as protection against extreme rainfall and weather conditions, or planting crops with higher drought tolerance to increase food security.

A key challenge is to mitigate the extent of climate change by reducing greenhouse gas emissions and increasing carbon sinks. Mitigation is essential to limit the damage caused by climate change and to limit global warming to below 1.5 °C by 2100, as reflected, for example, in the Paris Agreement. All 27 EU Member States have committed to making the EU the first carbon-neutral continent by 2050. To meet this specific target, Member States have committed to reduce their greenhouse gas emissions by at least 55% below 1990 levels by 2030. In particular, priority sectors in which it will be necessary to reduce greenhouse gas emissions are energy, transport, industry and waste management (Toll, 2005).

Industry was the largest source of Slovakia's greenhouse gas emissions (45.6%) in 2018. While in the EU, the energy sector (28%), fuel combustion by users (25.5%) and the transport sector (24.6%) accounted for the largest share of total greenhouse gas emissions in 2018 (EUROSTAT, 2018).

Graph 2: Share of greenhouse gas emission sources in Slovakia in 2018



Source: IEP processing by National Inventory Report (2020)

1.2 Fit for 55 – a big step towards carbon neutrality

The aim of the Fit for 55 proposal is to set the EU on the path to climate neutrality. Specifically, to ensure a 55% reduction in greenhouse gas emissions compared to 1990 and then to achieve climate neutrality in 2050. The Fit for 55 package is a set of interlinked proposals, all working towards the same goal of ensuring a fair, competitive and green transformation by 2030 and beyond. The package strengthens 8 existing pieces of legislation and introduces 5 new initiatives in the areas of climate, energy and fuels, transport, buildings, land use and forestry.

The core measures of Fit for 55 are:

- **Reform of the Emissions Trading Scheme (ETS), with an emphasis on extending it to the buildings and transport sectors.** The changes concern the creation of reserves, the redistribution of allowances, and the trading of allowances in connection with buildings, shipping, air and passenger transport, industry and other areas. The long-term goal will be to move towards a fully auctioned trading mechanism without free allowances. Greater reserves will also be built up, ensuring flexibility in case of unexpected events.
- **Increasing energy efficiency and the share of renewable energy sources (RES).** Targets for energy savings and for the share of RES in gross final energy consumption are increased. Energy savings trajectories and RES energy shares in selected sectors are also established.
- **Tightening CO_2 emission standards in automotive transport and switching to electromobility.** The Fit for 55 package aims to achieve carbon neutrality of new vehicles by 2035. This means that from 2035 onwards, sales of vehicles with internal combustion engines, which currently make up the majority of the fleet, will not be allowed.
- **Introduction of the so-called "carbon tax" for selected commodities.** The carbon border adjustment mechanism (CBAM), the so-called "carbon tax", will gradually replace the current free allocation of allowances from 2026 onwards. The carbon tax anticipates an import levy on cement, aluminium, fertilisers, steel and iron and steel products imported into the EU, to be paid by importers of products from outside the EU. The carbon tax will also be imposed on imported electricity, but countries can apply for an exemption valid until 2030. The mechanism will be implemented through CBAM certificates on imported products, which will be based on current EU ETS allowance prices and the amount of carbon contained in the products.
- **Achieving carbon neutrality in the land use, forestry and agriculture sectors by 2035.** After this year, agriculture should show negative values of carbon emissions and thus clean the air of carbon. Between 2026 and 2030, the net emissions removed should be 310 million tonnes of CO_2 equivalent, and from 2031 onwards, emissions other than CO_2 should also be taken into account. These results should be ensured by a better system of monitoring, evaluation, reporting and follow-up of compliance with commitments.
- **Compensation of part of the expenses related to the implementation of the package through the new Social and Climate Fund.** The fund will be used to address the social impacts resulting from emissions trading, particularly in the buildings and transport sectors. The Fund will operate from 2025 to 2032 and the maximum financial allocation for Slovakia will be EUR 1.7 billion, which represents 2.36% of the total allocation.

Table 1: Overview of the Fit for 55 directives

Focus	Basic information on the Directive	Additional information	Host (co-host)
ETS	Revision of the cap on emission allowances and the ETS market stabilisation reserve	Comprehensive package of changes linked to the trading of allowances within the ETS The changes will affect buildings, shipping, road transport and other	Ministry Of Environment (Ministry Of Transport And Construction, Ministry Of Economy, Ministry Of Finance)
Aviation / ETS	Changes to the aviation emissions trading scheme	Reducing emissions by 2030 in line with the European Green Deal Changing the ETS on the basis of a carbon offsetting and reduction scheme for international aviation	Ministry Of Environment (Ministry Of Transport And Construction)

		Revising the allocation of aviation allowances to increase auctioning	
ESR	Amendment of the Effort Sharing Regulation (ESR) to reflect the fulfilment of the increased ambition by 2030	Achieving the target of a net 55% reduction in total greenhouse gas emissions compared to 2005 outside the ETS Emphasis on meeting objectives collectively and as cost-effectively as possible while preserving the EU's competitiveness	Ministry Of Environment (Ministry Of Economy, Ministry of Agriculture and Rural Development, Ministry Of Transport And Construction)
Emission standards in road transport	Tightening CO_2 emission standards for new passenger cars and light commercial vehicles	Transport is the only sector where emissions are rising Transport emissions account for almost 25% of total EU greenhouse gas emissions Transition to zero-emission mobility Change in emission standards for passenger cars and light commercial vehicles	Ministry Of Environment (Ministry Of Transport And Construction, Ministry of Interior, Ministry Of Economy)
Aviation	Changes to the ETS compensation scheme for EU-based airlines	Simplifying the system and reducing the administrative burden	Ministry Of Environment (Ministry Of Transport And Construction)
ETS	Change in the quantity of allowances placed in the market stabilisation reserve	It sets both a minimum and a maximum volume of quota in the reserve, proposes a doubling of the reserve intake at 24% and lays down rules for the cancellation of quotas placed in reserve in previous periods	Ministry Of Environment (Ministry Of Economy, Ministry Of Finance)
Land and forests	Land use, forestry and agriculture	Changes to the accounting and reporting of agricultural, forestry and other products The scope of competence will be limited to the counting period 2021 to 2025 or 2026 to 2030	Ministry of Agriculture and Rural Development (Ministry Of Environment)
Renewable energy sources	Changing support for renewable energy	Greater integration of green energy into infrastructure, industry and the energy mix, with a year-on-year increase in green energy	Ministry Of Economy (Ministry Of Environment, Ministry of Agriculture and Rural Development)
Energy efficiency	Determining the energy efficiency of the EU as a whole	Tightening energy efficiency targets Tightening energy efficiency requirements in all sectors Setting energy efficiency targets for the EU as a whole, not nationally, in order to increase energy efficiency Public sector obligation to reduce its energy consumption Possibility to specify an energy criterion in public procurement and to take it into account in all procurements	Ministry Of Economy (Ministry Of Transport And Construction, Ministry Of Environment, Regulatory Office for Network Industries, Office for Public Procurement)

Aviation	Ensuring a level playing field for sustainable aviation	Establishes harmonised rules aimed at maintaining a competitive level playing field in the EU's internal aviation market while increasing the use of sustainable aviation fuels	Ministry Of Transport And Construction (Ministry Of Environment, Ministry Of Economy)
Carbon offsetting	Introduction of a carbon border adjustment mechanism	Carbon border adjustment mechanism is introduced in the form of CBAM certificates, the price of which is based on the ETS price	Ministry Of Finance (Ministry Of Environment, Ministry Of Economy)
Social and Climate Fund	Establishment of a social climate fund	Establishment of a social and climate fund for the period 2025-2032 to address the social impacts resulting from emissions trading in the buildings and road transport sectors Funds will be provided to Member States to provide temporary income support and to support their actions and investments aimed at reducing dependence on fossil fuels Each State shall develop a socio-climatic plan and submit it together with an update of the integrated national energy and climate plan	Ministry of Investments, Regional Development and Informatization (Ministry Of Environment, Ministry Of Economy, Ministry of Labour, Social Affairs and Family)

Source: MINISTRY OF ENVIRONMENT OF THE SLOVAK REPUBLIC

1.3 Slovak context of the proposed package

Slovakia's GHG emissions have been stagnant since around 2012, despite the fact that it has more modest sub-targets than the EU-wide targets. According to IEP modelling, a more ambitious reduction target will not be achieved without additional measures. The Fit for 55 package increases the original 2030 emissions reduction target at the level of 40% compared to 1990 and moves it up to a 55% reduction in net greenhouse gas emissions. It focuses on the buildings, small power generation and road transport sectors not yet covered by the ETS, while also tightening existing targets in other sectors. The emissions trading system is being expanded, savings targets are being increased, trajectories for achieving them are being set, and the use of RES is being enhanced. The package will also include a Social Climate Fund to compensate for negative social impacts.

Although Slovakia has achieved significant reductions in greenhouse gas emissions, the total volume has been stagnating for several years, putting the long-term targets at risk. Compared to 1990, we have reduced total emissions by 43% by 2019 under the impact of the economic transformation, which would be sufficient for the old reduction target but not for the newly proposed one. There has only been little change in greenhouse gas emissions since 2012, which has been slightly disturbed by the downturn in economic activity in 2020. The currently set domestic reduction targets are ambitious enough to achieve emission reductions in Slovakia in line with the new 2030 target. However, we will not achieve this without the actual introduction of additional stricter measures[1].

[1] Based on internal modeling, the cost of the additional measures necessary to meet the goal at the level is estimated at approximately 1 billion. EUR per year. It is based on the assumption that Slovakia will have a reduction target of 53%.

Individual measures in the package introduce more ambitious climate targets and cover new sectors. The EC's proposal with higher ambition was adopted on 14 July 2021 and sets a target of a net reduction of 55% in greenhouse gas emissions compared to 1990 levels. The intention is to follow a trajectory towards carbon neutrality in 2050 through meeting the target. The most important sector-specific measures are the inclusion of previously uncovered sectors in emissions trading schemes, the revision of the rules applicable to already included sectors, as well as compensatory measures for affected sectors or the population.

The Fit for 55 package targets socially sensitive areas where Slovakia has significant reserves. The buildings, small energy generation and transport sectors contribute significantly to emissions, with emissions from road transport rising steadily. At the same time, household welfare is sensitive to price changes in these areas, as their share of household[2] expenditure is high. In 2018, the share of energy spending among low-income households was more than 20%, the highest in the EU. Only the Czech Republic came close to the 20% threshold from below, the other countries have not exceeded 15%. In particular, heat and electricity costs are significant items. Domestic heating using low energy efficiency equipment is also problematic. Increasing traffic intensity is also associated with high average emissions from newly registered cars (around 120 g CO_2/km), well above the current target of 95 g CO_2/km.

The share of green energy in Slovakia is lower compared to the European average. In 2019, we exceeded the 2020 target (14%) with a share of RES in gross final energy consumption of 16.9%, due to a change in methodology and a one-off inclusion of biomass in households. Over the same period, the average share of RES across the EU was 18.9%, against a target of 20% for 2020. In 12 countries, the share exceeded 20%. Slovakia is very likely to meet the current 2030 target, but it is only half of the proposed European target. Indeed, the share of RES in final energy consumption will increase to 40% at Union level, a quarter of the current level. Investments in RES will also have to compensate for the expected increase in electricity generation from nuclear power in order to reach the target share. Due to the high share of the energy sector in total emissions, the necessary investments may also be passed on to consumer electricity prices in the future.

Table 2: Overview of the strategic objectives of the Fit for 55 package

	Slovakia		EU	
	Real value	**Objective**	**Original objective**	**New objective**
Reduction of greenhouse gas emissions (compared to 1990), of which :	-43 %[3] (2019)		-40 %	-55 %
ETS sectors (compared to 2005)			-43 %	-61 %
Sectors outside the ETS (compared to 2005)	-5 % (2019)	-20 %[4] (2030)	-30 %	-40 %
Energy sector, of which :				
Share of RES in gross final energy consumption	16.9 % (2019)	19.12 % (2030)	32 %	40 %
Savings in final and primary energy consumption	7.3 %[5] (2019)	30.3 %[6] (2030)	32.5 %	36 and 39 %
Annual energy savings	0.9 % (2014-2020)	0.8 % (2014-2020)	0.8 % (2021-2030)	0.8 % (2021-2023)

2 The bottom two income deciles
3 We reached a low of -45% in 2014.
4 The 2030 Environment Strategy sets a more ambitious reduction target of -20% compared to the baseline year but is also binding. The original target is -12%.
5 Savings in primary energy consumption.
6 Savings in primary energy consumption.

				1.5 % (2024-2030)
Annual rate of decline in final energy consumption in the public sector				1.7 %
Industry, of which :				
Share of green hydrogen in the industry				50 %
Annual growth rate of the share of RES in industry				1.1 p. p.
Transport, of which :				
Greenhouse gas savings in transport (by 2030)				-13 %
Share of green hydrogen and synthetic fuels in transport (by 2030)				2.6 %
Share of advanced biofuels in transport (by 2030)				2.2 %
Share of sustainable aviation fuels (by 2030)				5 %
Share of aviation e-fuels (by 2030)				0.7 %
Greenhouse gas savings in shipping (by 2030 compared to 2020)				6 %
Buildings, of which :				
Share of RES energy in buildings				49 %
Annual renewal rate of floor area of public buildings	76.16 GWh	52.17 GWh	52.17 GWh	3 %
Annual growth rate of the share of RES in heating and cooling			1.1 %	1.1 p. p.
Annual growth rate of the share of RES in heating and cooling of residential buildings				2.1 p. p.
LULUCF, of which:				
Capture volume (by 2030)				310 mio. tonnes
Tree planting (by 2030)				3 bio.

Source: IEP according to EC

The Emissions Trading System will be both expanded and tightened by a separate scheme. Under the new rules, the road transport and buildings sectors will also be subject to carbon trading, which, depending on the specific implementation model, will entail some form of fuel tax, with a cap on the number of permits issued. The scheme will also cover maritime transport and there will be a phasing out of the provision of free emission allowances for aviation. The overall emissions cap will be lowered and the annual reduction rate increased (European Commission, 2021).

The new rules intensify the pressure on the market diffusion of alternative fuels. In addition to the inclusion of the road transport sector in a specific carbon trading scheme, strict fleet limits are set for cars newly placed on the market (European Commission, 2021). By 2030, the average emissions of new cars will be 55% lower than in 2021 and up to 100% lower by 2035, ending the sale of new combustion-powered cars. This is followed by a standard for the availability of charging and refuelling points on the supporting infrastructure, with chargers available every 60 km and hydrogen stations every 150 km of the route (European Commission, 2021). The widespread use of alternative fuels also applies to aircraft and ships, as does the availability of the necessary infrastructure at transport hubs (European Commission, 2021; European Commission, 2021).

Industry faces increased demands to decarbonise both energy and processes but will be increasingly protected by the carbon tax. Through the new targets, there is a gradual increase in the share of RES use in industrial sectors, with particular attention being paid to the widespread use of hydrogen. The CBAM mechanism will be introduced for a selected group of imported industrial products[7], which may not be subject to emissions trading schemes and may also be subsidised (European Commission, 2021). The instrument will reduce the incentive to export carbon-intensive industries abroad and to supply products with a higher environmental footprint to the European market.

Measures in the buildings sector increase the share of RES in consumption and increase energy efficiency. In addition to the increased energy savings targets, the share of RES in the electricity, heating and cooling sectors will gradually increase. The public sector will be bound by stricter targets and will be obliged to renovate buildings in line with a long-term sustainable renovation strategy. The negative social impacts of the package of measures will be offset by the Social Climate Fund if the ETS is extended to the buildings and road transport sectors.

There is also a tightening in sectors outside the ETS, taking into account the economic level of Member States. The change in targets affects buildings, road and maritime transport, agriculture, waste and small industry. Differences in economic development are taken into account through GDP per capita, while the costliness of the measures is also taken into account. For each measure, the intervals are set as follows:

- Member States with a GDP per capita below 60% of the EU average,
- Member States with a GDP per capita above 60% and below or equal to 100% of the EU average,
- Member States with a GDP per capita above 100% of the EU average.

Member States should use the total proceeds from emissions trading for energy and climate projects, while a proportion should also be used for compensation schemes to mitigate the social impacts of the proposals. There will be an increase in resources in both the Modernisation Fund and the Innovation Fund, while around EUR 72 billion (a quarter of the proceeds for the buildings and transport sectors) will be available under the Social Climate Fund from the European Commission over the period 2025-2032 to address impacts on vulnerable income groups, small businesses or transport users (European Commission, 2021). This will be complemented at national level by at least a doubling of resources, as Member States are to finance at least 50% of the plan.

2 Impacts of the different parts of the Fit for 55 package

The Fit for 55 package is based on a combination of different approaches to achieve a common goal. The EC's impact analysis shows that over-reliance on enhanced regulatory policies would lead to unnecessarily high economic burdens, while carbon pricing alone would not remove persistent market failures and non-market barriers. The policy mix chosen should, therefore, represent a balance between pricing, targets, standards and support measures.

2.1 Extending the EU ETS to the road transport and building heating sectors

Road transport is responsible for 16.9% of total CO_2 emissions in Slovakia, with up to 55% of emissions coming from passenger cars (EUROSTAT, 2021). Road transport emissions continue to rise year on year, putting the EU's future climate targets at risk. Heating of buildings and institutions is responsible for almost 11.1% of total CO_2 emissions in the Slovak Republic. Energy supplied from heating and power plants is already covered by the EU ETS (EUROSTAT, 2021). However, there are many households in Slovakia that heat with fossil fuels (coal, natural gas), and therefore it is necessary to regulate emissions from these heating

[7] The draft regulation on the carbon tariff includes a list of products likely to be affected: cement (other, Portland, clinker), iron and steel (crude steel, hot-rolled steel, forged steel, pressed steel, wire), aluminium (aluminium and aluminium alloys), fertilisers (nitric acid, urea, mixed and other fertilisers).

sources. Emissions reductions in these sectors are to be mediated through the Emissions Trading System (ETS).

A separate trading system will lead to higher prices in the transport and building heating sectors and ensure that these sectors directly reduce emissions. Allowance prices in the stand-alone system should converge towards the EU ETS allowance prices in the future. Integrating the road transport and buildings sectors into the existing ETS would increase covered emissions by more than 50% but would not guarantee direct emission reductions in the integrated sectors. The abatement costs of road transport are higher and the elasticity of demand is relatively inelastic (i.e. demand for road transport responds very little to price changes) (Stenning, Bui, & Pavelka, 2020). Integration of the sectors would therefore result in higher prices for stationary installations (sectors already covered by the EU ETS), and hence, GHG emission reductions would occur mainly in these energy-intensive sectors.

The system will target upstream fuel suppliers, not directly consumers (drivers and households) (EU ETS, 2021)**.** Covered suppliers will have to surrender emission allowances for the fuel sold and/or reduce the fuel content. Emissions will thus be determined indirectly through the final quantity of fuel placed on the market. However, the price of the allowances will be passed on to the final consumers of the fuels, which should as a result stimulate behavioural change and adaptation towards the use of more environmentally friendly and efficient fuels (Oharenko, 2021). Exemptions for certain specific types of transport, such as agricultural or construction transport, could be achieved through specific fuel distributors who focus on selling fuel for these specific activities without the obligation to surrender emission allowances. In the future, the price of allowances should equal the price of allowances in the EU ETS.

The new system should be operational from 2025, but the total quantity of emission allowances will not be determined for the first time until 2026. It will be based on the trajectory of the emission limits from 2024, which will total 1,109,304,000 t (European Commission, 2021)**.** During 2025, regulated distributors will be required to hold allowances and report emissions for 2024 and 2025. Allowance surrender and other obligations will only apply from 2026, allowing the new ETS to be effective from the outset. The linear reduction factor (i.e. the annual share of the decrease in available emission allowances) should initially be 5.15% (European Commission, 2021). After 2027, the total quantity of allowances will be determined on the basis of average reported emissions from 2024 to 2026 and should be reduced by the same absolute annual reduction as determined from 2024 onwards, consistent with the linear reduction factor of 5.43%.

Emission allowances, unlike in the EU ETS, will not be allocated free of charge but will be auctioned from the outset, as the risk of CO_2[8] leakage in the road transport and building heating sectors is minimal to non-existent (European Commission, 2021). To avoid the risk of market imbalances (quota surplus or deficit) and inappropriate price signals, a mechanism similar to the Market Stability Reserve will be established. This will make it possible to manage expectations about future supply and to mitigate excessive price movements. When introducing emissions trading in new sectors, 600 million emission allowances should initially be placed in the reserve (Bellona Europa, 2021). Unused allowances will expire after 2030. There will be an upper limit of 440 million allowances and a lower limit of 210 million allowances. A reserve of 100 million allowances will either be released into or absorbed from circulation based on whether the total volume of allowances rises above or falls below the upper and lower limits.

Box 1: European Emissions Trading System (EU ETS)

The European Emissions Trading System (EU ETS) is the cornerstone of the EU's climate policy and covers around 45% of the EU's greenhouse gas emissions (roughly 5% of global emissions).

[8] Carbon leakage i.e. when companies move their production to countries with less stringent climate regulations.

Since its inception in 2005, the ETS has undergone four phases of implementation, with Phase 4 covering the period 2021-2030. The EU ETS currently regulates CO_2 emissions from around 11,000 installations from the 27 EU Member States, Norway, Liechtenstein and Iceland. The scheme covers CO_2 emissions from power stations and energy-intensive industries such as: oil refineries, steel mills and producers of iron, aluminium, cement, paper and glass. Flights within the EU and EEA are also covered, but flights outside the EU do not have to comply with the EU ETS (Heindl, 2021).

The EU ETS operates based on the polluter pays principle. Companies covered by the scheme must purchase emission allowances at auction for every tonne of CO_2-eq they emit into the atmosphere. However, some companies are given free allowances to avoid carbon leakage, i.e. the risk that companies will relocate their production to countries with less stringent environmental regulations, which could in principle lead to an overall increase in greenhouse gas emissions (European Commission, 2021).

The EU ETS is governed by a cap-and-trade system. A maximum absolute amount of emissions (cap) that covered entities can emit in order to meet the EU's emission reduction target is set. This maximum is gradually reduced by a linear factor (1.74% between 2013 and 2020, 2.2% from 2021), so that total emissions decrease (European Commission, 2021). Emission allowances can be traded (trade) on the stock exchange. Operators of affected installations and aircraft operators have the option to buy allowances if they want to emit more CO_2 than they have allowances. Conversely, if they have a surplus, they have the option to sell allowances on the market. If companies exceed their emissions, they will be penalised EUR 100 (indexed for inflation) for each tonne of CO_2 for which allowances have not been surrendered within a specified time (European Commission, 2021).

In 2021, 95 plants in Slovakia were included in the EU ETS scheme. In 2020, Slovakia received 12 793 129 free emission allowances. Verified emissions from installations covered by the EU ETS in 2020 were 18 169 948 tCO_2. US Steel Košice received 43.6% (5 576 436) of the total free allowances, Slovnaft 8.2% (1 052 255) and Duslo 5.2% (666 832). Up to 71% of the free allowances were allocated to the largest polluters in the steel, chemical and cement industries.

The price signal of emission allowances is one of the key functions of the emissions trading system that can significantly influence decisions on fossil fuel consumption and investment in low-carbon strategies. Studies have shown that the energy market, the electricity market and the financial market can have a significant impact on the price of carbon. Changes in energy prices affect the demand for fossil fuels, which in turn affects CO_2 emissions from fossil fuel combustion and the demand for emission allowances, thereby affecting the carbon price (Zhang & Huang, 2015); (Fan, Akimov, & Roca, 2013). For example, an increase in the price of electricity will incentivise energy companies to generate more electricity, thereby increasing emissions and the price of carbon. Emission allowances, on the other hand, increase the cost of fossil-fuel electricity generation, giving countries an incentive to replace these sources with low-carbon technologies (Ahamada & Kirat, 2015).

Emission allowance prices reached all-time highs in February 2022, but by early March they were already at pre-surge levels. At the start of the EU ETS (2005), the price per tonne of CO_2 was less than EUR 16. In the long term, ETS prices have reached a maximum of EUR 30/tCO_2, and between 2012 and the end of 2017 they were below EUR 10/tCO_2 in the long term. The increase began in October 2021, with spot market prices hitting a record high of over EUR 97/tCO2 in February 2022 but falling below EUR 70/tCO_2 after the start of the Russian army's invasion of Ukraine, which is almost at the level of prices before the significant increase in the autumn of 2021.

To avoid significant negative impacts on households, a Social Climate Fund will be established (see more in chapter 3.4**)**. The new system should affect all fossil fuels not already covered by the EU ETS. In transport, diesel, petrol and LPG should be covered, and only coal and natural gas for heating buildings, as heating plants in Slovakia are already covered by the EU ETS. Already this year, Germany has introduced separate emissions trading in the road transport and heating sectors, which has led to a EUR 0.07/litre increase in the price of petrol and EUR 0.08/litre increase in the price of diesel (Deutsche Emissionshandelsstelle, 2020). Emission allowances also apply to fuel oil, LPG, natural gas and coal. The German scheme works basically in the same way as the new European system should. The only difference is the allowance prices, which will be fixed in Germany between 2021 and 2025, which should make it easier to adapt to the new emissions trading scheme. Allowance auctions will start in 2026 and from 2027 the price of emissions will be freely market-determined.

Table 3: Fixed allowance prices in the new German ETS in the transport and buildings sectors 2021-2024

Year	Fixed price eur/t
2021	25
2022	30
2023	35
2024	45
2025	55

Source: DEHSt

For our estimates, we consider a medium scenario of EUR 55/tCO_2 as the main scenario, which is based on the allowance price in the new German ETS in 2025, when EU-wide emissions trading for road transport and building heating is expected to start. However, for a more comprehensive assessment, we work with three possible allowance prices of EUR 35, 55 and 75/tCO_2 and also consider that the price of the entire allowance is passed on from the distributor to the consumer. Allowance prices are expected to be lower than EU ETS prices initially, but prices are expected to rise in the future and converge towards EU ETS allowance prices. The initial price of EUR 35/tCO_2 is an estimate of where allowance prices in the new ETS might start (i.e. lower than the EU ETS price). The price of EUR 75/tCO_2 is a projection of where prices are close to the EU ETS allowance prices.

Table 4: Calculation of building heating price increases for coal and natural gas per kg, m3 and MWh

	Price of emission allowances (EUR/tCO_2)			
Fuel	**35**	**55**	**75**	**Unit**
Hard coal	8.47	13.31	18.15	eurocent/kg
Brown coal	3.99	6.27	8.55	eurocent/kg
Natural gas	0.007	0.011	0.015	eurocent/m3
Hard coal	12.25	19,125	26.25	EUR /MWh
Brown coal	12.74	20.02	27.3	EUR /MWh
Natural gas	7	11	15	EUR /MWh

Source: IEP

Table 5: Calculating the increase in road transport prices for petrol, diesel and LPG per litre

	Price of emission allowances (EUR/tCO_2)			
Fuel	**35**	**55**	**75**	**Unit**
Petrol	8.35	13.15	17.93	eurocent/l
Diesel	9.124	14.52	19.18	eurocent/l
LPG	5.83	9.16	12.49	eurocent/l

Source: IEP

According to the projections, households heating with hard coal will be the most affected by the price increase (up to 63.4%) and fuel costs will increase (up to 12%). The medium scenario brings price increases of around EUR 20 /MWh for coal and 13 to 15 euro cents for gasoline and diesel. Fuels used for heating buildings will see more radical price increases than those used for road transport. Users of natural gas and LPG will pay the least for these fossil fuels.

Table 6: Increase in fuel prices for heating buildings (%)

	Percentage price increase at quota price [9]		
Fuel	**EUR 35**	**EUR 55**	**EUR 75**
Hard coal	40.3	63.4	86.4
Brown coal	23.5	36.9	50.3
Natural gas	15.1	23.7	32.3

Source: IEP

Table 7: Increase in road transport fuel prices (%)

	Percentage price increase at quota price [10]		
Fuel	**EUR 35**	**EUR 55**	**EUR 75**
Petrol	5.6	8.77	11.95
Diesel	6.6	10.41	14.19
LPG	7.5	11.73	16

Source: IEP

Households in individual buildings can pay up to EUR 450 a year extra for hard coal, EUR 367 for brown coal and more than EUR 300 for natural gas compared to today. For apartment buildings using natural gas, the increase should be less than EUR 100 per year. The increase in annual heating costs for buildings (Table 8) depends on the level of insulation. The calculation of the need for hard coal and lignite is based on data on their annual consumption; it is possible that households combine more than one fuel and thus use other solid fuels, e.g. wood. Therefore, household price projections may vary based on their particular fuel mix. Natural gas price increase estimates are based on an assumed average consumption in a residential house of 8.6 MWh, and in a single-family house with an average consumption of 28.3 MWh (SIEA; SPP Distribúcia).

Table 8: Calculating the increase in the cost of heating buildings in the average household

	Hard coal			Brown coal		
	Emission allowance prices (EUR/tCO_2)					
	35	**55**	**75**	**35**	**55**	**75**
Uninsulated	288.2	453	617.7	233.3	366.6	500
Partially insulated	187.4	294.4	401.5	151.6	238.3	325
Fully insulated	86.5	135.9	185.3	70	110	150

Natural gas	Family house 150 m²	Emission allowance prices (EUR/tCO_2)		Apartment in an apartment building 72 m²		
	35	**55**	**75**	**35**	**55**	**75**
Uninsulated	198.3	311.6	424.9	60.2	94.6	129
Partially insulated	128.9	202.5	276.2	47.3	74.3	101.3
Fully insulated	59.15	93.5	127.5	34.3	53.9	73.5

Source: IEP, SLOVAK HYDROMETEOROLOGICAL INSTITUTE

Depending on the consumption of the car, the annual costs for petrol and diesel will increase by between EUR 80 and EUR 175 for users of passenger transport. Freight transport will be 0.5 cents more expensive per tonne-kilometre, an increase of 7.5%. Prices will be slightly more expensive for diesel (Table 9). It is important to note, however, that we take into account the fixed consumption of cars. In practice, prices will be comparable because diesel cars are more efficient and, on average, have lower consumption

[9] Compared to the price of hard coal EUR 210 per ton, brown coal EUR 210 per ton, brown coal EUR 210 per ton, brown coal EUR 210 per ton, brown coal EUR 210 per ton. coal 170 eur/t, and natural gas 46.4EUR MWh (According to Tariff D5 from SPP, without fixed monthly rate).
[10] Compared to average fuel prices in the 45th week of 2021.

than petrol cars of the same size. However, this is not the case for PM particles and NOx emissions, where diesel cars contribute significantly more to air pollution.

Table 9: Modelling the increase in road transport prices (at the Slovak annual average)

	Emission allowance prices (EUR /tCO2)					
	35		55		75	
Increase in the price of fuel	Annually	Monthly	Annually	Monthly	Annually	Monthly
Low consumption (5.2 l/100km)						
Petrol	51.62	4.30	81.29	6.77	110.84	9.124
Diesel	57.12	4.76	89,176	7.48	122.40	10.20
LPG	36.04	3	56.62	4.72	77.21	6.43
Medium consumption (6.8 l/100km)						
Petrol	67.5	5.63	106.30	8.86	144.94	12.08
Diesel	74.7	6.22	117.38	9,178	160.06	13.34
LPG	47.13	3.93	74.05	6.17	100.97	8.41
High consumption (10.1 l/100km)						
Petrol	100.26	8.35	157.89	13.16	215.28	17.94
Diesel	110.94	9,125	174.34	14.53	237.74	19,181
LPG	70	5.83	109,198	9.17	149,197	12.50

Source: IEP Calculations

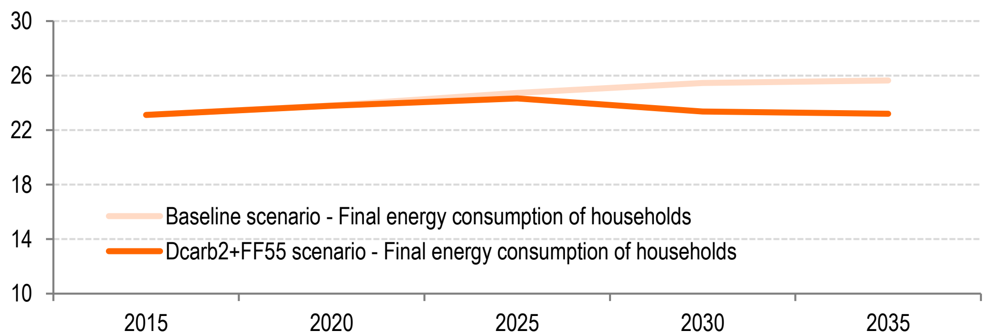
Table 10: Increase in road freight transport prices

	Emission allowance prices (EUR /tCO2)		
Price increase EUR/km	35	55	75
Diesel	0.003	0.005	0.007
Price increase %			
Diesel	4.48	7.46	10.45

Source: Calculations of IEP, DELLA, EEA

Extending the ETS to the building heating sector can deliver more than an 8% reduction in final energy consumption of households in 2030. In the analysis, we compare the reference scenario, which does not assume the introduction of additional climate support policies after 2020, with the decarbonisation scenario Dcarb2+FF55 (see Box 2 for more details), which foresees the extension of the ETS to the household and transport sectors, stricter emission standards in transport and higher ETS permit prices. Final energy consumption of households increases steadily in the reference scenario, while in the decarbonisation scenario it starts to decrease after 2025. The key decline occurs in energy use for heating and cooling. Electricity consumption for other purposes remains almost the same in both scenarios.

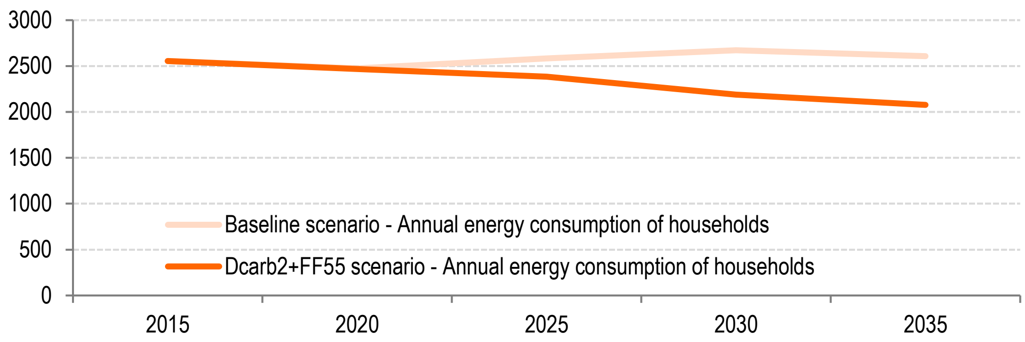
Graph 3: Final energy consumption of households by scenario (in thousands TWh)



Source: IEP according to CPS

The energy savings of the decarbonisation scenario also have a significant impact on greenhouse gas production in the household sector. In 2030, in the Dcarb2+FF55 scenario, emissions are reduced by over 480 ktCO_2eq per year, which is almost on par with the emissions from the Vojany coal-fired power plant. In the reference scenario, emissions are more or less stable over the whole period.

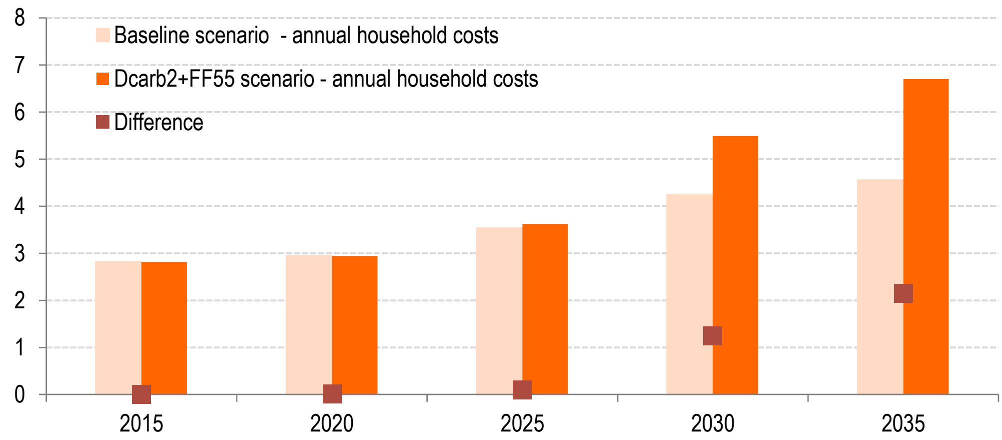
Graph 4: Annual emissions in the household sector by scenario (ktCO_2e)



Source: IEP according to CPS

Household costs in the Dcarb2+FF55 scenario are significantly higher compared to the reference scenario from around 2030 onwards by more than EUR 1 billion per year due to the increased rate of insulation. Household costs include maintenance costs, capital costs, fuel costs as well as ETS fees. Increased costs should be borne by the household sector as well as the public sector, for example through the Social Climate Fund. Household savings in 2030 will be EUR 200 million higher than in the reference scenario (savings are included in costs). By 2030, the cumulative cost difference will reach EUR 4.3 billion.

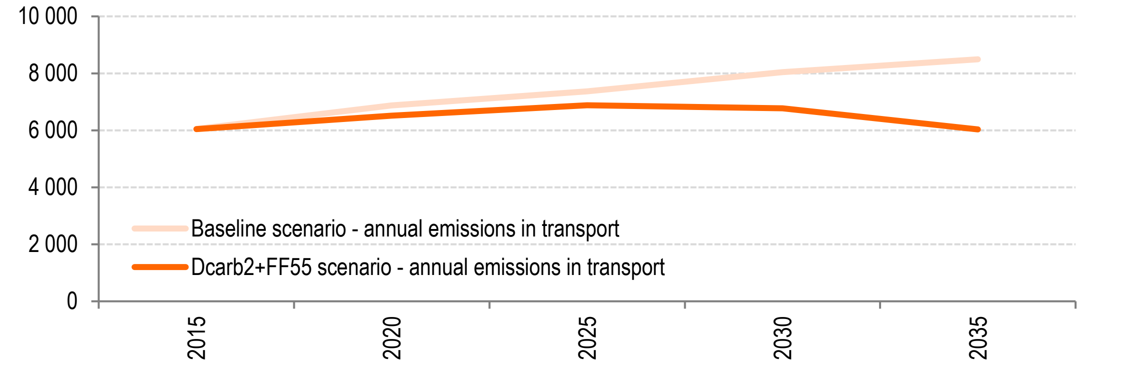
Graph 5: Annual household costs by scenario (EUR billion)



Source: IEP according to CPS

In the reference scenario, transport emissions increase, in Dcarb2+FF55 they only increase until 2025. Increasing transport volumes are causing greenhouse gas emissions to rise, despite the increasing efficiency of vehicles and the proliferation of alternative powertrains. The difference in emissions by 2030 between the scenarios reaches almost 1.3 MtCO_2eq, representing over 2.5% of all Slovak emissions today. The difference in emissions by 2035 between the scenarios reaches almost 2.5 MtCO_2eq, which is 5% of all Slovak emissions today, i.e., more than the output of the entire petrochemical industry combined. **Failure to implement transport measures beyond the reference scenario would make it very difficult to meet Slovakia's GHG emission commitments.**

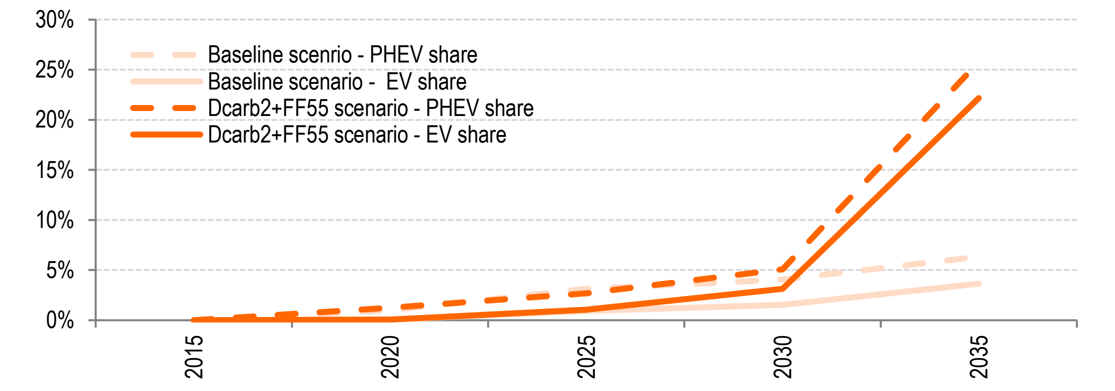
Graph 6: Annual transport emissions by scenario (ktCO2e)



Source: IEP according to CPS

Compared to the reference scenario, the Dcarb2+FF55 scenario sees a significant increase in the number of electric cars and hybrids after 2030. In the Dcarb2+FF55 scenario, almost half of passenger cars will have some form of electric drive in 2035. Hydrogen passenger cars will have a relatively low share in both scenarios (0.4-3.6%). In the reference scenario, the number of internal combustion engine vehicles increases, while in the Dcarb2+FF55 scenario it decreases after 2030, with fewer of these cars in 2035 than in 2015.

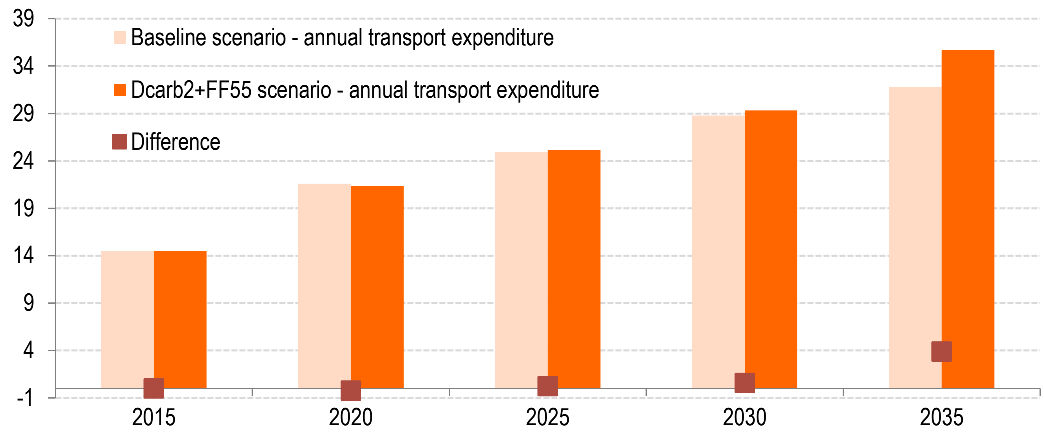
Graph 7: Share of electric cars and plug-in hybrids in all passenger cars by scenario



Source: IEP according to CPS

With respect to the volume of total expenditure in the transport sector, transport costs vary significantly only after 2030. The additional costs increase over time, from EUR 0.5 billion per year in 2030 to almost EUR 4 billion per year in 2035. This difference also includes fuel costs, which are higher by almost EUR 0.7 billion in 2030 in the reference scenario. Cumulatively, the cost difference will reach EUR 1.6 billion by 2030 and up to EUR 14 billion by 2035.

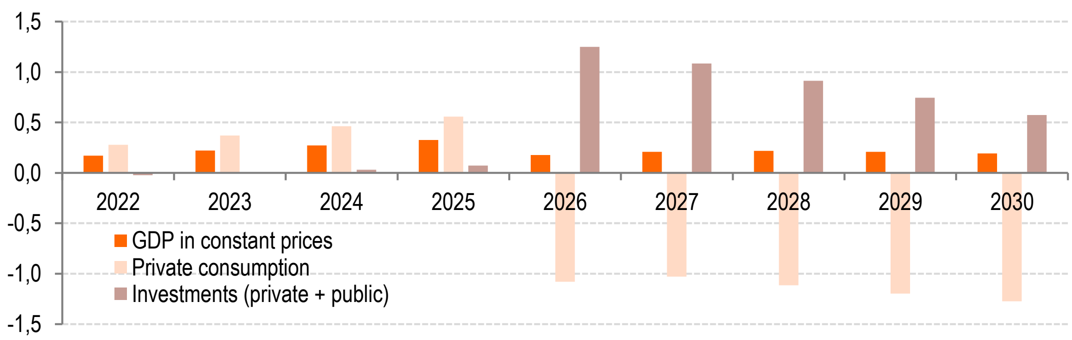
Graph 8: Annual transport costs by scenario (EUR billion)



Source: IEP according to CPS

According to estimates, the extension of the ETS to transport and buildings, after an initial slowdown in GDP growth, is projected to lead to an increase in GDP growth in 2026 as a result of increased investment activity, especially in energy efficiency. In the analysis, we compare the macroeconomic impacts of the Dcarb2+FF55 decarbonisation scenario with the baseline scenario. The Dcarb2+FF55 scenario includes an extension of the ETS, tightening of emission standards for transport and many other decarbonisation measures, such as fossil fuel phase-out, extension of the ETS or installation of RES (see Box 2 for more on the scenarios and the MEK model). The increased investment activity is related to the financing of measures aimed at changing the energy mix and energy efficiency. The biggest change in the volume of investment in energy efficiency occurs in 2026, when the extension of the ETS is introduced. Tightening emissions standards for transport and other decarbonisation measures will require an almost 2.5-fold increase in energy efficiency investments in 2026. At the same time, from 2026 onwards, the total investment in energy will increase. Other private and public investment will increase by around 1.2% in 2026 compared to the scenario without ETS extension. Private consumption is substituted by domestic investment, resulting in private consumption correcting overall GDP growth. Compared to the baseline scenario, private consumption falls by over 1% in 2030. Compared to the scenario without ETS extension to road transport and heating of buildings, total imports from the EU and third countries will fall, while exports will only increase from the SR to other V4 Member States in 2026.

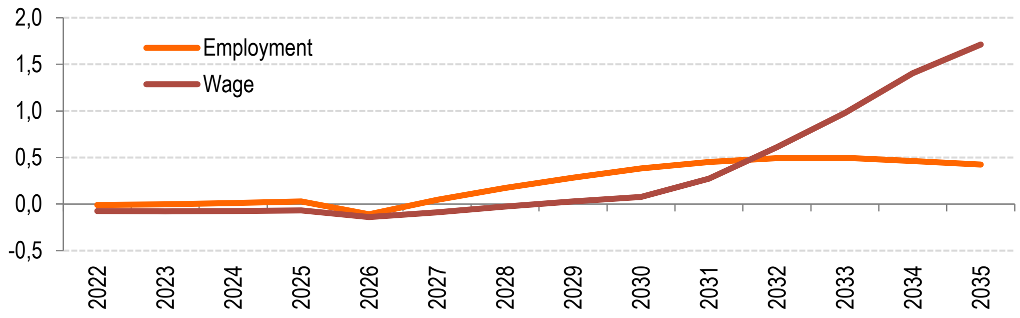
Graph 9: Impact of ETS extension on real GDP, private consumption and total investment in the Slovak Republic (%)



Source: IEP according to MEK

The extension of the ETS to road transport and building heating in 2026 will lead to an increase in real wages and employment after an initial slight decline. Both wage and employment growth will be driven by investments in energy efficiency, which will create new jobs with a higher share of employment of less skilled labour. Compared to the baseline scenario, labour demand is expected to be about 0.1% lower in 2026 and almost 0.4% higher in 2030. Real wages will be about 0.14% lower in 2026 compared to the baseline scenario but will be almost 0.08% higher in 2030 and up to 1.7% higher in 2035.

Graph 10: Impact of the ETS extension on real wages and employment in the Slovak Republic (%)



Source: IEP according to MEK

As a result of decarbonisation, fossil energy sources will be replaced by renewable energy sources and investments in energy efficiency will boost production, particularly in the iron and steel and building materials sectors. Coal-fired power generation will gradually decline, with a roughly 96% decline in 2030 compared to the baseline scenario. Gas-fired power generation will also decline, falling by more than 30% in 2030 compared to the baseline scenario. The decline in fossil fuels will also negatively affect refineries, whose output will also be reduced as internal combustion engine cars are replaced by electric cars. Compared to the baseline scenario, refinery production will be more than 7% lower in 2030 and almost 15% lower in 2035. At the same time as fossil energy production declines, production from renewable energy sources such as wind, solar and geothermal will increase. Compared to the baseline scenario, both solar and wind electricity generation will increase by around 77% in 2030. As a result of the increase in energy efficiency investments, which also include building renovations, output in the iron and steel, non-metallic mineral products and non-ferrous metals sectors will increase by around 16%, more than 3% and 0.2% respectively in 2030 compared to the baseline scenario.

Box 2: Macroeconomic model (MEK) and energy system model of Slovakia (CPS)

Models, available to the IEP thanks to the collaboration with the World Bank on the preparation of the Low Carbon Study, were used to analyse the impacts of more ambitious targets. There are two models, a macroeconomic model (MEK) and an energy system model (CPS). The MEK (Macroeconomic Energy and Climate) model works with macroeconomic indicators and describes the behaviour of individual production and consumption sectors such as industry, households, and foreign countries. The CPS (Compact PRIMES Slovakia) model describes the behaviour of the energy system in Slovakia including all entities that handle energy, such as industry, electricity generation, the third sector, households and transport. The MEK together with the CPS model of the energy system were used to model emission reduction scenarios in the Low Carbon Study of the Slovak Republic (MoE, 2019) and the Low Carbon Development Strategy of the Slovak Republic (MoE, 2020).

The Compact-PRIMES energy system model (CPS) is a partial equilibrium model for the energy sector of Slovakia. It models the decisions (technologies used, power plant position, fuel switching, etc.) for energy supply and demand in Slovakia and at the same time guarantees the equilibrium of these decisions due to their impact on the price. Thus, the model predicts the prices of different forms of energy directly from the minimization of the supply price and its effects on demand. As such, the model does not have an overall optimization function, instead balancing supply and demand, leading to an overall economic optimum and the lowest energy price for the end user. **The CPS is useful for quantifying long-term energy planning and policies to reduce energy related GHG emissions.**

In the area of demand, the model simulates choice decisions (e.g., technology, fuel, or investment choices) for industry, transportation, households, and other demand. Losses due to transmission and distribution of electricity and heat are also included. On the supply side, it addresses optimal construction, expansion, or decommissioning at the plant level. It also takes into account technical and operational constraints such as fuel availability, water availability (for hydropower plants), etc. The model then calculates the power system costs and based on these, the electricity prices for the different demand sectors. These prices are then used on the demand side and all the previous steps are iteratively repeated, thus providing a feedback loop between supply and demand. At the same time, equilibrium energy constraints ensure that the demand for all forms of energy such as electricity, heat, steam, biomass and hydrogen is met by their supply.

The Macroeconomic Energy and Climate (MEK) model complements the energy model, using detailed results from the CPS energy model and assessing their economy-wide impacts. This model belongs to the recursive-dynamic general computable equilibrium models (Van der Mensbrugghe, 2017). It was developed by the World Bank, with which Slovak experts worked on its adaptation to the conditions of the Slovak economy.

In the model, producers are represented who minimize their production costs; consumers, on the other hand, maximize their utility. In addition to basic macroeconomic indicators, the model estimates the amount of emissions produced by the activities of each sector. The results of the model show how the sectors interact with each other and the impacts of the measures and policies put in place on the sectors. For a given input setting of the economy, the simulation results in an equilibrium state where the optimisation conditions of each sector represented are satisfied. **The two models are interlinked and so the macroeconomic impacts of measures affecting the energy system modelled by the CPS can also be evaluated.**

The Reference Scenario is a no-action baseline scenario based on the European Commission's 2016 Reference Scenario and shows the development of the economy and energy system without the introduction of additional climate-supporting policies after 2020. We use this scenario in order to compare it with scenarios that foresee the introduction of measures that lead to decarbonisation. We have adjusted the baseline scenario for the new quantities of free allowances as well as for the new ETS prices, which have been increased compared to the original ones to EUR 75 per tCO_2 in 2025, EUR 90 per tCO_2 in 2030 and EUR 105 in 2035.

Dcarb2 is the main decarbonisation scenario of the Low Carbon Study and was also used in the Low Carbon Strategy as a scenario with additional measures (WAM). This scenario takes a balanced approach to achieving both energy efficiency and renewable energy targets.

Dcarb2+FF55 is the scenario developed in the CPS energy model and, compared to Dcarb2 on which it is based, assumes an extension of the ETS to the household and transport sectors, stricter transport emission standards resulting from the Fit for 55 package and higher ETS allowance prices, as in the updated baseline scenario. The expected prices of emission permits in the new household and transport sectors were modelled with the same values as the ETS prices (EUR 75 per tCO_2 in 2025, EUR 90 per tCO_2 in 2030 and EUR 105 in 2035. We compare it with the updated reference scenario and not with Dcarb2, as Dcarb2 has extensive building and transport measures in place as a significant decarbonisation scenario in its own right. These will be strengthened by the extension of the ETS to buildings and transport, but it is not possible to examine the isolated impacts of this measure.

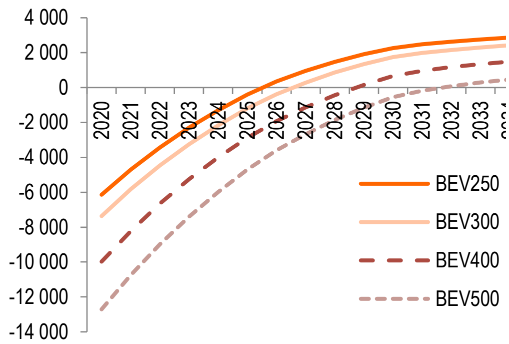
2.2 Financial balance of CO2 neutrality of new vehicles

The Fit for 55 package represents a commitment to 100% share of zero-emission vehicles in new vehicles by 2035. The first to be introduced are stricter CO_2 emission standards for cars and vans, which should accelerate the transition to zero-emission vehicles by requiring new cars to reduce emissions by 55% from 2030 and by 100% from 2035. The European Commission forecasts that by 2030 there will be around 30 million zero-emission vehicles on Europe's roads (Carroll, 2021; Deloitte Central Europe, 2021). However, the infrastructure for their recharging (electric vehicles) or refuelling (hydrogen-powered vehicles) is insufficient. To facilitate the transition to zero-emission vehicles, the EU has set a target of charging stations every 60 km on motorways.

Currently, there are mainly two types of alternative propulsion produced for the purpose of reducing emissions - electric and hydrogen. Much more prominent in the forecasts, and in the current market, are electric vehicles, which we divide into fully electric and plug-in hybrids. Although innovations in the direction of zero-emission alternative fuels could allow vehicles with internal combustion engines already in use to be powered by renewable sources in the future, electric cars are for the time being the most acceptable alternative to reduce emissions from road transport and are favoured even by the largest traditional car companies in their plans (Carroll, 2021).

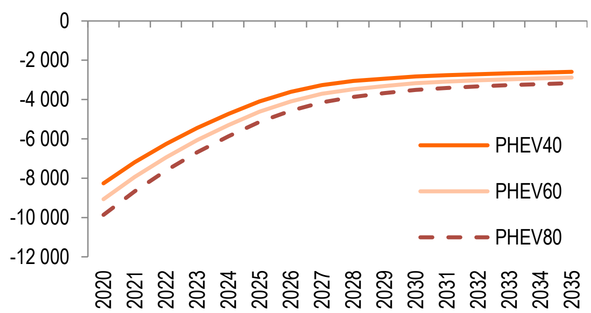
The price of batteries has a major impact on the competitiveness of electric vehicles and is expected to fall significantly. Currently, the price of electric vehicles is higher than that of internal combustion vehicles, but due to falling battery prices, all-electric vehicles are expected to become cheaper than internal combustion vehicles before 2031 (Graph 4) and plug-in hybrids after 2035 (Graph 5). Based on the ICCT models, so-called purchase price parity will be achieved between fully electric (BEVs) and internal combustion vehicles (ICEVs) between 2025 and 2031, depending on their size and range (note: BEV250 - 250 km range; PHEV40 - 40 km range) (Lutsey, Cui, & Yu, 2021). After this period, their price will continue to fall. It looks different for plug-in hybrids (PHEVs) as their price is less dependent on the price of batteries. They are expected to fall in price more slowly and are therefore likely to be still more expensive than internal combustion engines by 2035. Sales of new cars of both types (internal combustion and plug-in hybrids) will cease this year.

Graph 11: Price difference fully el. and combustion cars (eur)



Source: Lutsey, Cui and Yu (2021)

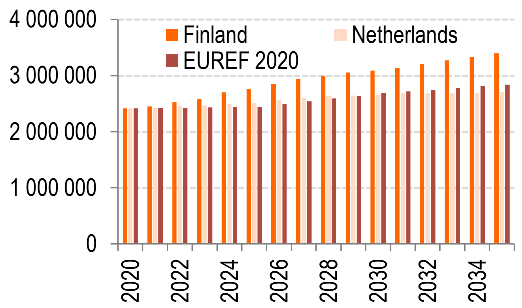
Graph 12: Price difference plug-in hyb. and combustion cars (eur)



Source: Lutsey, Cui and Yu (2021)

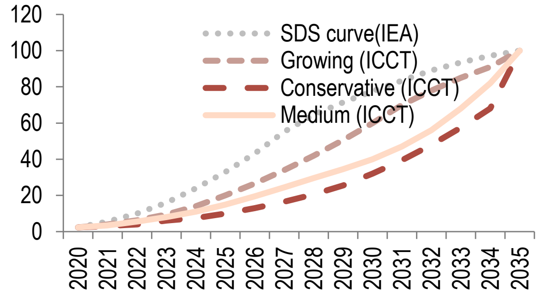
The Slovak fleet in 2035 may have up to 3.4 million cars. Motorization (number of passenger vehicles per 1000 inhabitants) in Slovakia has been growing for a long time and is linked to the level of GDP per capita (GDPpc). After comparing the similarity of the development of historical GDPpc parity of European countries with the value of GDPpc of Slovakia in 2020 and the projected value of GDPpc in 2035 per capita, we can determine the upper and lower scenarios of motorisation. The upper scenario is based on the development of the number of cars in Finland and corresponds to a country with long distances where the number of cars is expected to be high and for Slovakia would be 3.4 million cars in 2035, which is 40.8% more than in 2020. The lower scenario is derived from the development of motorisation in the Netherlands and reflects a smaller country with a well-developed network of alternative modes of transport, which would mean 2.7 million cars in 2035. According to the EC's EUREF 2020 EU energy system models, there could be 2.8 million cars in Slovakia in 2035 (European Commission, 2021). This comprehensive model includes the legislative commitments made to reduce emissions in 2020 and presents a possible sectoral decarbonisation breakdown to meet these commitments. If other sectors are decarbonised more significantly, a higher motorisation of Slovakia is possible. Given the expected infrastructure development and the potential for alternative modes of transport, we consider mainly the development of the upper scenario. The fleet renewal rate, the ratio of new vehicles to total vehicles, has averaged 5.16% over the last 5 years. This figure, together with the age of de-registered vehicles, influences the average age of a vehicle. Slovakia is one of the oldest countries in the EU, with an average age of more than 13 years.

Graph 13: Development of motorisation in Slovakia (number)



Source: IEP, Eurostat, World Bank , OECD

Graph 14: Electric car sales trend



Source: IEP

The biggest impact on the financial balance of the transition to electric vehicles for Slovak households is the trend of sales of individual types of electric vehicles and the construction of the necessary infrastructure. We model the evolution of the car fleet to 2035 based on Lutsey, Cui, and Yu (2021) and data for the Slovak Republic (Lutsey, Cui, & Yu, 2021). The main parameters are the motorization trend, the share of EVs in new vehicle sales, the evolution of the share of PHEVs in EVs, the preferred range, and the overall car fleet renewal rate. We present six scenarios that capture the differential rapid uptake of EVs, the decline in the composition of plug-in hybrids, and the state of charging infrastructure. The speed of EV uptake is influenced by subsidies, for example, especially in the early years when EVs are more expensive than cars with internal combustion engines. Developing charging infrastructure is key to the preference for EV commuting. In each scenario, we assume that all new cars sold in 2035 are fully electric.

The eventual high share of plug-in hybrids on electric vehicles will mean higher household costs by 2035. Scenario A represents the interest of households and the private sector in maximising short-term utility. There is a slow growth of electric cars and the share of PHEVs in the EV market for new cars remains at current levels. The high share of PHEVs and their higher price will cause Slovak households to pay EUR 206 million more than if they were buying cars with internal combustion engines.

With a slight reduction in the share of plug-in hybrids in electric vehicles, Slovak households could save up to EUR 65 million by 2035. Scenario B, in contrast to Scenario A, presents a slow decline in the share of PHEVs in new cars and represents a plausible scenario without intensive infrastructure and electric car support. Consumers are looking to capitalise on the growing charging station infrastructure and the concomitant potential drop in fuel prices driven by the substitution effect. In Scenario F with lower motorisation, this would be a saving of EUR 15 million.

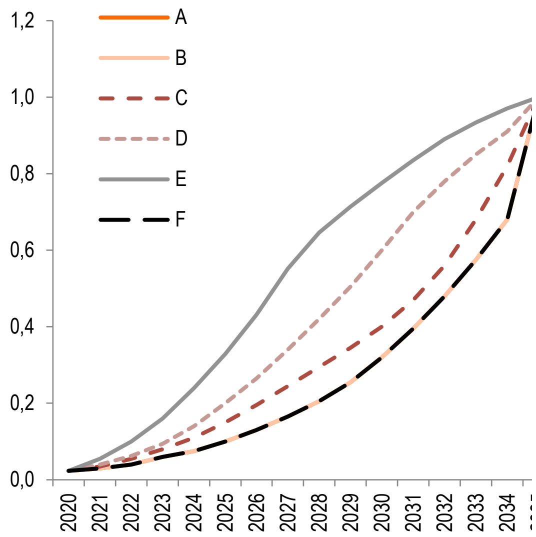
Table 11: Impacts of selected scenarios

	Scenario A	Scenario B	Scenario C	Scenario D	Scenario E	Scenario F
	With low support for e-cars and infrastructure	**Moderate support for e-cars, high motorisation**	**High infrastructure support**	**High support for e-cars, low infrastructure**	**High support for e-cars and infrastructure**	**Moderate support for e-cars, low motorisation**
Motorisation trend	Finland	Finland	Finland	Finland	Finland	The Netherlands
Electric car sales trend	Conservative	Conservative	Medium	Growing	SDS curve	Conservative
Vehicle range	Pref. higher	Significantly higher	Pref. lower	Significantly higher	Pref. lower	Significantly higher
PHEV share declines	No change	Slow	Slow	Fast	Fast	Slow
Number of fully electric. (2030)	108,357	141,826	194,589	383,670	570,676	125,377
Proportion of fully electric (2030)	3.51 %	4.59 %	6.30 %	12.43 %	18.48 %	4.71 %
Number of plug-in hybrids (2030)	101,866	68,397	95,356	22,019	35,280	61,293
Share of plug-in hybrids (2030)	3.30 %	2.22 %	3.09 %	0.71 %	1.14 %	2.30 %
Financial balance in euros (2035)	- 206 mio.	65 mio.	901 mio.	- 56 mio.	1.8 bil.	15 mio.
Balance per car purchased euros (2035)	- 87.30	27.53	381.74	- 23.57	770.03	7.30

Source: IEP

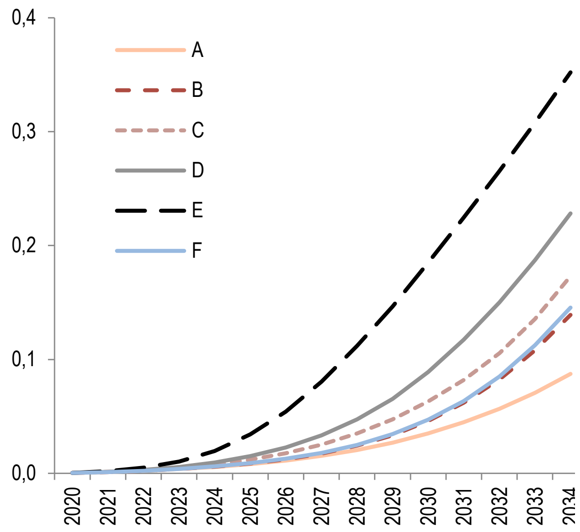
The financial benefits of buying electric vehicles grow with better infrastructure. Scenario C includes significant infrastructure support, allowing consumers to purchase more electric vehicles with shorter ranges that are more cost-effective. Therefore, there will be potential household savings of up to EUR 900 million. Scenario E represents an ideal situation in which there is a rapid and significant infrastructure boost and also support for fully electric vehicles with savings of up to EUR 1.8 billion. In Disadvantageous Scenario D, there is a rapid uptake of fully electric cars, but due to a lack of infrastructure support, consumers prefer more expensive cars with a longer range.

Graph 15: EV share of new cars in scenarios



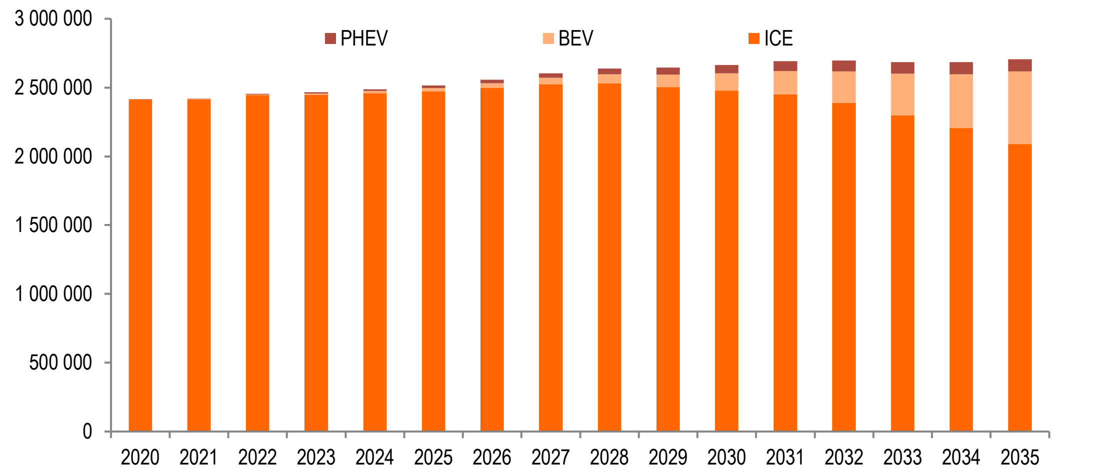
Source: IEP

Graph 16: Share of fully electric cars in the fleet by scenario



Source: IEP

Graph 17: Fleet development under scenario B



Source: IEP

2.3 Carbon border adjustment mechanism

The amount of free allowances is currently high in some sectors, which impairs the functioning of the EU ETS pricing mechanism, as producers are not sufficiently incentivised to meet environmental targets due to the excessive amount of free allowances. The free allowances are intended to encourage EU businesses not to relocate their operations to countries outside the EU with lower environmental standards, which would lead to lower investment in the EU and higher global emissions. However, the free allocation of allowances often does not provide the most effective solutions for changing production practices towards low-carbon technologies.

As part of the Fit for 55 package, the European Commission has unveiled a carbon border adjustment mechanism (CBAM), the so-called 'carbon tax', to be introduced in 2026 (Dumitru, Kölbl, & Wijffelaars, 2021)**.** A carbon tax is an alternative to measures aimed at addressing the risk of carbon leakage under the EU ETS. The aim is to prevent the Union's efforts to reduce emissions from being neutralised by an increase in emissions outside the EU due to relocation of production or increased imports of lower carbon intensity products. A carbon tariff will encourage producers in non-EU countries to green their production processes.

Carbon pricing under the CBAM will contribute to levelling the playing field for domestic and foreign producers, ensuring equal treatment of EU and imported products. Importers will be able to benefit from the same level of free emission allowances as EU producers. If the non-EU producer can prove that it has already paid the price for the carbon used in the production of the imported goods, the cost can be fully deducted (European Commission, 2021). When the mechanism is fully implemented, the duty will be levied on the full volume of carbon contained in the products. Importers will buy carbon certificates with a price corresponding to the carbon price that would have been paid if the goods had been produced under EU rules. The amount of carbon tax paid will thus depend not only on the current ETS price, but also on the difference between the carbon intensity of production (more in Box 4) in the importing country and the share of emissions within the EU benchmark covered by free allowances (European Commission, 2021).

The carbon duty will thus be calculated as follows:

$$\boxed{\textit{Carbon tax}} = \left(\boxed{\textit{Import emissions } (tCO_2/t \textit{ product})} - \boxed{\text{Free emission allowances } (\textit{tCO}_2/t \textit{ product})}\right) \cdot \boxed{\textit{Import to the EU (in t)}} \cdot \boxed{\textit{Price of the EU ETS}} - \boxed{\textit{Price for carbon paid in the exporting country}}$$

CBAM will introduce a levy on imports of cement, aluminium, fertilisers and iron and steel products into the EU. The main criterion for the selection of goods was the cumulative GHG emissions of a particular sector, as well as the degree of exposure of the sector to the risk of carbon leakage. The total volume of greenhouse gases covered by the EU ETS is limited by a 'cap' on the number of emission allowances (European Commission, 2021). European Free Trade Association countries are exempted due to participation in or linkage to the EU ETS. The carbon tax focuses on direct emissions from the production process (Scope 1), although the scope could also be extended to indirect emissions from energy purchases (Scope 2) and other indirect value chain emissions (Scope 3) after a transition period ending in 2025.

Although the CBAM will also apply to imported electricity, imports from third countries account for only about 3.4% of domestic electricity consumption, a significant amount of electricity imported into the EU comes from countries that already pay for carbon (Marcu, Mehling, & Cosbey, Border Carbon Adjustments in the EU: Sectoral Deep Dive, 2021). The CBAM will apply to electricity from countries wishing to integrate their electricity markets with the EU until these markets are fully integrated (European Commission, 2021). If technical solutions cannot be found to ensure the application of the CBAM to electricity once the markets are integrated, these countries should benefit from the carbon tax exemption until 2030 at most, and only if they commit to implementing a carbon pricing mechanism that ensures the same price as the EU ETS while achieving carbon neutrality by 2050 (European Commission, 2021). Therefore, the impact of the introduction of a carbon tax on the energy sector can be expected to be limited compared to other CBAM sectors. The introduction of CBAM on electricity imports should not have a significant impact on Slovakia either, as electricity from non-EU countries is imported to Slovakia only to a minimal extent from Ukraine. After the start-up of the Mochovce nuclear power plant, electricity production in Slovakia will increase significantly, with Slovakia exporting 12.3% of the electricity produced in 2025 and roughly 10.7% of the electricity produced in 2030 (Ministry of Economy of the Slovak Republic, 2021).

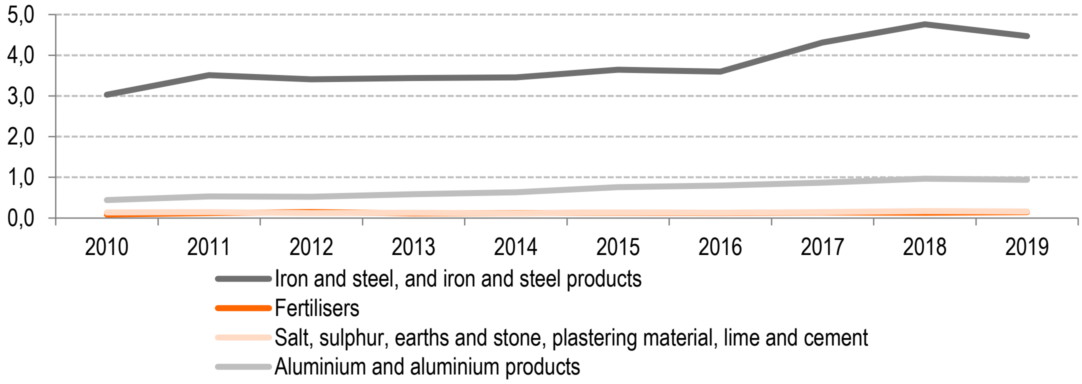
Between 2026 and 2035, the allocation of free allowances for CBAM products will be continuously reduced by ten percentage points each year (Stibbeblog, 2021). The carbon tax is due to enter into force in January 2026 after a three-year transition period during which only data will be collected, while ensuring a smooth roll-out of the mechanism to reduce the risk of disruptive effects on trade. During the transition period, importers should report quarterly on actual sequestered emissions in imported goods, detailing direct and indirect emissions and any carbon price paid abroad. In 2035, no more free allowances will be issued for the production of products covered by the carbon tax. A faster reduction in the amount of free allowances may translate into increased costs for domestic producers and may also be reflected in the prices of European products.

Table 12: Planned development of free allowances in the period 2026-2035 for CBAM products

	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Free allowances	90 %	80 %	70 %	60 %	50 %	40 %	30 %	20 %	10 %	0 %

Source: (European Commission, 2021)

Graph 18: Development of imports into the Slovak Republic for selected CBAM products (billion



Source: Statistical Office Of The Slovak Republic

The introduction of the CBAM will support domestic producers, but with the accelerated decline in the amount of free emissions, the costs of domestic production will also rise. The carbon tax will not be fully implemented until 2035, which means that the amount of free allocation in the steel, aluminium, fertiliser and cement sectors will be zero in that year. The highest prices can be expected in 2035, which is thus also an important year for our analysis. The results of the macroeconomic energy-climate model used (more on modelling in Box 3) for both GDP and employment show that the positive effect of introducing a carbon tariff will be largely negated by the effect of reducing the amount of free emissions. The final effects on GDP and employment in both the EU and Slovakia are thus moderate.

Box 3: Carbon tax in the macroeconomic model

The macroeconomic energy-climate (MEK) model, which is one of the recursive-dynamic computable general equilibrium models, is used to assess the results of the scenarios (Van der Mensbrugghe, 2017). The MEK model works with macroeconomic indicators and describes the behaviour of different production and consumption sectors, such as industry, households, foreign countries (more on the MEK model in Box 2). The effect of introducing a carbon tax is modelled by examining the differences between the two scenarios. These are the baseline scenario, which describes the business-as-usual (baseline) situation, and the carbon tax scenario itself. The baseline scenario is the updated MEK scenario from the Low Carbon Study (MoE, 2019) with the current ETS prices (EUR 75 per tCO_2 in 2025 and EUR 90 per tCO_2 in 2030) and the share of free allowances by sector. The carbon tax scenario is based on several assumptions, which we outline in the rest of this box.

In the carbon tax scenario, we are specifically interested in cement, aluminium, fertilisers, iron and steel, on which a carbon tariff is being imposed. With the exception of iron and steel, these products in the model are part of manufacturing industries that also include other products. In the MEK model, when calculating the impact of the introduction of a carbon tax on the production of steel, fertilisers, cement and aluminium, we have taken into account the share of imports of these products from non-EU countries within the relevant manufacturing sectors. In the case of fertilisers, this is the manufacture of basic chemicals, rubber and plastics products, which also includes paints, varnishes and plastics, among others. Fertilisers, thus, account for around 0.3% of total imports from third countries to Slovakia within the sector concerned. In the case of cement, the sector includes non-metallic mineral products, which includes, inter alia, porcelain and ceramic products. Cement accounts for roughly 6.9% of total imports from non-EU countries to Slovakia within the non-metallic mineral products sector. Aluminium belongs to the non-ferrous metals sector, which also includes, for example, copper and lead. Aluminium accounts for roughly one third of total non-ferrous imports from third countries to Slovakia.

Table 13: Share of imports from non-EU countries in the MEK sector in 2020

	Sector MEK model	SR	EU
Steel	Iron and steel	100 %	100 %
Fertilisers	Chemicals, rubber and plastic products	0.3 %	1.6 %
Cement	Non-metallic mineral products	6.9 %	4.2 %
Aluminium	Non-ferrous metals	33.5 %	19.16 %

Source: Eurostat (DS-1060915)

Table 14: Share of imports of goods in total imports from non-EU countries in 2020

	Steel	Fertilisers	Cement	Aluminium
SR	1.17 %	0.34 %	0.05 %	0.02 %
EU	1.38 %	0.77 %	0.04 %	0.23 %

Source: Eurostat (DS-1060915)

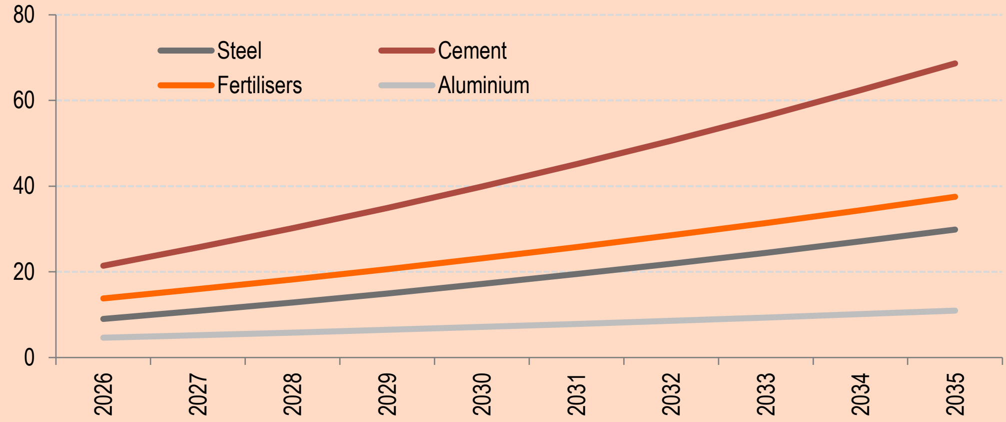
Producers who minimize their production costs and consumers who maximize their utility are represented in the model. In addition to basic macroeconomic indicators, the model estimates the amount of emissions produced by the activities of each sector. The results of the model show how the sectors interact with each other and the impacts of different measures and policies on the sectors. With a given input setting of the economy, the simulation results in an equilibrium state where the optimization conditions of each sector represented are satisfied. The comparison is made against a baseline scenario without the introduction of new custom duties on goods, with more modest reductions in tax-free quotas in sectors under CBAM.

Table 15: Price per tonne of steel, aluminium, ammonia and aluminium (euros)

	Steel	Cement	Fertilisers (ammonia)	Aluminium
Price per tonne (EUR)	526	108	620	2611

Source: IEP

Graph 19: Increase in the price of imported CBAM products as a result of the introduction of the carbon tariff (%)



Source: IEP

Table 16: ETS price (euros per tonne of CO2 emissions)

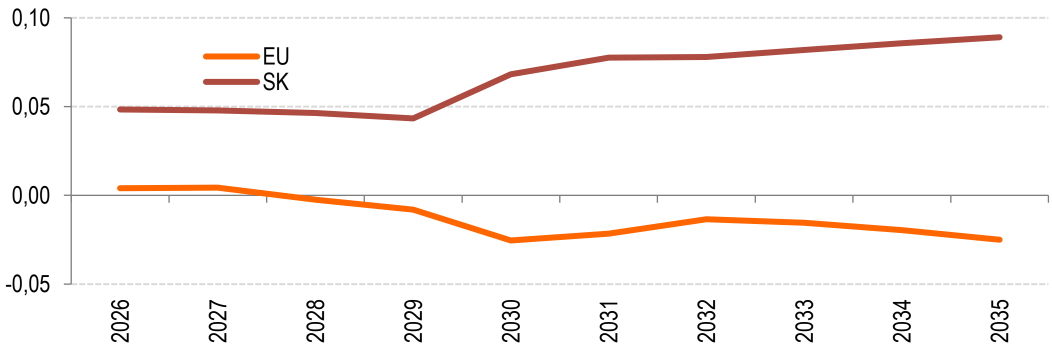
	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
ETS Price	78	81	84	87	90	93	96	99	102	105

Source: IEP

The rate of increase in import charges depends on the price of the ETS as well as the carbon intensity of production in the country from which the product is imported into the EU. We explain the method of calculating carbon intensities for imported CBAM products in more detail in Box 4. For the ETS price, we assume a linear increase between 2026 and 2035 with a price of EUR 78 per tonne of CO_2 in 2026 and EUR 105 per tonne of CO_2 in 2035. We also assume that the amount of free emissions in CBAM sectors will gradually decrease from 2026 onwards, reaching zero in 2035. Increasing import taxes on these goods will increase their price to domestic buyers. Once higher prices are introduced into the model, an alternative scenario will arise, which will cause a deviation from the equilibrium path of development. The model then finds a new equilibrium state of the economy that differs from the baseline scenario. The results of this scenario do not take into account the cumulative effects of the other parts of this analysis, but only reflect the effects of the introduction of a carbon tax.

The introduction of a carbon tax should have a slight negative impact on the EU real GDP and a slight positive impact on Slovakia's real GDP. Compared to the baseline scenario, the European economy could be about 0.03% smaller in 2035, while the Slovak economy could be 0.09% larger. GDP at current prices will increase significantly for both the EU and Slovakia as a result of the increase in the price level. The introduction of CBAM will have only a marginal impact on exports, decreasing by 0.16% by 2035 compared to the no-carbon-tax scenario. **The modelling results are valid under the assumption that third countries do not impose retaliatory taxes.**

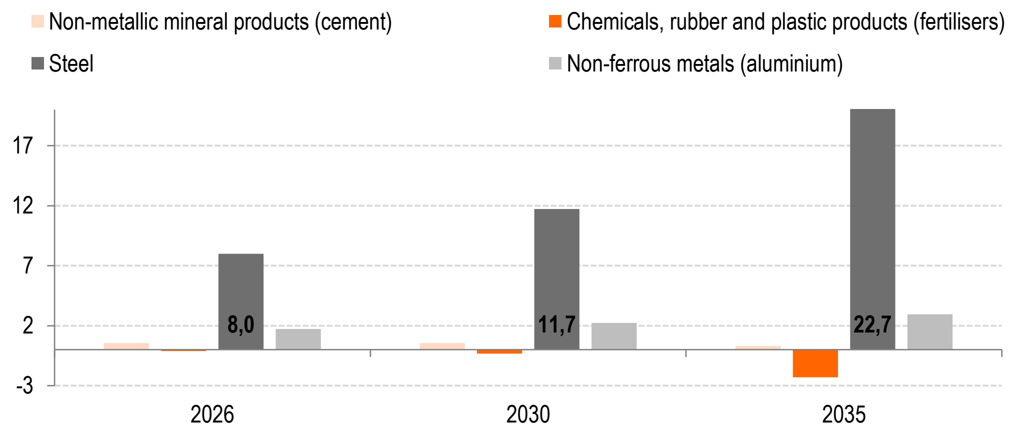
Graph 20: The impact of a carbon tax on real GDP in the EU and Slovakia in 2026-2035 (%)



Source: IEP according to MEK

As a result of the introduction of the carbon tax, the largest change in output in Slovakia will be in the steel production sector, whose output will be almost 23% higher in 2035 compared to the baseline scenario. The increase in the price of CBAM products is the result of both reduced volume of imports, where the demand for domestic production will increase compared to more expensive production from third countries, as well as a decrease in the amount of free emissions in the CBAM sectors. Domestic firms in the steel, aluminium and cement sectors will respond to higher prices by increasing production. In the case of steel, we anticipate the largest increase in production, with steel production expected to grow by up to 22.68% in 2035 compared to the baseline scenario, which could also benefit U.S. Steel Košice, which employs around 12,000 people (Strapáč, 2018). We assume that non-ferrous metal (aluminium) production is projected to grow by 2.94% in 2035 compared to the baseline scenario. The change in the production of non-metallic mineral products (cement) in Slovakia will be the smallest of all CBAM products. Compared to the baseline scenario, the production of non-metallic mineral products will increase by only 0.31% in 2035. In the chemicals, rubber and plastics (fertilisers) sector, we forecast that the quantity produced will be about 2.31% lower in 2035. The decline in output in this case is due to lower demand as a result of the increase in fertiliser prices.

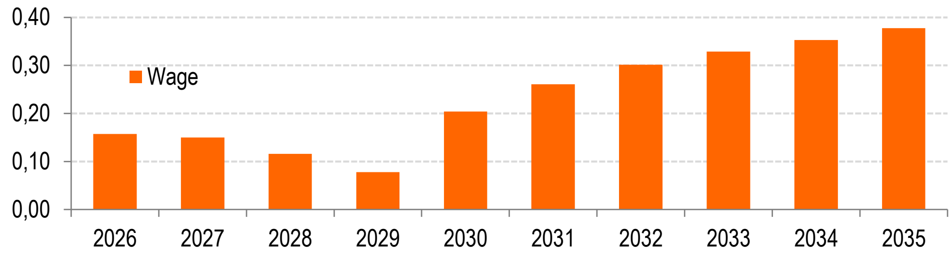
Graph 21: Impact of the introduction of a carbon tax on the output of sectors in the Slovak Republic between 2026 and 2035 (%)



Source: IEP according to MEK

The increase in the price of CBAM products together with the increase in the price of electricity may have a negative impact on the automotive industry in Slovakia. In addition to the increase in the prices of steel, aluminium, fertilisers and cement, we also expect an increase in the price of electricity, which is an important input production factor in many sectors of the economy. Compared to the baseline scenario, its production will be about 1.9% higher in 2035. We expect production in the motor vehicles and parts sector to fall by around 1.2% in 2035 compared to the baseline scenario due to the increase in input prices. This is because steel represents a significant production input for the automotive industry. In the machinery and equipment manufacturing sector, we expect a decline in output of around 2.5% compared to the scenario without the carbon tax. In other economic sectors, we expect that higher input costs in manufacturing should not have significant negative effects on production.

Graph 22: Impact of the introduction of a carbon tax on real wages in the Slovak Republic

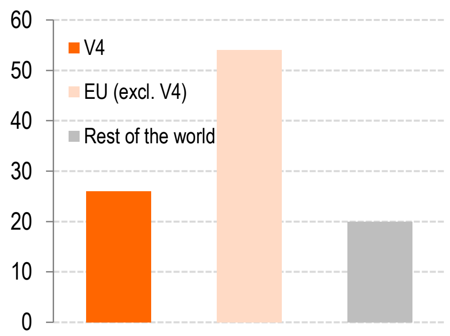


Source: IEP according to MEK

The impact of the introduction of a carbon tax on real wages will be slightly positive for Slovakia due to higher production. As higher productivity in manufacturing will put upward pressure on wages, we expect real wages in Slovakia to be 0.38% higher in 2035 compared to the scenario without the carbon tax. Higher producer costs and consequently higher product prices will push Slovak products out of non-EU markets due to lower competitiveness. However, steel and aluminium production in Slovakia will increase due to higher prices of imported CBAM products. This is also due to the fact that Slovak exports are generally concentrated in the EU, where Slovakia exports up to about 80% of its production. At the same time, we expect that the introduction of the carbon tax will further increase Slovak exports to the EU by around 0.45% in 2035 compared to a scenario without the carbon tax.

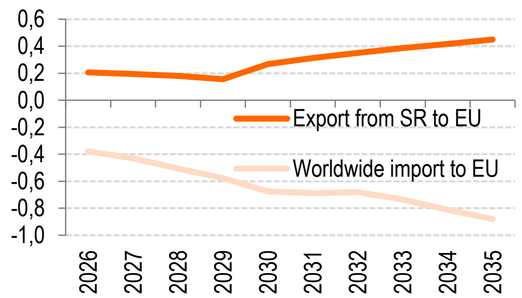
Graph 23: Slovakia's exports and the impact of the introduction of the carbon tax on imports from the world to the EU and exports from Slovakia to the EU

Exports from Slovakia for 2021 (%)



Source: IEP according to MEK

Impact of the introduction of a carbon tariff on



Source: IEP according to MEK

The introduction of a carbon tax due to increased production in Slovakia will increase the annual production of CO_2 emissions. Without additional tightening of conditions for domestic producers, Slovak carbon dioxide emissions would increase by about 0.57% in 2026, 0.49% in 2030 and 0.62% in 2035 compared to the baseline scenario. The increase in CO_2 emissions in Slovakia is driven by an increase in cement, aluminium and steel production, which are still significant sources of emissions despite the introduction of cleaner technologies. In the EU, although CO_2 emissions are expected to increase by 0.01% in 2026 compared to the scenario without a carbon tax, they will be around 0.24% lower in 2030 and 0.03% lower in 2035. The different dynamics of CO_2 emissions development in the EU compared to Slovakia is based on the fact that for the EU the model results do not assume such a high increase in production in the CBAM sectors as in the case of Slovakia. In order to reduce CO_2 emissions in Slovakia, despite the increase in production in Slovakia compared to the baseline scenario, it is necessary to pursue a targeted decarbonisation of Slovak industry with direct support for investments in new technologies.

Once fully implemented, the CBAM is expected to raise roughly EUR 1 billion annually from the carbon tax, which should be used to support decarbonisation in developing countries (Sánchez, 2022)**.** The introduction of a carbon tax is associated with possible negative impacts on developing countries that currently export products to the EU on which the carbon tax will be imposed. The EU therefore expects that, after assessing the potential risks, to support the transition process that EU importing countries would have to undergo in order to adapt to the new carbon tax (European Commission, 2021). The funds would thus be used directly to decarbonise manufacturing industries in the developing world (Sánchez, 2022).

Box 4: Carbon intensity of production

The carbon intensity of production expresses the amount of CO_2 released into the atmosphere during the production process per unit of product. The carbon intensity depends on the technology of production, transport or the quality of the materials that go into production. The total carbon intensity of production does not include, inter alia, the electricity supplied in the production process or the heat if it is provided by a supplier who already pays for the emissions from the combustion of the fuel. The carbon intensity of production is key to the calculation of the carbon tax, the amount of which is based, in addition to the current ETS price, on the difference between the carbon intensity of production in the importing country and the share of emissions within the EU benchmark that remain covered by free allowances (European Commission, 2021). We obtained the average carbon intensity of production in the EU for each CBAM product as the ratio of total emissions to total production within the manufacturing industry for a given CBAM product. The total amounts of emissions are based on ETS data, and we have calculated the total output as the quotient of the assigned GHG emissions included in the benchmark and the Phase 3 benchmark (European Commission, 2021).

Blast furnace production is the most important steel production method in the EU, with electric arc furnace production accounting for around 26% of total steel production in the EU. While in the case of blast furnace production, steel is usually produced from iron ore, in the electric arc furnace it is produced from scrap metal, which contains iron in a higher concentration and also does not need to be stripped of impurities, causing the two production processes to have significantly different carbon intensities.

The production of a tonne of steel in a blast furnace releases on average around 2.01 t of emissions in Russia, Turkey and China, which together with Ukraine are the largest importers into the EU, compared to around 1.96 t in the EU. In the case of blast furnace steelmaking process, the carbon intensity includes emissions from coke production, pig iron production, iron casting or ore roasting. Russia has a relatively low carbon intensity of blast furnace production compared to the EU, mainly due to the better availability and higher proportion of natural gas in the production process. Turkey and China, as the second and third largest steel importers, have more emission-intensive blast furnace steel production compared to the EU.

Table 17: Carbon intensity of steel production in electric and blast furnace (tCO_2 / tonne of steel)

	EU	Russia	Turkey	China
Electric furnance	0.26	0.51	0.43	1.04
High furnace	1.96	1.85	2.06	2.35

Source: Hasanbeigi & Springer (2019); Tunç, et al. (2015)

The carbon intensity of steel production in electric arc furnaces in the EU is around 0.26 tCO_2 per tonne of steel, while for the largest EU importers it is on average up to around 0.49 tCO_2 per tonne of steel. The figure for the largest EU importers was obtained assuming constant electric arc furnace power consumption (Ohol, VK, Shinde, & Balachandran, 2019) and from international benchmarks for energy and carbon intensity (Hasanbeigi & Springer, How Clean is the U.S. Steel Industry? An International Benchmarking of Energy and CO2 Intensities, 2019). The carbon intensity of electric furnace steelmaking is about half that of Europe for Turkey. Russia has up to twice the carbon intensity of electric furnace steelmaking compared to the EU, while China has up to four times as much.

China has the largest share of blast furnace steel in the total amount of steel produced, where up to 94% of the total amount of steel is produced in the blast furnace. For the EU and Russia, the share is 74% and 69% respectively. Only Turkey produces more steel in the electric furnace, where it accounts for 66% of the total amount of steel produced, as a result of which steel production in Turkey is on average less carbon intensive than in the EU.

Table 18: The share of a given type of steel with respect to the method of production

	EU	Russia	Turkey	China
Electric furnance	26 %	31 %	66 %	6 %
High furnace	74 %	69 %	34 %	94 %

Source: Hasanbeigi & Springer (2019); Tunç, et al. (2015)

Table 19: Total (EU) production and imports of steel by production method (in tonnes)

	EU	Russia	Turkey	China
Electric furnance	34,645,131	1,503,234	1,212,215	90,700
High furnace	97,055,412	3,345,907	572,959	1,420,963
Total	131,700,543	4,849,141	1,685,174	1,511,663

[1]For imports into the EU, the country-specific representation of steel production has been used for Russia, Turkey and China.

Source: Hasanbeigi & Springer (2019); Tunç, et al. (2015)

As there are no significant technological differences in the production process for cement, there are also no significant differences in carbon intensity between EU and non-EU producers. We included cement production from both grey and white clinker in the total carbon intensity of cement production. A comparison between the EU and Turkey, which is the largest importer of cement into the EU, shows that for every tonne of clinker, the EU produces about 0.81 tonnes of emissions, while the same carbon intensity applies to Turkey (Cementis Gmbh, 2018). **In the case of fertilizers, we considered ammonia, which is the main and most emission-intensive raw material in the production of all nitrogen fertilizers.** Russia is the largest importer of ammonia into the EU, so we compared the carbon intensity of ammonia production in the EU and Russia. In the EU, the production of a tonne of ammonia releases on average roughly 1.95 tonnes of emissions into the atmosphere, while in Russia it adds up to approximately 2.22 tonnes (Hoxha & Christensen, 2019).

Table 20: Comparison of carbon intensities of the production of CBAM products (tCO_2/t of product)

	Slovakia	EU	Import
Steel (blast furnace)	1,995	1,960	2,010
Cement (clinker)	0.760	0.810	0.810
Aluminium	1,776	1,640	2,720
Ammonia	1,570	1,950	2,220

Source: Hoxha & Christensen (2019); Cementis Gmbh (2018); The Carbon Trust (2011); Hasanbeigi & Springer (2019); consult. with industry

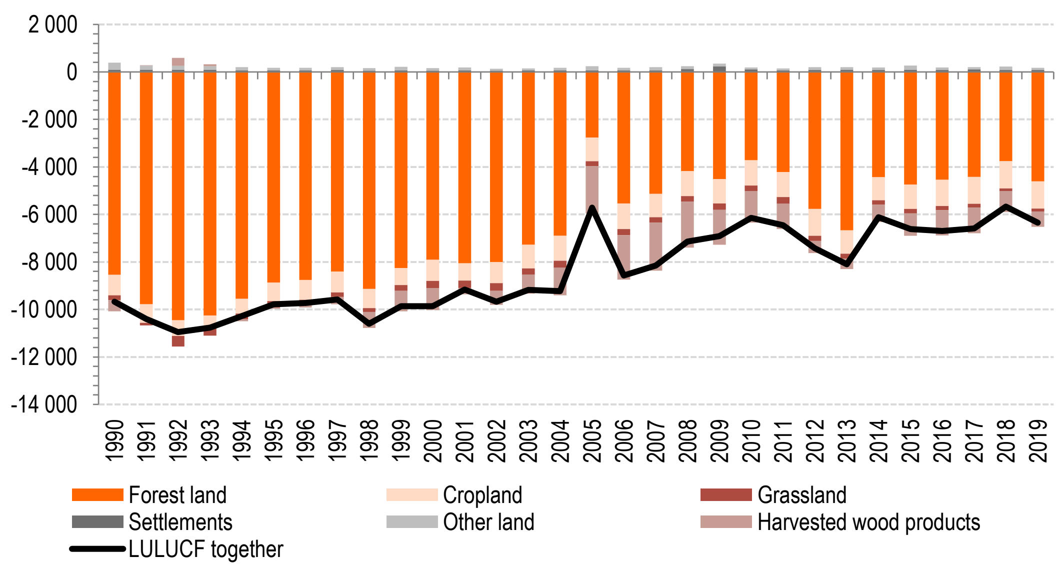
Aluminium production in the world is significantly more emissions-intensive than in the EU. We obtained the carbon intensity of aluminium production worldwide from a report by The Carbon Trust (The Carbon Trust, 2011), where from the total 11.9 tons of emissions during aluminium production, we subtracted process emissions from bauxite mining and alumina refining, which are already included in the carbon intensity within other production processes. We then further reduced the new figure by the indirect emissions resulting from electricity consumption. A subsequent comparison between the global carbon intensity of aluminium production and that of the EU shows that while the EU produces on average 1.64 tonnes of emissions per tonne of aluminium, the global average is 2.72 tonnes of emissions.

2.4 Revision of the Land Use, Land Use Change and Forestry Regulation

The LULUCF sector is unique in its ability to reduce overall greenhouse gas emissions by storing atmospheric CO_2 in vegetation, soil and wood. LULUCF[11] is a greenhouse gas inventory sector that covers emissions and removals of greenhouse gases from human activities in land use, land-use change and forestry. Forests in Slovakia provide more than 2/3 of the CO_2 sequestration in this sector, while agricultural landscapes, permanent grasslands and harvested wood products also provide sequestrations. In contrast, net emissions are produced by forest fires, soil mineralisation due to land use change and biomass burning after forest harvesting.

Total removals in the LULUCF sector have been declining since 1990, with average removals for 2010-2019 35% lower than in 1990-1999. The largest decline occurred in the category of forests, which is related to increased logging, the age structure of forests (ageing stands and a higher proportion of new stands) and increased incidental logging (e.g. as a result of wind calamities or dieback of spruce forests after intensive infestation by bark beetles). Increased harvesting is reflected in a higher share of harvested wood and wood products on the hauling sites, which increased up to 4 times. In the agricultural land category, there was a 44% increase in captures. Captures in the permanent grassland category decreased due to a decrease in the area of grassland. Emissions from the other countryside and settlements categories remain relatively stable. The LULUCF sector is one of the sectors in which changes are slow to take effect, often decades later. Examples include increasing land afforestation or planting new forests, where trees have very little wood mass gain during the first 10 to 20 years of their life, with minimal impact on increasing carbon sinks.

Graph 24: LULUCF removals and emissions for Slovakia from 1990 to 2019 (ktCO_2eq.)



Source: IEP according to OSN and IPP

Slovakia has one of the highest LULUCF capture targets in Europe and 85% higher than the EU average. In the current proposal, the Slovak Republic has a proposed LULUCF sequestration target for 2030 of -6.8 MtCO_2eq, which is the second highest per unit area after Luxembourg. Within the V4, Slovakia's target is significantly higher than the other countries, with neighbouring Austria's target being as much as 52% lower.

[11] Land Use, Land Use Change and Forestry – land use, land use change and forestry.

Table 21: Comparison of forest cover and LULUCF targets for selected countries

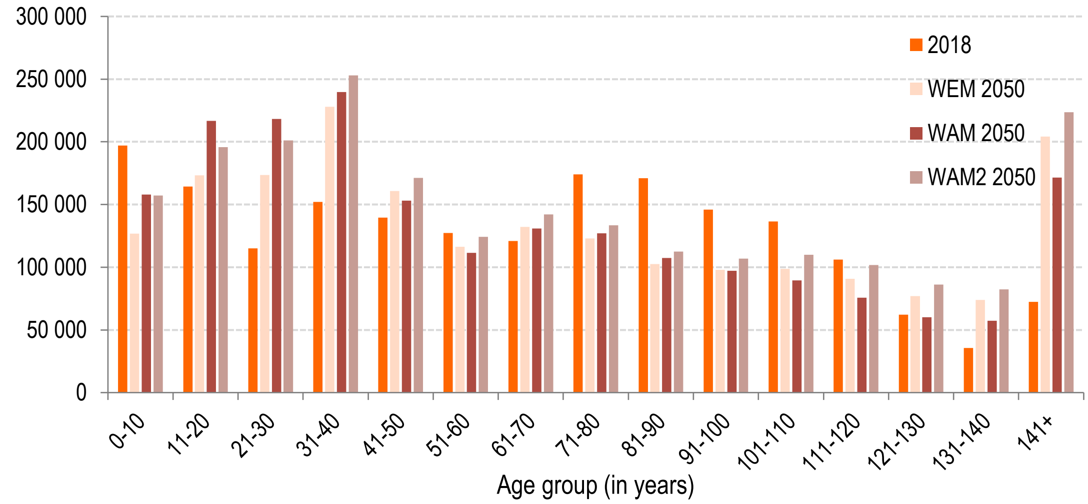
Country	Forest cover (%)	LULUCF objective (t/km^2)	share of the Slovak objective
Czech Republic	34.7	-15.6	11 %
Hungary	22.5	-64.0	45 %
Austria	47.3	-67.4	48 %
EU average	**38.6**	**-76.8**	**54 %**
Poland	31.0	-121.8	86 %
Slovakia	40.1	-141.8	100 %

Source: IEP according to World Bank and National Forest Centre Of The Slovak Republic

Calculating capture ratios from the three-year average introduces a large degree of uncertainty. The national targets are based on average removals in 2016-2018, calculated to an overall target of 310 MtCO2eq. based on the land area of each state. The method of setting national targets places a greater burden of capture on states with higher captures in the past, while not reflecting their capture potential in the future. The most abundant forests in Slovakia are in age stages 1 and 2 (1-20 years old) and age stages 8 and 9 (71-90 years old). Stage 1 and 2 forests are still young and their ability to capture carbon is minimal, which is a problem because forest captures are projected to decline until the young forests are mature, which will take decades.

In order to achieve this goal, Slovakia will have to fundamentally rethink its current approach to forest management. Forests in the 8th and 9th age stages (the age stage is 10 years) are at an ideal age for regeneration, i.e. timber harvesting. To meet the Fit for 55 objectives, it will be necessary to reduce regeneration of the forest at the cutting season. Slovakia already has a large part of forests in the 15th age stage, which are almost exclusively in national parks and protected areas. Unless harvesting is reduced, especially after 2030, when forestry actors are planning for more significant restoration, it will be difficult to meet the targets, as confirmed by the modelled scenarios (see Box 5 for more details).

Graph 25: Change in forest age structure (age groups) for WEM and WAM scenarios (ha)



Source: IEP according to National Forest Centre Of The Slovak Republic

Box 5: Modelled scenarios and methodology for LULUCF measures

The projections in the Forests category use outputs from the FCarbon model[12], which is being actively developed by the National Forestry Centre. The FCarbon model is used to predict the future age structure,

[12] https://web.National Forest Centre of the Slovak Republic.org/?page_id=17445&lang=en

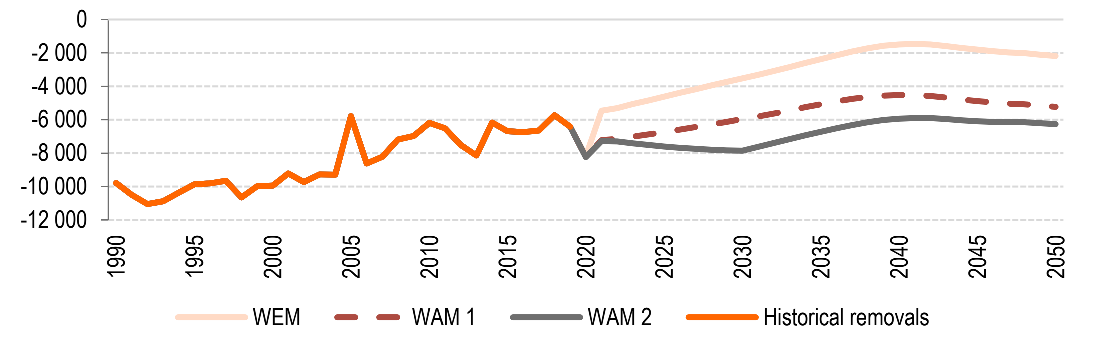
stock, harvest and increment of even-aged forests based on growth tables. As inputs, it is the initial age structure (area of 10-year age stages) according to tree species, their stock, value, and shading. Due to data availability, the model is calibrated for the years 2014-2019. Projections of emissions and removals are for the three desired development scenarios, WEM and WAM1 and WAM2, where:

- The Existing Measures Scenario (WEM) includes policies and measures adopted by the end of 2020 and their effect on LULUCF emissions/removals from 2020 onwards. The WEM scenario mainly includes afforestation of unused agricultural land, establishment of fast-growing tree plantations on agricultural land, grassing of agricultural land and measures to reduce fires. All measures are based on the Rural Development Programme (RDP), the National Forestry Programme (NFP) and the Low Carbon Strategy.
- The scenario with additional measures (WAM1) represents the LULUCF scenarios with applied measures after 2020. WAM1 includes protection and enhancement of stand resilience as well as increasing forest cover through afforestation of agricultural land not used for agriculture and additional measures to prevent deforestation. Measures to increase carbon sequestration in agricultural soils have also been taken into account in the development of the WAM1 scenario.
- The WAM2 scenario is developed as more ambitious in terms of increasing CO_2 sinks in the LULUCF sector mainly through reduced logging. It contains three additional measures. The first is the extension of the no-deforestation regime to 75 % of the area of the national parks, i.e. an area of approximately 130,000 ha. This would bring the total number of non-protected areas to 130 hectares by 2030 compared to the current situation. The second measure is to reduce the volume of incidental logging through forest protection measures from a steady-state peak of 5.5 million m^3 in 2020 to 4.4 million m^3 in 2030. This measure has the greatest impact on LULUCF targets of the additional measures in WAM2. The third, and least, important measure is to increase the forest area by settling and including non-forest woody vegetation (so-called white areas) in forest land in the range of 100 thousands ha by 2030.

The FCarbon model used has several known limitations, primarily it is designed to simulate the evolution of even-aged forests (all tree species in it are of the same age). Therefore, it only supports understorey and clearcutting harvesting methods and is not suitable for simulations of other management methods favouring a different age structure of stands (e.g. selective management and nature-based forest management in general). For now, FCarbon does not contain an algorithm for applying natural tree mortality and there are no restrictions on the upper age of stands. Thus, it is not able to simulate the natural decay of forest stands at the top age stages and the conversion of living biomass to dead wood and its subsequent decomposition. It also lacks a natural disturbance module. Therefore, it is not designed for simulations of carbon cycles of a no-interference regime of forest development. Uncertainty is also introduced by the use of currently valid growth tables, which may prove inaccurate in long-term projections as a result of climate change. Another Slovak specificity is the land not used for agriculture that is spontaneously overgrown with forest vegetation (so-called white areas), for which there is a lack of data accurately describing its age and species composition. For the WAM2 scenario they are therefore included on the basis of expert estimates, in the future they will already be included on the basis of detailed georeferenced land use data, which should start to be used in the next two years.

Only the most ambitious WAM2 scenario is projected to meet the LULUCF target. Under the original WAM scenario (WAM1), removals in 2030 would amount to just under 6 Mt CO_2 eq. The WAM2 scenario foresees removals of almost 7.9 Mt CO_2 eq by 2030, which is almost 16% higher than the national target. In the original WEM scenario, removals in 2030 would be only 3.5 Mt CO_2 eq., which is about half of the Slovak target. The National Forestry Centre assumes that in case of the WAM 2 scenario, the harvesting will stabilise around the level of 8 million m³ followed by a slow growth caused mainly by the previous afforestation and the growth of the forest area in Slovakia. The WEM baseline scenario assumes that logging will continue to grow after 2030, with a possible decline after 2040.

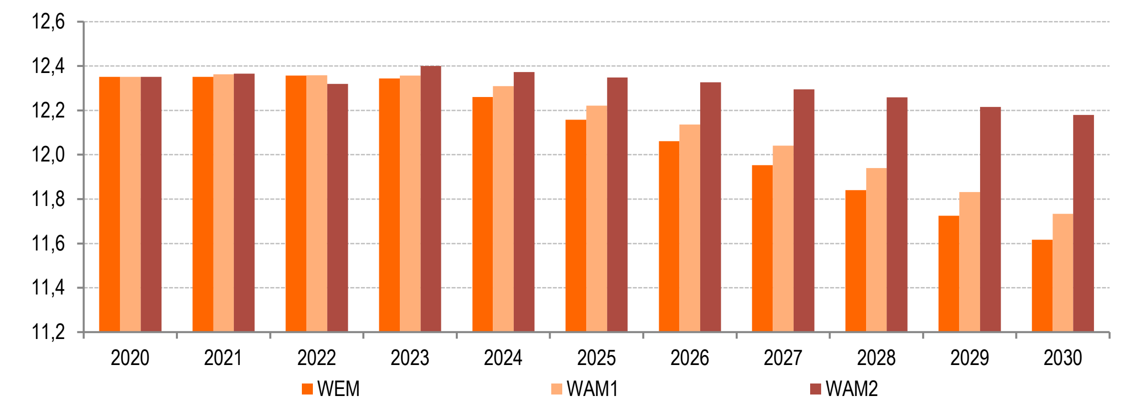
Graph 26: Result of WEM, WAM1 and WAM2 scenarios for LULUCF capture projections (kt



Source: IEP according to National Forest Centre Of The Slovak Republic

The National Forestry Centre (NFC) predicts that timber stocks will decline in the coming years and decades. Declines are expected to occur under both scenarios, mainly due to a gradual change in the age structure of forests. Primarily, the proportion of young forests up to 50 years of age should increase and the proportion of forests with an age of 80-120 years should decrease. In recent decades, the share of conifers, which are more productive, has also been declining significantly, while the share of broadleaves has been increasing. In 1980, coniferous forests accounted for more than 42% of all forests, today it is only 36% and this figure is decreasing every year. The decline is mainly due to the breakdown of spruce monocultures as a result of climate change and the associated wind and lycopodium calamities.

Graph 27: Evolution of wood increments under WEM and WAM scenarios (mio. m³)



Source: IEP according to National Forest Centre Of The Slovak Republic

The modelling of carbon captures and emissions assumes a certain degree of generalisation, so the projections may not correspond to actual future developments. It is, therefore, necessary to continuously evaluate the implementation and take adequate measures accordingly. In the WAM2 scenario, these are the main risks:

- According to NLC, the modelled additional measure to reduce the impacts of natural disturbances, and thus the volume of incidental harvesting, is dependent on future support and timely implementation of forest protection measures against harmful agents. In the absence of support or other obstacles to the timely implementation of these measures, NLC believes that it is not realistic to expect the benefits of this additional measure to be captured.

- The evolution of climate change and the occurrence of weather extremes may partially affect tree growth and reduce the accuracy of modelled measures.
- Failure to achieve the modelled proportion of intervention-free areas by 2030 may change the results.
- The model does not take into account the impact of a change in forest management towards nature-based management.
- The slower rate of conversion of so-called white areas (already forested agricultural land), while not affecting their actual catches, does affect the accuracy of the modelling results.
- The extension of the EU ETS to the buildings sector is likely to lead to a switch from coal to biomass heating in many households, which will increase the demand for wood.

The model assumes a continuous decline in agricultural land, mostly at the expense of forests. Slovakia had approximately 1.5 million hectares in the agricultural land category in 2020. Both the WAM2 and the WEM scenarios assume a decline in agricultural land equally until 2040**.** The rate at which farmland will be lost should increase over the years. This process is mainly due to afforestation of unused land.

Afforestation is expected to continue at an increasing rate under all scenarios. The WEM scenario assumes afforestation (land conversion to forest) above 2,000 ha, WAM2 with almost 2,500 ha per year. This growth is expected to continue and reach up to more than 3,000 ha per year in 2050. This is an ambitious target, as over the last 30 years, forest land has grown by an average of 1,603 ha per year, but cropland has only grown by 993 ha per year (Ministry of Agriculture and Rural Development of the Slovak Republic, 2021). It is necessary to ensure that the planned increments are not achieved by administrative actions alone through transcription of so-called white areas (already forested agricultural land) into forest land. Otherwise, more restrictions on planned harvesting will be necessary to achieve the objective.

Reducing deforestation will also contribute to achieving the target. Between 1990 and 2020, Slovakia experienced an uneven level of deforestation (forest changing to another landscape type) with an average deforestation of 301 ha. In order to increase captures, it is necessary that there is no significant deforestation, WEM2 assumes a stable deforestation of less than 200 ha per year and WAM2 foresees a continuous decrease of deforestation below 100 ha per year before 2025. The size of the Residences and Other Land categories assume the same growth for both the WAM2 and WEM scenarios. The smallest changes are expected to occur in the Forest Fire and Wetlands categories.

Sinks also increase carbon storage in long-lived wood products such as building and carpentry products at the expense of shorter-lived products such as firewood and paper**.** While the carbon storage time for paper products is 2 years, for wood panels it is 25 years and for lumber it is 35 years. Carbon is mostly released from wood products only after the product has been burned or decomposed. Increasing the share of long-lived wood products will need to be balanced against the expected higher demand for fuelwood as a substitute for fossil fuels.

In Slovakia, captures from arable land in 2019 were the highest in the whole EU. Arable land also sequestered carbon to a lesser extent in Slovenia and Hungary. By contrast, arable land was a net emitter of greenhouse gases in Austria, Poland or the Czech Republic. To understand the difference in removals in Slovakia and other EU countries, it would be helpful to check the methodology for calculating the carbon balance on arable land, which is carried out in Slovakia by the National Agricultural and Food Centre (NPPC). However, the low proportion of organic matter in soils in Slovakia indicates the potential to sequester carbon.

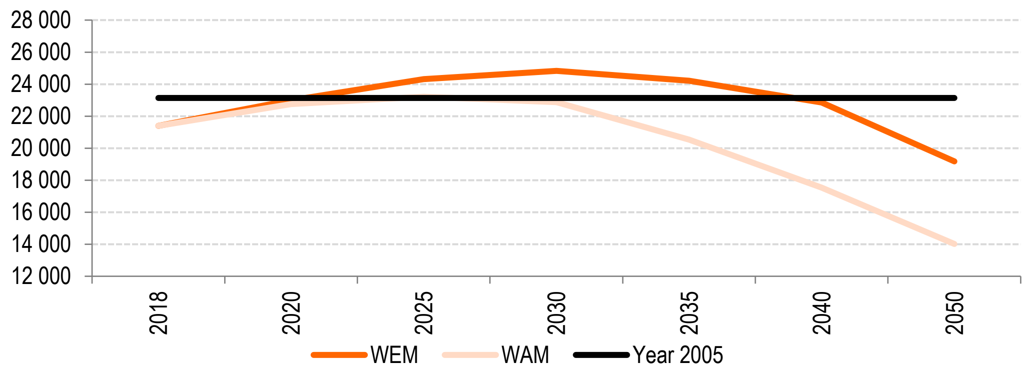
2.5 Objectives resulting from the revision of the Effort Sharing Regulation

The Effort Sharing Regulation (ESR) sets national targets for emission reductions in selected sectors. The ESR was established in 2018 and covers sectors outside of the ETS. The ESR ensures that all Member States contribute to EU climate action in a just manner and distributes the effort so that Member States with higher GDP per capita have higher emission reduction targets. The following sectors, or parts of sectors, are covered by the ESR and are not covered by the ETS:

- transportation,
- buildings[13],
- agriculture,
- construction and manufacturing,
- waste,
- volatile fuels sector,
- energy,
- industry,
- small-scale agriculture, forestry and fishing.

Slovakia has so far failed to meet the target for emission reductions in sectors under the ESR (or emissions outside the ETS). The current target foresees a 12% reduction in CO_2 equivalent emissions in 2030 compared to 2005. The –12% target has been increased to -20% in Envirostrategy 2030. The proposed Fit for 55 target is to increase this to 22.7%. Emissions projections are created for two scenarios. A scenario with existing measures (WEM)[14] only considers measures in place today, while the scenario with additional measures (WAM) assumes the introduction of additional measures in the near future that have an effect on reducing emissions. Based on the projections of the WEM scenario, emissions would increase by 7% in 2030 compared to 2005, and according to the WAM scenario, total emissions would reduce only by 1.14%.

Graph 28: Evolution of total ESR emissions for the WAM and WEM scenarios (ktCO_2e)



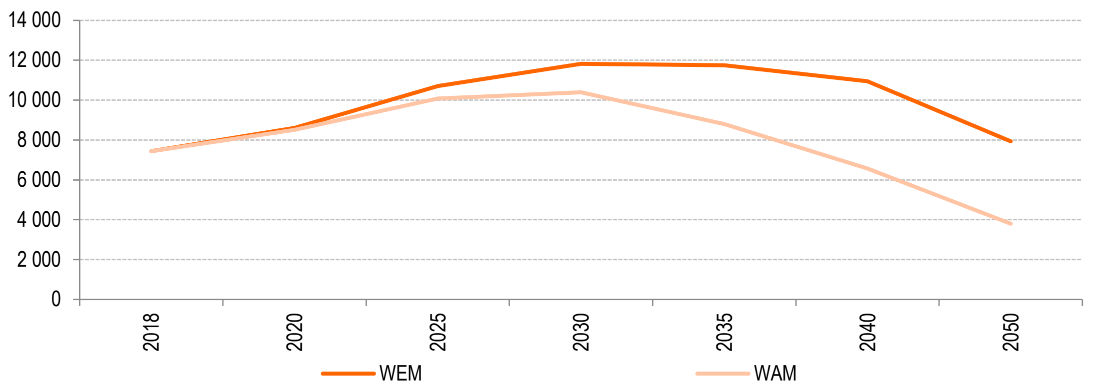
Source: Slovak Hydrometeorological Institute

The most problematic sector under the ESR is transport, which accounts for more than 40% of total ESR emissions and is set to grow in the coming years. Under the WAM scenario, emissions in the transportation sector are projected to grow by up to 40% by 2030 compared to 2018. The growth in emissions is driven by increasing mobility, rising car ownership and a very slow shift to alternative modes of transport. The first decline is not expected until after 2030 and emissions are not expected to fall below today's levels until around 2040. The subsequent decline could be rapid, with transport emissions reaching around 50% of today's emissions in 2050. In the WEM scenario, i.e. without additional measures, the level of emissions in

[13] Although the buildings and transport sectors will be reported under the ETS, they will also be reported under the ESR target.
[14] The list of measures used for individual sectors can be found at https://oeab.shmu.sk/app/cmsSiteBoxAttachment.php?ID=8&cmsDataID=0

2050 will still be around 7% higher than in 2018. The growth in emissions is also driven by the slow transition to electromobility, mainly due to an insufficient charging station network infrastructure.

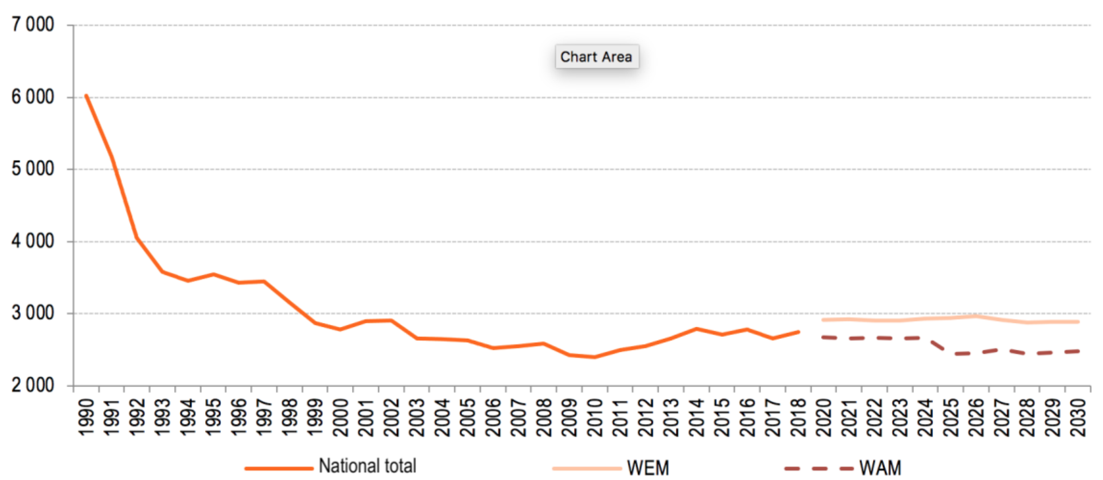
Graph 29: Evolution of transport emissions for the WEM and WAM scenarios (ktCO_2e)



Source: Slovak Hydrometeorological Institute

Agriculture has a significant influence on air quality and a significant impact on surface water and groundwater quality. The sector both captures and produces greenhouse gas emissions. The evolution of livestock numbers has had a significant impact on the reduction of GHG emissions and pollutants in this sector after 1990. The main reasons for the decline were the economic changes and the transformation of the sector after 1989. A further decline in livestock numbers can be observed after 2004, when Slovakia joined the European Union. However, this decline was of short duration, as since 2006 we have recorded a stabilisation of these numbers in addition to a continuous decline in dairy cow numbers (Grznár, M., Szabo, Ľ., Jankelová, N.). Additionally, due to subsidies received from the common budget of the EU, which have been earmarked to support European farms from the Common Agricultural Policy of the EU (SPP EU), the decline in livestock numbers has been mitigated and it is expected that there will be a stabilisation to a slight increase in numbers for some types of animals, while it is also expected that there will be an increase in the area of harvested crops (wheat, rye, oilseeds and legumes). With the further implementation of innovations and modernisation in livestock production after 2020, it can be assumed that, despite the increase in animal numbers, GHG and pollutant emissions will decrease after 2020, or their growth will not follow the growth curve of agricultural production.

Graph 30: WEM and WAM projections of greenhouse gas emissions in agriculture (ktCO_2e)



Source: Slovak Hydrometeorological Institute

The development of agricultural emissions is steady with a potential decline by 2030. The WEM scenario takes into account policies and measures adopted by 2020 that result in a 10% increase in emissions compared to 2005. This is a 52% decrease compared to 1990. The WAM scenario, which considers the application of additional measures, assumes a 6% decrease in emissions compared to 1990. The increase in emissions in the WEM scenarios after 2005 is due to the projected increase in yields per hectare in some of the crop production sectors, which will increase the consumption of applied nitrogen fertilisers, offsetting organic matter and nutrients to the soil in the form of applied plant matter. Emissions will continue to rise even if livestock production stagnates or there are no significant increases in livestock numbers. We expect grazing livestock (sheep, goats) to increase as a result of the planned promotion of pastoral livestock farming.

Table 22*: Trend in WEM projections of GHG emissions from agriculture (kt)*

Year	1990*	1995*	2000*	2005*	2010*	2015*	2020	2025	2030
CH_4	129,143	81.40	60.69	52.34	46.38	45.53	42.60	42.08	39.169
N_2O	9.13	4.77	4.04	4.31	4.00	4.98	5.93	6.06	6.07
CO_2	66.35	85.24	62.92	33.48	47.09	85.43	79,171	81.80	87.55

*GHG Inventory Source: Slovak Hydrometeorological Institute

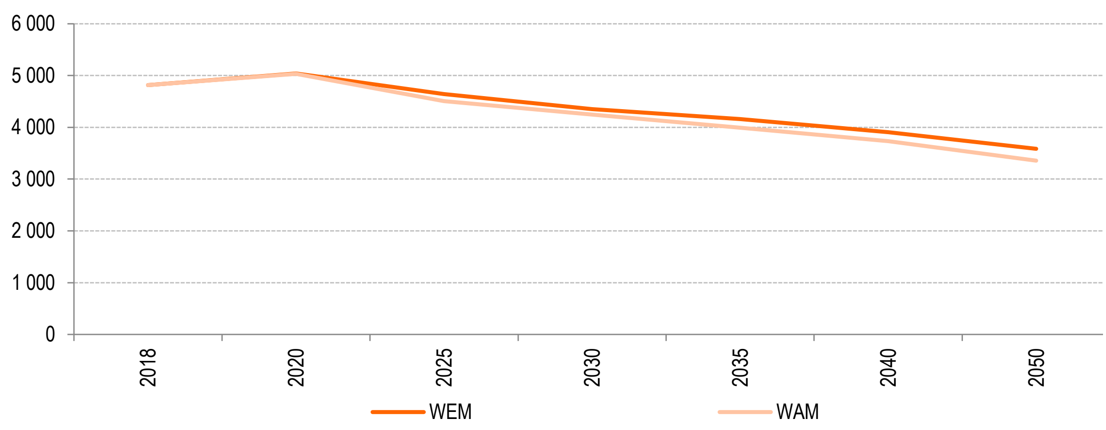
Table 23: *Trend in WAM projections of greenhouse gas emissions in agriculture (kt)*

Year	1990*	1995*	2000*	2005*	2010*	2015*	2020	2025	2030
CH_4	129,143	81.40	60.69	52.34	46.38	45.53	38.04	35.06	35.12
N_2O	9.13	4.77	4.04	4.31	4.00	4.98	5.52	4.99	5.11
CO_2	66.35	85.24	62.92	33.48	47.09	85.43	79,171	81.80	79,162

* GHG Inventory Source: Slovak Hydrometeorological Institute

The buildings sector accounts for around 10% of total greenhouse gas emissions, with a slight growth in recent years. These emissions were generated from general building operations and activities such as heating, hot water production and general household operations. A large portion of these emissions is the heating, which, in many cases, is inefficient. This efficiency can be increased by reducing heat losses, introducing more modern heating technologies, more efficient appliances, etc. Examples include insulating buildings or replacing windows, which can save up to more than half of the fuel needed for heating.

Graph 31: Development of ESR emissions in the building sector for WEM and WAM ($ktCO_2e$)

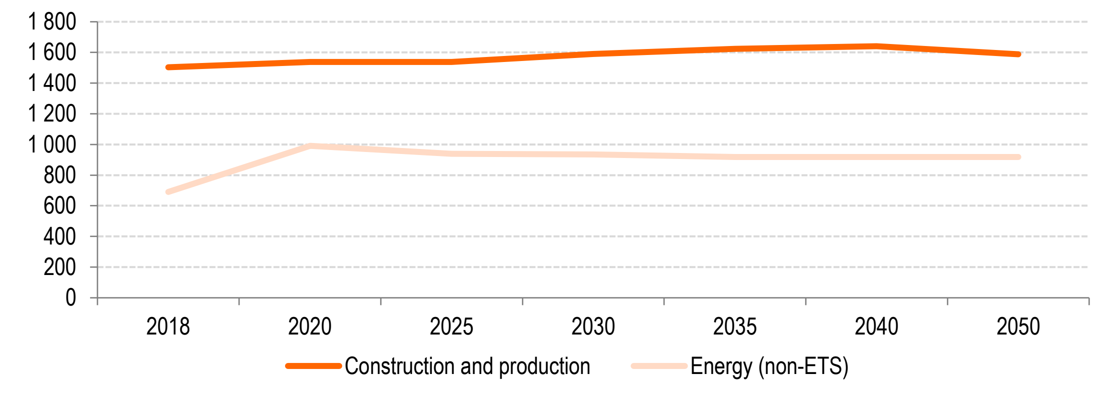


Source: Slovak Hydrometeorological Institute

Both WEM and WAM scenarios assume a similar trajectory of emission reductions in the buildings sector. Both scenarios foresee emission reductions of more than 30% by 2050 compared to 2020. The WAM scenario accounts for additional measures, namely more energy efficiency improvements, the development and the use of RES and a subsequent change in the energy mix. The decrease is mainly due to the reduction of losses and the streamlining of household operations.

Emissions growth is also visible in the non-ETS sections of the energy and construction sectors. The energy sector accounts for 3.5% and the construction sector for almost 6% of total emissions, with emissions in both sectors slowly growing. Emissions are expected to stabilise and then decline slowly in the energy sector and to grow slowly in the construction sector, driven by the rapid development of infrastructure and housing. The construction sector is expected to grow but will still use more environmentally friendly materials, instead of those with detrimental effects on the environment.

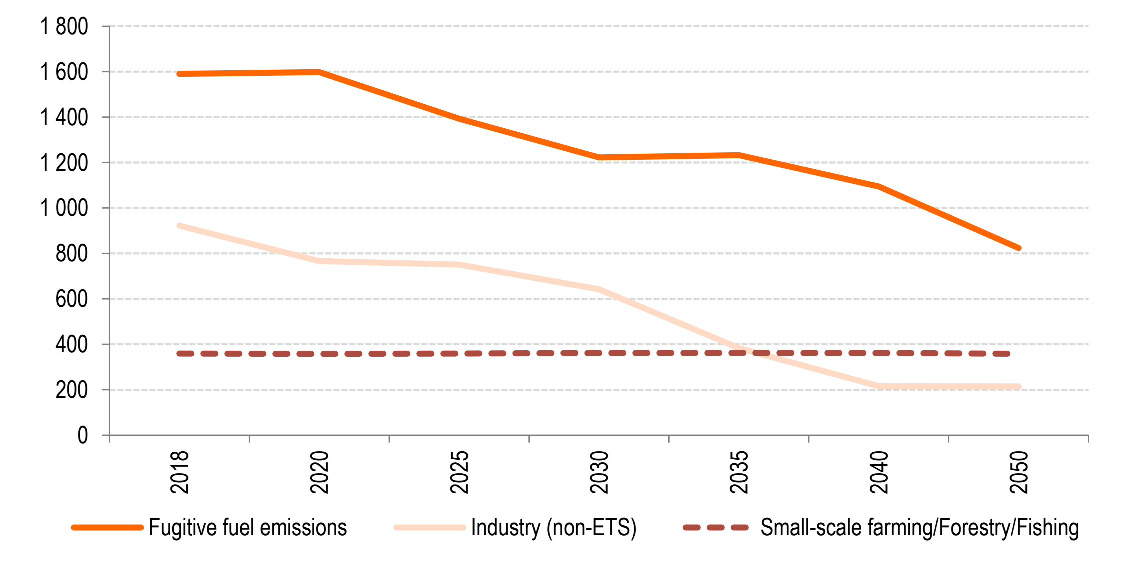
Graph 32: Development of ESR emissions in the construction and energy sectors (ktCO_2e)



Source: Slovak Hydrometeorological Institute

In other sectors, the trend is steady or declining. In other sectors of the ESR, emissions are projected to decline. For the non-ETS industrial sector and the volatile fuels sector, the decline is significant, with up to a 30% decline in the industrial sector and a 23% decline in the fuels sector by 2030.

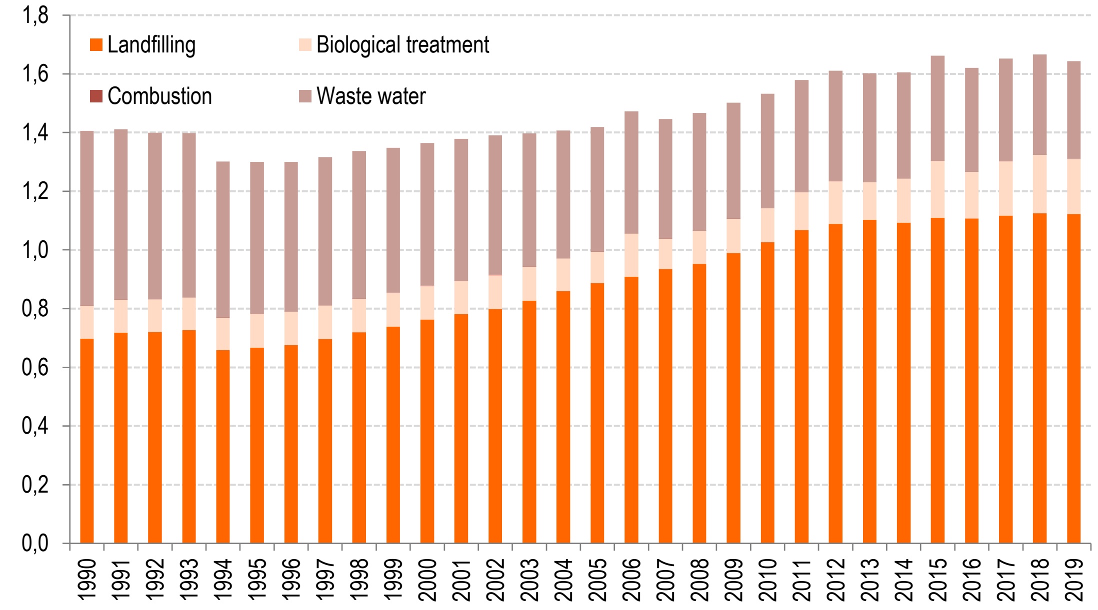
Graph 33: Evolution of emissions in other smaller sectors for the WAM scenario (ktCO_2e)



Source: Slovak Hydrometeorological Institute

The waste sector accounts for around 4% of greenhouse gas emissions and the trend has been increasing over the long term. Rising emissions in the waste management sector are also due to the overall rising standard of living, which results in higher waste production. Slovakia has a long history of high rates of landfilling of waste, where, especially in the case of bio-waste, methane emissions are generated, which has a significantly higher climate impact than CO_2.

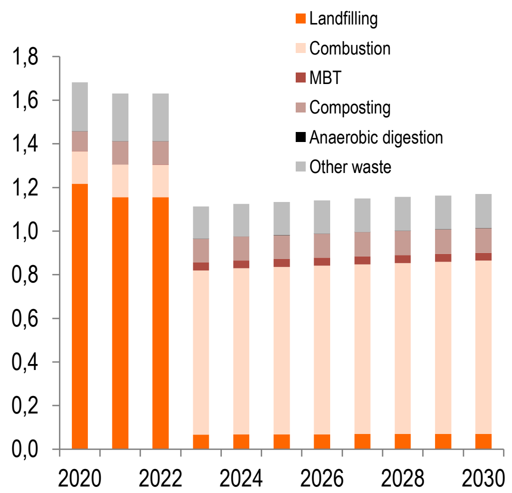
Graph 34: Development of greenhouse gas emissions in waste management (million tonnes



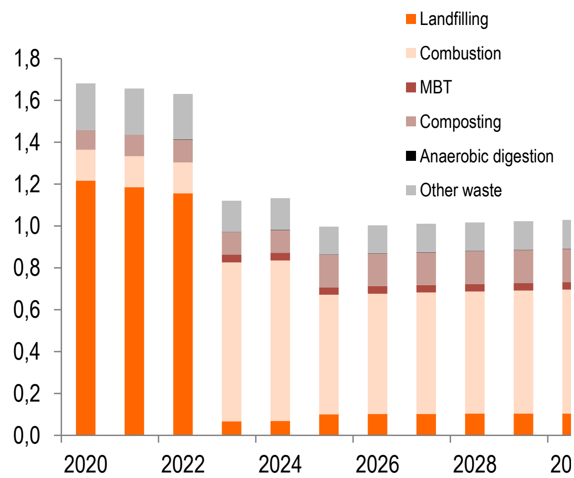
Source: IEP according to Slovak Hydrometeorological Institute

Both planned and potential additional measures in waste management will significantly reduce emissions in the sector compared to the reference year. Increasing landfill charges, sorted collection of kitchen bio-waste or pre-treatment of waste before landfilling will divert components that are responsible for a significant part of methane emissions away from landfills. The introduction of back-up of disposable beverage packaging has the potential to encourage recycling, thereby indirectly saving emissions that may have been generated by less desirable waste management methods. As additional measures, the impacts of the introduction of a quantitative collection of municipal waste and a more convenient collection of household bio-cooking waste have been modelled. The scenario with the planned measures leads to a 17.5% reduction in waste emissions by 2030 compared to 2005. In the scenario with additional measures, emissions are reduced by up to 27.4% over the same period.

Graph 35: Greenhouse gas emissions from waste - scenario with plan. measures (million tonnes CO2eq.)



Graph 36: Greenhouse gas emissions from waste - scenario with add. measures (million tonnes CO2eq.)



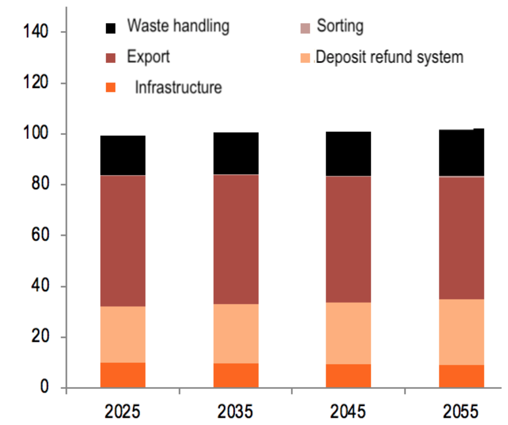
Source: IEP

Source: IEP

The possible increase in the share of energy recovery from municipal waste would result in this waste management method being utilized for the bulk of waste emissions. According to the amendment to the Waste Act from 2023[15], only the waste that undergoes treatment can be landfilled, which is likely to lead to increased energy recovery of waste. Higher potential reductions will require an increase in reuse and recycling at the expense of incineration. Measures to promote circular economy, waste prevention, and a preference for reusable or recyclable packaging can contribute to this.

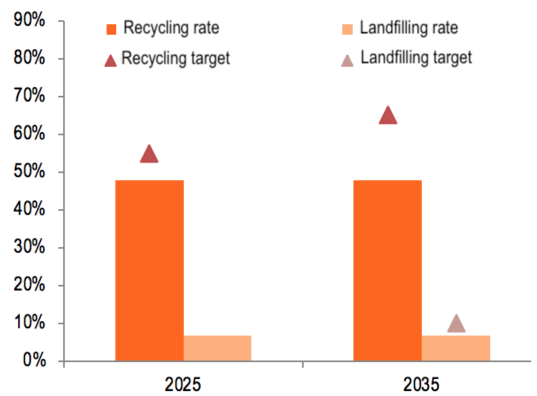
The planned measures will increase waste management costs by almost EUR 100 million per year but will not be sufficient to meet municipal waste recycling targets, although the landfill target should be met. We estimate that the introduction of the planned measures, such as collection of kitchen bio-waste, door-to-door sorted collection in family houses, deposit of disposable beverage containers and treatment of waste prior to landfill, will lead to an increase in costs of EUR 99.4 million per year compared to the no-measures baseline scenario, in which the costs amount to EUR 226 million per year. The increase will be mainly due to the introduction of sorted collection of kitchen bio-waste and mandatory treatment before landfilling, while landfilling costs will decrease by up to EUR 70 million per year. The recycling rate of municipal waste will increase to 48%, so the targets for the recycling rate in 2025-2035 would not be met. The landfill rate would fall to 7%, which corresponds to the 2035 target.

Graph 37: Costs of the planned measures compared to the baseline scenario (EUR million)



Source: IEP

Graph 38: Distance from targets in the scenario with planned actions

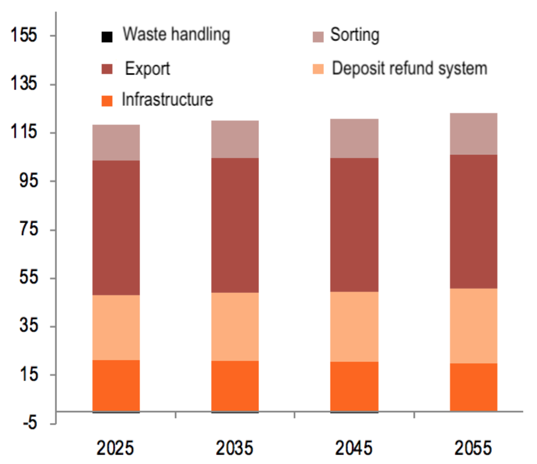


Source: IEP

The introduction of additional measures will increase recycling to 58% and the landfill rate to 7%, which will require EUR 18 million more in costs compared to the projected scenario. In addition to the planned measures, the scenario with additional measures quantifies the costs and benefits of introducing full-scale bulk collection, including electronic record-keeping in family houses, and more convenient collection of kitchen bio-waste by means of baskets in each household. The introduction of quantitative collection must be preceded by the right distance to infrastructure, door-to-door sorted collection, and sorted collection of bio-waste, information and education campaigns for residents as well as enforcement and control of the rules. The higher costs will be mainly due to increased costs for the export and sorting of waste from the separate collection and the costs for the treatment of waste. Saved landfill costs will amount to EUR 67 million.

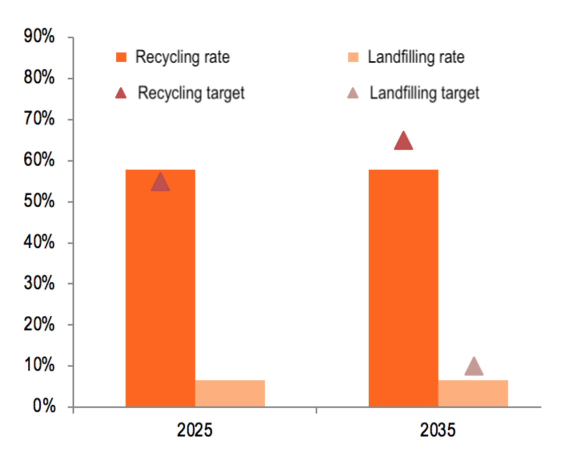
[15] The obligation has been in effect since 2021, but until 2023 an exception applies to municipalities that ensure the implementation of a trial collection. This includes practically all municipalities in Slovakia.

Graph 39: Cost of additional measures compared to the baseline scenario (EUR



Source: IEP

Graph 40: Distance to targets in the scenario with additional measures

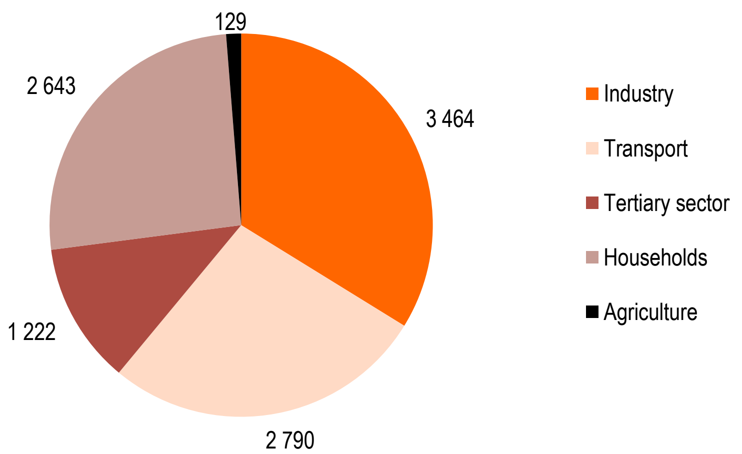


Source: IEP

2.6 Revision of the Energy Efficiency Directive

Final energy consumption consists of energy that is used in each sector for final usage and not for generation of other energy. Primary energy consumption is the difference between gross and non-energy consumption, thus taking into account the amount of energy needed to produce each type of energy. In 2019, industry's share of final energy consumption was around 35%, with iron and steel production accounting for more than a quarter of this. Aluminium and wood processing, as well as chemicals production, account for more than 10%. Transport accounts for around 27 %, of which up to 90 % is road transport, which depends primarily on fossil fuels. Households account for 26 % of final energy consumption, mainly because of heating. The third sector (public administration, shops and services) consumes around 12% of energy and around 1% is consumed in agriculture.

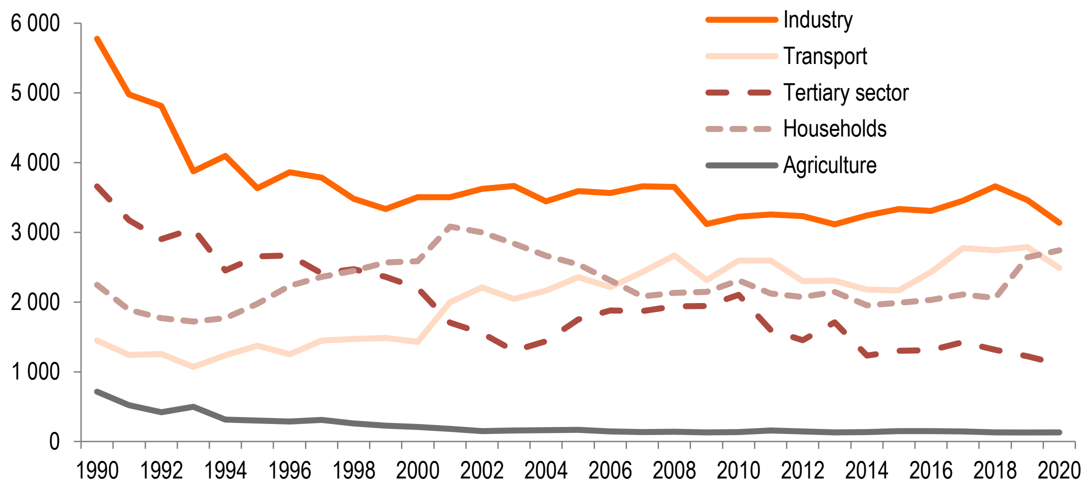
Graph 41: Structure of final energy consumption, 2019 (in ktoe)



Source: Eurostat

Final energy consumption has been stagnant since the mid-1990s, although its structure continues to change. While industry and households are stagnating, energy consumption in transport is increasing and consumption in the third sector is in declining. However, data for consumption in the third sector is not directly collected, instead it is assigned a final energy consumption not attributed to any other sector. Therefore, the downward trend may be more significantly influenced by the methodology.

Graph 42: Development of final energy consumption by sector (in ktoe)

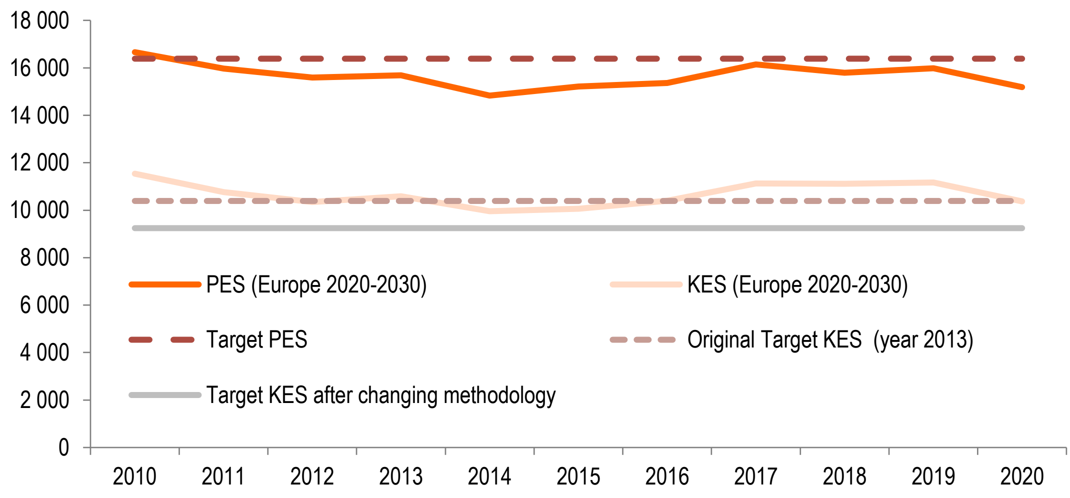


Source: Eurostat

Despite the growh of the economy, final energy consumption is stagnant, which is the result of energy-saving efforts. Between 2014 and 2020, Slovakia had achieved cumulative energy consumption savings of around 29.6 TWh (2,290 ktoe), thus exceeding its EU commitment by almost 12%, which was set set at 26.6 TWh. Voluntary energy saving agreements in the industry and the insulation of residential buildings sectors accounted for the largest share. According to Article 5 of the Directive, an annual target of 52.17 GWH of energy savings in public buildings by 2020 has been set for Slovakia. This target was exceeded, with a total of 482 GWh saved between 2014 and 2020, exceeding the target by almost 32%.

Meeting the absolute energy consumption targets was hindered by changes in energy statistics, where the target would have been met after taking into account those changes. Primary energy consumption reached 15,812 ktoe in 2020. Therefore, Slovakia had met the target on the primary energy consumption side, exceeding it by 7.9%. The final energy consumption reached 10,371 ktoe in 2020. The originally proposed final energy consumption target of 10,390 ktoe was achieved, and even exceeded by 0.18%. Based on changes in energy statistics during the period under review, Slovakia reduced its target to 9,243 ktoe, which it failed to fulfil.

Graph 43: Energy efficiency targets for primary and final energy consumption (in ktoe



Source: Slovak Hydrometeorological Institute

The potential for reducing final energy consumption beyond the NECP savings target for 2021-2030 is estimated at around 700 ktoe or 7,800 GWh[16]. In the industrial sector, data from energy audits in industrial enterprises carried out between 2013 and 2017 were taken into account. In the buildings sector, the data on heat savings after building insulation from the SIEA Energy Efficiency Monitoring System, on the number and state of building renovation from the current Census of Population, Houses and Dwellings, and the Ministry of Transport and Construction Long-Term Strategy for the Renewal of the Building Stock. The forecast for the transport sector is based on scenarios for the development of the number of vehicles and electric cars, as well as data on the fuel consumption[17] of individual vehicle types.

The ability to meet the target for reducing final energy consumption is largely dependent on the unpredictable evolution of energy consumption in the economy, and thus beyond the control of the state. In the case of a positive development (i.e. a natural decrease) in energy consumption, the gap will be smaller and the cost of government intervention to meet the target will also be lower. The main risks to meeting the targets are the continuation of the rapid growth in the number of registered vehicles (which has increased by more than 40% over the last 10 years) and new investments in energy-intensive industries (e.g. battery production for electric vehicles).

The baseline scenario against which final energy consumption is to be reduced has not yet been definitively agreed upon. The current proposal foresees a reduction target for Slovakia of 8.7% (and 8.1% for primary energy consumption) compared to the EU REF2020 scenario. Compared to the NECP scenario, the European Commission scenario foresees almost 12% lower final energy consumption in 2030. Including an additional reduction of 8.7%, the energy savings requirement would rise to almost 20% by 2030 (or 22%, when statistics on biomass home heating are included).

The target of reducing final energy consumption by 8.7% compared to the EU REF2020 scenario is unrealistic. The gap under this scenario exceeds the identified reduction potential by more than a factor of three. The potential to reduce consumption by 8.7% can only by fulfilled against the goal set in the NECP, and even then only with a positive evolution of final energy consumption.

Table 24: Gaps to meet the energy efficiency target in different scenarios (in ktoe)

Development scenarios		Optimistic 10,329	Medium 10,763	Pessimistic 11,296
Potential for savings	Total		668	
	Industry		215	
	Family houses		109	
	Residential houses		47	
	Public buildings		95	
	Other buildings		34	
	Transport		168	
NECP scenario - 8.7%	Goal		9,893	
	Need for savings	436	869	1,303
	Gap	-232	202	635
EU REF2020 scenario - 8.7%	Goal		8,738	
	Need for savings	1,591	2,024	2,457
	Gap	923	1,357	1,790

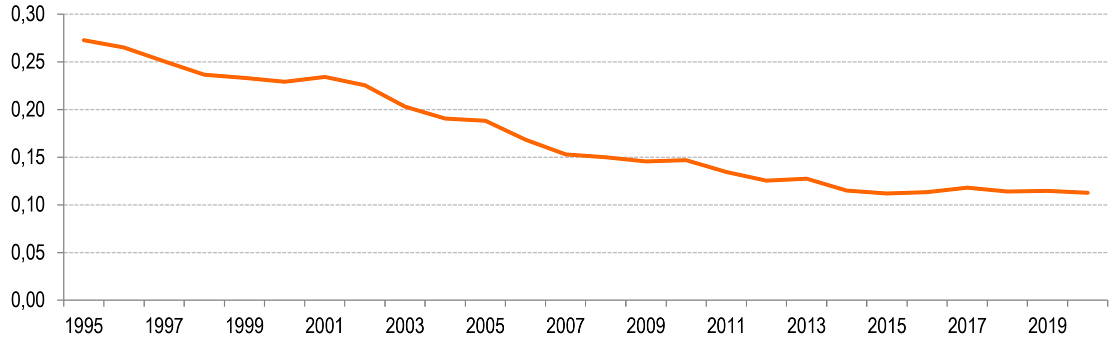
Source: CpHO

Ambitious targets for reducing energy consumption can only be achueved with significant support from public sources. The potential for energy savings with a short payback period is gradually depleting

[16] The estimated gap may not be accurate. On the one hand, the gap overlaps with savings already foreseen in the NECP (i.e. it may be lower), on the other hand, it may not capture all potential savings as it was estimated based on limited data (i.e. it may be higher).
[17] https://ecoscore.be/en/info/ecoscore/co2

and the economically stronger entities (households, companies) with sufficient resources for energy saving investments are declining. The most profitable investments have already been largely realised. For this reason, the energy intensity of the economy has been stagnating for a number of years, having previously been declining significantly.

Graph 44: Final energy consumption/GDP at constant 2015 prices (ktoe/million euro)



Source: Eurostat

The public resources needed to achieve the 8.7% reduction target in the NECP scenario by 2030 are estimated at EUR 5-20 billion, and in some scenarios it could be even more. Potential costs have a very high variance due to the large number of input variables. The final cost to the State will depend on variables such as the evolution of final energy consumption, the potential for savings, the specific investment intensity, the savings rate after insulation at the highest cost-effectiveness, the natural rate of investment, the amount of the necessary co-financing by the State, the weather, or the evolution of energy prices.

Investments in energy efficiency in industry are the cheapest measure, while insulation of public buildings is the most expensive. The estimated specific investment intensity per GWh saved between 2021 and 2030, after adjusting for inflation, is EUR 1.4 million. In other sectors, the estimated investment intensity is significantly higher (roughly EUR 3 to 5.5 million per GWh saved). After taking into account natural investments without the need for state intervention and the amount of estimated state support, these values fall in the range of EUR 0.7 to 2.4 million per GWh. The costliest are investments in the insulation of public buildings, the entire burden of which falls on the state. The current draft of the Fit for 55 package foresees a target of reducing final energy consumption in the public sector by 1.7% per year and renovating 3% of the total floor area of public buildings per year. An additional risk to public resources is the private sector's response to the energy saving subsidies that will be required to achieve the targets. It cannot be ruled out that the willingness of firms and households to finance investments in savings without public participation will decrease, and that, in the absence of public resources, they will postpone their investments until a new round of financing is offered by the state.

Table 25: Investment intensity of energy savings in different sectors by scenario

		Industry	Family houses	Residential building	Public buildings	Other buildings	Electric cars
Investment intensity* (EUR million/GWh)		1.4	5.4	4.2	5.2	4.7	3.3
Natural investments		38 %	53 %	0 %	0 %	20 %	0 to 200 thousand ***
Scenario 1	**Public resources ****	23 %	16,600 euros for the house	EUR 5,465 per apartment	100 %	24 %	EUR 5,000 per car
	Investment intensity	0.33	1.04	2.43	5.15	0.88	0.67

Scenario 2	**Public participation ****	29 %	30 %	30 %	100 %	39 %	EUR 5,000 per car
	Investment intensity	0.42	1.03	1.27	5.15	1.47	1.52

* adjusted for inflation
** including the natural rate of investment
*** the scenarios assume different rates of EV market diffusion and different natural recovery rates

Source: CpHO

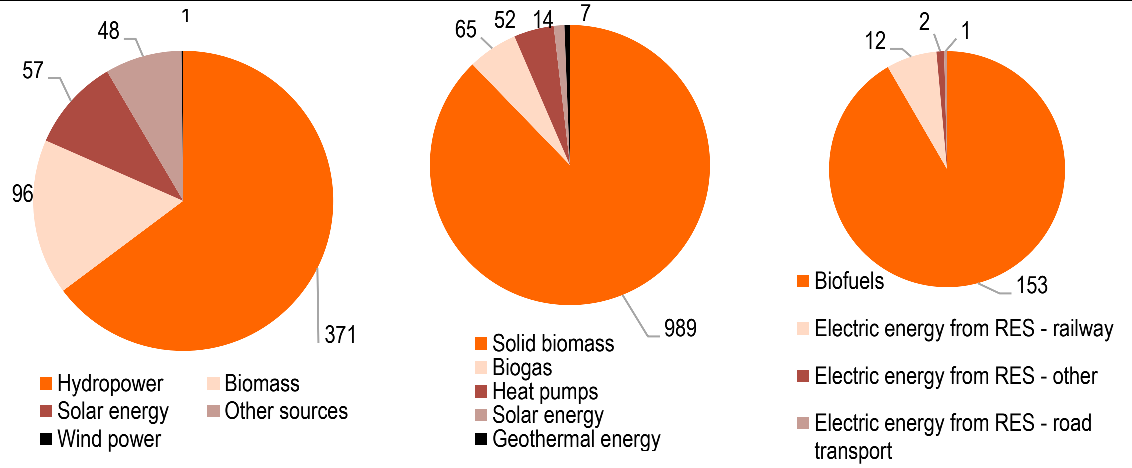
Meeting ambitious energy efficiency targets will require high public spending. Ensuring sufficient European resources or relaxing ambitions is necessary to ensure the stability of public finances, taking into account the structure and size of the economy. From the point of view of motivating the targeted entities (businesses, households, public administrations...) to invest in energy intensity reduction measures, the conditions for granting a non-repayable financial contribution from public funds are in many cases much more important than the amount of the contribution. It is therefore necessary to design financial mechanisms in a way that makes them sufficiently attractive for the target entities for which they are intended as well.

When setting benchmarks, it is necessary to be base them on the NECP. The EU REF2020 scenario requires a reduction in final energy consumption of around 20% relative to the NECP. It is therefore not a suitable starting point for Slovakia. At the same time, it is important that the targets take into account changes in energy statistics that have already occurred or may occur by 2030. For the sub-targets, it is crucial to insist on technology neutrality in the way emissions are reduced. Otherwise, there is a risk of failing to meet the targets or a sharp increase in the costs of achieving them. The energy efficiency sub-targets are ambitious. Under the current proposal, savings from the ETS and savings from fuel switching will not count towards savings, which will prevent more than 75% of potential savings from counting towards the target. The same applies to the explicit determination of the share of RES for the conditions of efficient district heating, which does not envisage low-emission sources (nuclear energy or hydrogen).

2.7 Promoting renewable energy

The use of renewables in individual areas is technologically quite concentrated and the additional potential is partly limited. However, estimates of the potential for RES are not up-to-date and may be underestimated in selected cases. The main indicator for RES is the share of renewable energy in gross final energy consumption. The use of RES in electricity generation is dominated by hydropower plants in Slovakia, accounting for 65% of electricity generation from RES in 2020. Other important sources are biomass (17%), solar energy (10%) and biogas (7%), with some potential for wind and geothermal energy. In 2021, the share of biomass in heating and cooling was estimated at around 88%. Biogas (6%) and heat pumps (5%) also have a smaller share. The share of geothermal and solar energy can be partially increased. In transport, the use of RES is also for technical reasons reduced to the share of biocomponents in fuels and the use of electricity from RES in transport. In 2020, biocomponents in fuels (biodiesel and bioethanol) accounted for up to 92% of the total share of RES in transport. The remaining 8% is accounted for by the use of electricity, mainly in rail transport. Other opportunities for the use of RES in transport come from innovative solutions (e.g. hydrogen) or unique technologies (recycled carbon fuels).

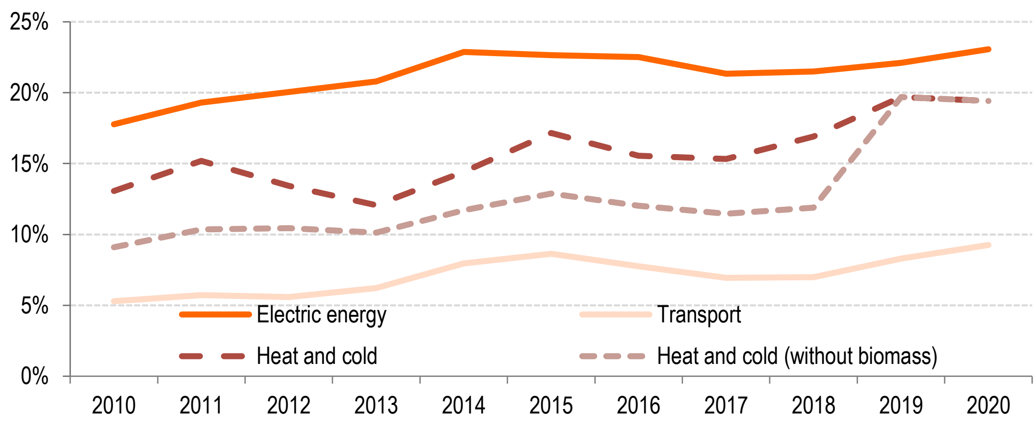
Graph 45: Use of RES in electricity, heat and cooling, and transport (in ktoe)



Source: CpHO according to NECP and Eurostat

Slovakia had managed to exceed its target for the share of RES in gross final energy consumption for 2020 of 14%, and it is growing in all areas. The final figure reached 17.34%. The primary reason for the sharp increase compared to previous years is the inclusion of biomass used in households from 2019 onwards, for which data has not been collected until then. This constituted an average volume of roughly 400 ktoe per year, representing 3.7% of gross final energy consumption in 2020. Without this additional RES source, the 2020 target would most likely not be met. The shares of RES in individual domains in Slovakia are the highest in electricity generation (23.1% in 2020), followed by heat and cold (19.4%) and transport (9.3%). The National Energy and Climate Plan (NECP) has set a target of 19.2% for 2030. However, this target does not take into account a one-off inclusion of biomass, which would push it above 22%. At the same time, sub-targets for the use of RES in individual sectors have also been set.

Graph 46: Share of RES in each sector



* after accounting for biomass, there has been a step increase
** including back-estimation of the biomass share

Source: Eurostat

The potential for the target for the share of RES in gross final energy consumption by 2030 was estimated to be in the range of 23-24%. The trajectory of RES use presented in the NECP up to 2030 after adjustment for biomass has been taken into account, assuming a constant volume of biomass from small heating sources at the level of the long-term average. The optimistic scenario is derived from the final energy consumption targets in the Fit for 55 package and the EU REF 2020 modelling (-8.7 pp). Under the pessimistic scenario, the final energy consumption from the NECP is increased by biomass and the projected energy consumption for the production of electric vehicle batteries with an annual capacity of 60 GWh. The medium scenario was estimated based on the average of the two previous scenarios. The physical and technical limits to the development of RES in each sector were also taken into account.

In terms of the share of RES in electricity generation, Slovakia is limited primarily by the criterion of safe and reliable operation of the electricity system. Maintaining the reliability of the SR electricity system requires a sufficient level of stable and flexible resources to ensure balancing supply and demand without the threat of congestion and supply interruptions[18]. The share of nuclear energy in total electricity generation is expected to exceed 60% after the start-up of the third and fourth units of the Mochovce nuclear power plant and the phase-out of coal-fired power generation in 2030. As nuclear power is not suitable for flexible use in the transmission system, sufficient flexible resources are needed to stabilise the transmission system. However, more extensive use of stable and flexible RES (hydro, biomass) is potentially in conflict with nature conservation, which narrows the scope for increasing RES. SEPS sees scope for increasing the share of RES in total electricity generation by 2 pp (approx. 770 GWh) by 2030 beyond the targets set out in the NECP.

Table 26: Additional RES potential in electricity generation

Source	Estimate 2030 (MW)	Additional potential		Note
		MW	GWh	
Solar energy	1,200	300	315	unstable source
Wind energy	500	215	500	unstable source
Biogas	200	0	0	unlikely to increase
Hydropower	1,755	0	0	in conflict with water protection
Biomass	200	0	0	in conflict with forest protection
Geothermal energy	4	8	60	stable resource with need for
Total	**3,859**	**558**	**875**	

Source: CpHO

The development of the potential of wind energy is also insufficient due to public disfavor. The civil society often refers to drastic interventions in the physical environment and fundamental degradation of the landscape. The legislative conditions in the permission and support schemes have so far been insufficiently motivating, so that wind energy contributes only a negligible share to the overall energy mix. Nevertheless, a number of investment projects are currently being assessed in terms of environmental impacts (e.g. Močenok, Tvrdošovce, Horná Kráľová - Hájske, Rohov or Rubáň).

The actual physical potential, e.g. in the case of wind power, is challenging to estimate. The estimates are based on long-term weather conditions, but may not take into account, for example, protected areas and legislative conditions that would preclude investment in selected locations, even though they would be suitable from a wind perspective. Indeed, the largest capacities of the Austrian power sector are located in geographically close and adjacent areas of Lower Austria (693 turbines with a capacity of 1,535 MW) and Burgenland (426 turbines with a capacity of 1,026 MW) (IEA, 2017).

A potential of 100 ktoe (approx. 1,160 GWh) above the 2030 targets has been identified for the share of RES in heat generation. These are biogas, heat pumps and geothermal sources beyond heat pumps, whose additional potential can be utilized with additional financial support from the state. The Table below summarises the potential for additional use of RES in the production of heat and cold.

18 Currently, the costs of modifying the transmission system, which would be associated with investments in increasing the flexibility and stability of the transmission system, are not known. In recent years, additional connection projects with the Hungarian and Czech systems have been implemented. In the future, the stability of the network will be strengthened by e.g. also battery storage for storing excess energy, which will be released in times of increased demand.

Table 27: Additional RES potential in heat production

Source	Estimate 2030 (ktoe)	Additional potential (whoe)	Note
Geothermal energy	50	20	increase possible with support
Solar energy	43	0	unlikely increase
Solid biomass	650	0	in conflict with forest protection
Biogas	100	50	increase possible with support
Heat pumps	106	30	increase possible with support
Total	**949**	**100**	

Source: CpHO

For transport, opportunities to increase the share of RES are minimal. In fact, electromobility from RES is not counted in the overall target as it would be double counted with electricity generation from RES (this is not the case for the sub-target of the share of RES in transport). For biofuels, the targets for 2030 are set at the level of the technological capabilities of vehicles. There is some potential for the use of hydrogen or recycled carbon fuels, but the technology for such use does not yet exist today.

Table 28: Results of scenarios for RES by 2030

Share of RES		23 %	24 %	25 %	26 %	27 %
The Gap (p. p.)	Pessimistic	1.2	2.2	3.2	4.2	5.2
	Medium	0.6	1.6	2.6	3.6	4.6
	Optimistic	0.1	1.1	2.1	3.1	4.1
Need to increase RES (%)	Pessimistic	5.4	10.0	14.5	19.1	23.7
	Medium	2.8	7.2	11.7	16.2	20.6
	Optimistic	0.3	4.6	9.0	13.3	17.7
Need to increase RES (ktoe)	Pessimistic	127	235	343	452	560
	Medium	65	171	276	382	487
	Optimistic	6	109	212	315	418
Potential for increasing electricity production from RES (whoe)				66		
Potential for increasing heat production from RES (whoe)				100		
Resulting balance* (ktoe)	Pessimistic	-39	69	177	286	394
	Medium	-101	5	110	216	322
	Optimistic	-160	-57	46	149	252

* a positive balance means a gap between the scenario and the target, which is undesirable

Source: CpHO

The RES potential beyond the NECP was estimated at 166 ktoe (roughly 7% of RES use in 2030 under the NECP scenario). For electricity generation, a potential of 75 ktoe has been identified, but this is higher than the estimated capacity of 66 ktoe of RES connection to the transmission system. For heat and cold generation, a potential of 100 ktoe was identified.

From the point of view of public finances, it is more advantageous to promote electricity from RES. The estimated public costs for additional increase of RES energy production expressed in million euros per ktoe are the lowest for solar and wind (1.2 and 1.7, respectively). This is followed by heat production from biogas and heat pumps (2.2 and 2.4 respectively). The most expensive source is geothermal energy (3.7 for electricity and 5.8 for heat) - however, there is a possibility of cheaper energy, in the case of combined production of electricity and heat from geothermal energy (2.0). The expert estimates of the Energy Section of the Ministry Of Economy Of The Slovak Republic were used in the calculations. The Table below summarizes the calculation of state cost estimates per ktoe for individual types of RES, where the potential for an increase compared to the NECP targets until 2030 has been identified.

Table 29: Scenarios for the cost-effectiveness of supporting individual renewables

Source	Electric energy – solar	Electric energy – wind	Heat – biogas	Heat pumps	Electric energy – geotherm.	Heat - geotherm.	Electric energy and heat - geotherm.*
Potential (whoe)	27.1	43.0	50	30	5.2	20	15.2
Potential (MW)	300	250	233	152	8	78	8
Investment (million EUR/MWh)	0.9	1.5	1.5	1.2	8	3	12.8
Investment (EUR	270	375	349	182	64	233	102.4
Natural rate of investment	50 %	20 %	20 %	20 %	0 %	0 %	0 %
Co-financing	25 %	25 %	40 %	50 %	30 %	50 %	30 %
State expenditure (EUR million)	33.8	75.0	111.6	72.8	19.12	116.3	30.7
State expenditure	1.2	1.7	2.2	2.4	3.7	5.8	2.0

*5 ktoe of electricity and 10 ktoe of heat *Source: CpHO*

The total cost to the state of increasing the use of RES to its maximum potential is estimated at EUR 410 million in the medium scenario. In the case of a positive interplay of technological and natural factors, it would be possible to combine electricity production and half of the heat production, which could result in a cost reduction of around EUR 45 million to EUR 366 million. In prioritising support for RES electricity generation, the stability of the transmission system has been taken into account,[19], for which geothermal energy is preferred as a stable source compared to solar and wind energy. The lower RES generation limit due to transmission system constraints than the potential was therefore reflected in the failure to use the full estimated capacity of the increase in wind generation.

The cost to the state of investing in RES depends on energy prices. The higher the prices, the higher the natural renewal and the lower the participation rate that needs to be offered in order for the private sector to invest. On this basis, two scenarios for cost estimation have been developed - an optimistic and a pessimistic one, which assume a change in the natural rate of investment of +/-50% and a change in the need for co-financing of +/-10 percentage points. Under these assumptions, the range of costs to the State is between EUR 280 million and EUR 610 million (in 2021 prices).

Although the high share of emission-free nuclear electricity contributes significantly to the decarbonisation of the energy sector, it limits a more significant increase in the share of RES. The share of nuclear power in total electricity generation currently exceeds 50% and will reach almost two-thirds by 2030 after the launch of the third and fourth units of the Mochovce nuclear power plant and the shutdown of the Nováky power plant. When the expected electricity production from RES is included, the proportion of emission-free sources in total generation will reach 90% of production and almost 100% of consumption. Given that the stability of the transmission system requires the connection of a certain share (at least 5%) of stable sources (the definition of which for RES is met only by biomass and to some extent also by hydropower), the potential to increase the share of RES in electricity generation is significantly limited.

More ambitious targets for electricity generation from RES would require higher electricity production from biomass and hydropower, while the excess electricity would be directed to export. There is a potential conflict with water and forest protection. Wind and solar energy are of limited consideration due to their unstable nature. The situation is similar with heat production, where the countries with the highest share of RES are characterised by the widespread use of biomass. Achieving the identified

[19] Electricity sources with regard to the stability of the transmission system were prioritised according to the following key: 1 - flexible; 2. stable; 3. unstable.

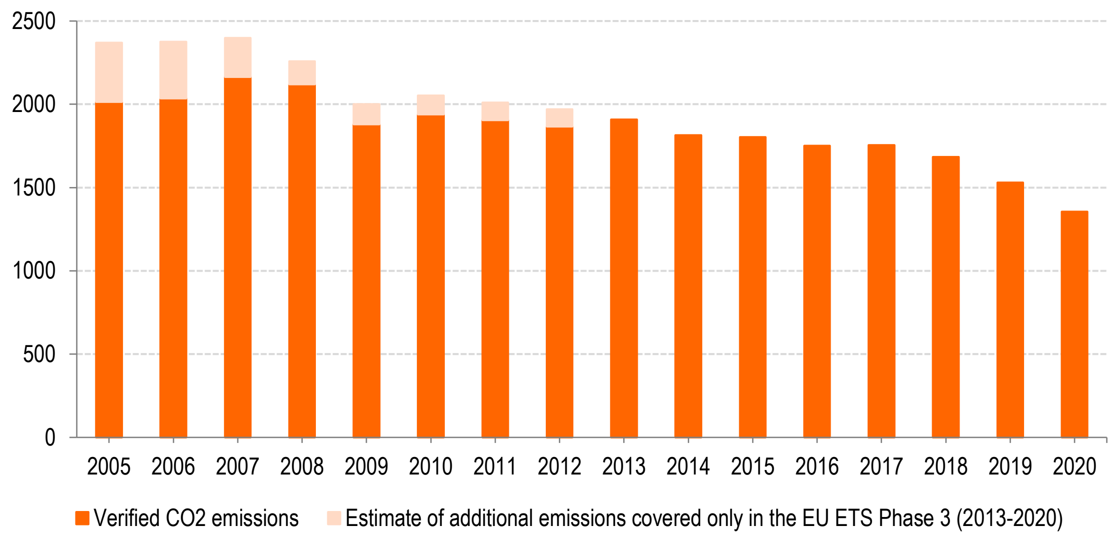
potentials beyond the NECP targets would require ambitious investments. These include the use of heat from heat pumps (an increase of around 140% compared to the 2021 estimate), electricity (120%) and heat (210%) from solar energy, electricity from wind energy (2400%), and electricity (50%) and heat from biogas (130%).

A realistic estimate of the share of RES in gross final energy consumption by 2030 is 23-24%. Such a target would reflect the low share of emission technologies in electricity generation in Slovakia, the stability of the transmission system, the protection of forests and water flows, and would also be growth-oriented in terms of the share of RES. We estimate the cost of achieving the 24% target (which roughly corresponds to the identified potential) to be in the range of 300 to 600 million depending on the development of energy prices.

2.8 Revision of the market stability reserve under the EU ETS

Since the emission trading scheme was implemented, greenhouse gas emissions in ETS sectors have decreased by 42.8% (European Commission, 2021). The EU ETS saved approximately 1.2 billion tCO_2 between 2008 and 2016, which is around 3.8% of global emissions. These reductions represent almost half of the EU-wide Kyoto Protocol target. Businesses covered by the EU ETS emitted an estimated 11.5% less than they would have emitted in a world without emissions trading (Bayer & Aklin, 2020). The trend of declining emissions in the sectors covered by the EU ETS has been present since the launch of the scheme. The EU ETS acts as a signal regarding the future increases in the cost of burning fossil fuels. For this reason, the EU ETS has stimulated innovation in low-carbon and green technologies and has also influenced firms' long-term investment strategies (Bayer & Aklin, 2020). The EU ETS increased low-carbon innovation among covered firms potentially by up to 10% by 2016 (Calel & Dechezlepetre, 2016).

Graph 47: Historical development of emissions in sectors covered by the EU ETS ($MtCO_2eq.$)



Source: EEA

In the revision, the Commission proposes, after a one-time reduction of the total emission ceiling (so-called cap rebasing) by 117 million allowances, a more significant annual reduction of emissions by a linear reduction factor of 4.2% per year (instead of 2.2% per year under the current scheme). The cap, i.e. the overall limit of allowances in the system, continues to exceed actual emissions, creating a structural surplus that the Market Stability Reserve alone cannot fully address (European Commission, 2021). The linear reduction factor will be increased to 4.2% from the following year after the entry into force of the proposal of the particular directive. The increased linear reduction factor is combined with a one-time downward adjustment of the cap on the number of emission allowances in the total circulation, so that the new linear reduction factor will have the same effect as if it had already started to apply in 2021. This will ensure that the total quantity of allowances (the "cap") decreases at an increased rate per year, leading to an overall reduction of 61% in emissions in the sectors under the EU ETS by 2030 compared to 2005 (*ibid)*.

The Market Stability Reserve (MSR) was introduced in response to the long-term surplus of emission allowances experienced during the global economic crisis. The second phase of the EU ETS (2008-2012) demonstrated the lack of supply flexibility in auctioning allowances to adjust to economic shocks (Marcu, et al., 2021). The introduction of the reserve ensured this lack of flexibility. The stability reserve also addresses the historical surplus of emission allowances while increasing resilience to future market shocks. The Market Stability Reserve adjusts the number of allowances auctioned in a particular year based on the size of the aggregate bank ("surplus") from the beginning of the previous year. If firms covered by the EU ETS have more than 833 million unused allowances (the cap), the number of allowances auctioned during the year will be reduced by an amount equal to 24% of the total surplus (European Commission, 2021). These allowances are placed in a market stabilisation reserve and are thus temporarily removed from the trading system. They are re-released in volumes of 100 million per year as soon as the total bank falls below 400 million (the lower limit). The Market Stability Reserve has reduced the surplus of allowances to below 1.6 billion as of 2019.

The MSR helps to stimulate innovation in low carbon and green technologies and the decarbonisation of energy-intensive industries. In fact, reducing the number of allowances on the market drives up the price of carbon, which encourages investment. At the same time, the EU ETS is better equipped to absorb the impacts of complementary policies, such as renewable energy measures or the phasing out of coal combustion (European Commission, 2021). Increasing the share of renewable energy and phasing out coal reduces the demand for emission allowances, which has the undesirable effect of increasing the surplus of emission allowances and the price pressure on allowances. However, the MSR also offsets this surplus of allowances caused by environmentally desirable measures and alleviates price pressures.

Fit for 55 proposes to maintain the current MRS intake parameters until the end of 2030. This should maintain the increased revenue at 24% of the overall surplus after 2023. Directive (EU) 2018/41010 of the European Parliament and of the Council amended Decision (EU) 2015/1814 and doubled the percentage to be used to determine the number of allowances to be placed in the market stabilisation reserve each year from 12% to 24% by 31 December 2023 (European Commission, 2021). From 2024, the percentage rate was to revert back to 12%. However, the impact assessment of the market stabilisation reserve shows that the 12% rate will not be sufficient to meet the targets. If the reserve is to reduce the surplus of auctioned allowances on the market and ensure resilience to market shocks, it is essential that the percentage remains at 24% beyond 2023 and the minimum number of allowances to be placed in the reserve should remain at 200 million. In addition, the 24% rate after 2023 should be set separately from the general revision of the EU ETS Directive and the decision to establish a market stabilisation reserve, in order to strengthen the EU emissions trading system in line with the increased climate ambition by 2030 (European Commission, 2021). In addition, from 2023 onwards, allowances in excess of those auctioned from the previous year will be removed from the Market Stability Reserve.

Slovak companies can expect a more stable but higher carbon price in the long term. The one-time reduction in the cap on allowances is adjusted to historical emissions, so it should not have a significant isolated impact. Combined with a higher linear reduction factor, it will put upward pressure on carbon prices and hence decarbonisation investments. The strengthened MSR parameters will prevent the creation of an oversupply of allowances, thus also preventing the collapse of prices as in the past. In the long term, there will be a gradual increase in pressure on the price of emission allowances, but this will be corrected in the event of market fluctuations by placing allowances in the reserve or by releasing them.

2.9 Air transport directives

For technological reasons, aviation will continue to be heavily dependent on fossil fuels in the future. This is currently due to the lack of approved and cost-competitive alternatives for sustainable aviation fuel sources in the short to medium term. High energy density fuel is needed to power commercial aircraft. Presently, only the liquid jet fuel known as Jet A and Jet A-1 (including certified sustainable fuels) has sufficient energy density to meet this requirement (European Commission, 2021). Other options such as electricity and hydrogen may be widespread alternatives in the future.

The proposed "ReFuel Aviation" regulation aims to increase the share of renewable energy sources (RES) in aviation. Aviation fuel suppliers will be required to blend a sustainable fuel component into conventional aviation fuel in specified proportions. Sustainable aviation fuels (SAF) are a technologically feasible solution to replace conventional fossil aviation fuel. As an additional fuel, they can be blended with conventional kerosene to power existing aircraft engines without any technological change (European Commission, 2021). From 2025, aviation fuel available for EU airports should contain 2% SAF, rising to 5% by 2030, 32% by 2040 and 63% by 2050 (Table 30).

Table 30: Fuel mix shares under the proposed ReFuel Aviation regulation

	Objectives					
Fuel mix shares (%)	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**
Sustainable aviation fuel (SAF)	2	5	20	32	38	63
Share of green synthetic fuel in SAF	-	0.7	5	8	11	28

Source: European Commission

Potential sources of sustainable aviation fuels may include, for example, advanced biofuels, vegetable oils and waste lipids, synthetic liquid fuels, and fuels based on forage and food crops. Advanced biofuels have considerable potential but are not yet widespread. SAFs can be produced from feedstock such as lignocellulose materials (e.g. agricultural or forestry residues, grass materials), algae, bio-waste materials (biogenic content of municipal solid waste) and others. These types of raw materials are abundant, but demand for advanced biofuels is likely to be significant due to their use in other sectors. Vegetable oils and waste lipids can contribute to the decarbonisation of aviation, but their potential is limited due to reduced availability of input raw materials. The vast majority of biofuel production from vegetable oils and waste lipids goes to the road transport sector. Synthetic liquid fuels have significant potential for the decarbonisation of aviation, but face challenges with resource availability and technology readiness. Crop-based biofuels are commercially exploited, but availability of input raw materials is limited and the use of these biofuels may threaten the sustainability of soil or nature conservation (European Commission, 2021).

SAF technologies are currently at different stages of commercial development and face different challenges. The use of different alternative fuels will therefore not be uniform in the coming period. Although biofuels from vegetable oils and waste lipids could be available before 2025, their contribution will be limited mainly due to the limited availability of feedstock. Advanced biofuels and synthetic liquid fuels have the greatest potential to increase the sustainability of aviation but are currently in the experimental phase before widespread operation. Therefore, they are expected to become commercially available after 2030, but additional incentives will be necessary. The potential of crop-based biofuels for aviation decarbonisation is significantly lower compared to other SAFs (European Commission, 2021). A clear definition of sustainable aviation fuel is needed for civil aviation, which will increase the certainty in e.g. road transport, where the share of RES is dependent on bio-based fuels.

The regulation also introduces measures to prevent the so-called "tankering", which can cause unwanted delays. In this case, aircraft operators refuel more aviation fuel than necessary at a particular airport in order to avoid partial or full refuelling at the destination airport where aviation fuel is more expensive.

Refuelling leads to more fuel being consumed than necessary, leading to an unnecessary increase in emissions (European Commission, 2021). In addition to contradicting the EU's efforts to decarbonise aviation, tankering is also detrimental to healthy competition in the EU aviation sector. The downside of the proposal is the potential time delays at airports that will be caused by the redistribution of aircraft among refuelling capacities across the whole area.

Table 31: Affected entities that will be covered by the ReFuel Aviation Directive

The obligations will apply to	In Slovakia this will affect
aviation fuel suppliers	Shell and Slovnaft
airport operators	Letisko M.R. Štefánika - Airport Bratislava, a.s. (BTS)
aircraft operators	Air carrier Smartwings Slovakia, s.r.o.
the competent authorities in the Member States in the framework of the monitoring and application of sanctioning mechanisms	–

Source: Ministry Of Transport And Construction Of The Slovak Republic

The proposed Alternative Fuels Infrastructure Regulation (AFIR) also puts into practice the electrification of aviation. This initiative seeks to ensure the availability and usability of a dense, widespread network of infrastructure for alternative (sustainable) fuels across the EU, not only in road transport, but also in aviation and maritime transport. The AFIR complements the ReFuel Aviation Regulation in the field of aviation. The AFIR imposes an obligation to ensure that operators of airports included in the TEN-T network provide "electricity" for all aircrafts on stands near the terminal from 2025 and at all remote airport aprons used for aviation from 2030. The basic and aggregated TEN-T network in Slovakia includes M.R. Štefánik Airport Bratislava, Košice Airport and Poprad-Tatry Airport. In addition, from 2024, countries will have to develop a national policy framework for market development - a plan for providing infrastructure for alternative fuels at airports beyond the supply of electricity to stationary aircraft - in particular for hydrogen refuelling and electric charging of aircraft (European Commission, 2021). **The proposal will require additional public sector investment which may be adversely affected by the spatial capacity of existing infrastructure.**

Another proposal in the field of aviation introduces changes to the EU ETS legislation in relation to its application to civil aviation. The aim is to ensure that civil aviation contributes to the 2030 emission reduction target in line with the European Green Deal and that the EU ETS is changed accordingly on the basis of the International Civil Aviation Organisation's Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). At the same time, it is proposed to review the allocation of allowances in civil aviation with a view to increasing auctioning. The sector will thus contribute to the ETS reduction target of 61% by 2030 compared to 2005. The free allocation of allowances to civil aviation will be phased out between 2024 and 2027 and the conditions for the use of the CORSIA global market-based measure are also being adjusted. Under this measure, EU-based aircraft operators will be notified that they are subject to zero offsetting in relation to 2021, in accordance with international standards and the International Civil Aviation Organisation's Environmental Protection and CORSIA.

3 Impacts of Fit for 55 as a whole

By reducing emissions through the measures in the Fit for 55 package, the European Union's economy will move towards greater energy security and resilience and increase its global competitiveness in the low-carbon market. However, this economic transformation will not be without negative externalities, especially in the form of social impacts and necessary investment costs. Several funds have already been established to mitigate the negative impacts, but a new Social and Climate Fund will also be added.

3.1 Strengthening energy security

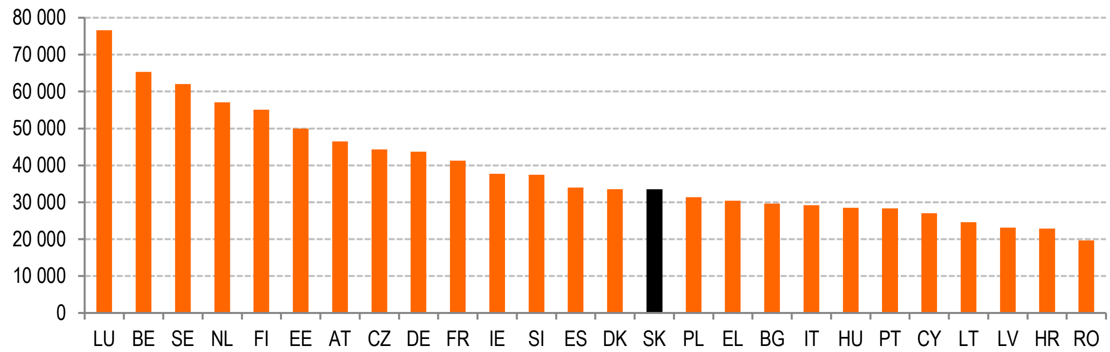
The Fit for 55 package aims to increase energy efficiency, the share of RES and reduce fuel consumption, thus strengthening the energy security of EU countries. Each country faces different types of challenges in energy security. Available energy security indices include market concentration as measured by the Herfindhal-Hirschman Index (HHI), or the Energy Security Price Index (ESI). The World Energy Trilemma Index measures energy security as a country's ability to reliably meet current and future energy demand, and to withstand and quickly rebound from systemic shocks with minimal disruption to supply. Slovakia scored 69/100, the same score as for example Austria. **The concept of energy security has several aspects:**

- uninterrupted availability of energy supplies at affordable prices,
- flexibility of energy supply,
- stability and diversification of suppliers,
- the resilience of infrastructure to internal and external influences,
- reduced consumption through energy efficiency,
- environmental sustainability.

The threat of instability of energy supply or a reduction in strategic reserves due to unrest or conflict is still present. It is therefore necessary to continuously strengthen global as well as regional energy security.

Within the EU, Slovakia ranks among the countries with lower primary energy consumption. The Slovak Republic had a total primary energy supply (TPES) of 16.02 million tonnes of oil equivalent (Mtoe) in 2020, which is an average of 34 083 kWh/capita. Since 1990, Slovakia has managed to reduce energy consumption by 24.89%. Slovakia's CO_2 emissions from energy sector fell by 51.65% compared to 1990. Within the category of energy availability and flexibility of supply, Slovakia is well secured, therefore the risk of energy unavailability in Slovakia is reduced to extreme events.

Graph 48: Total energy consumption per capita in EU countries in 2019 (kWh)

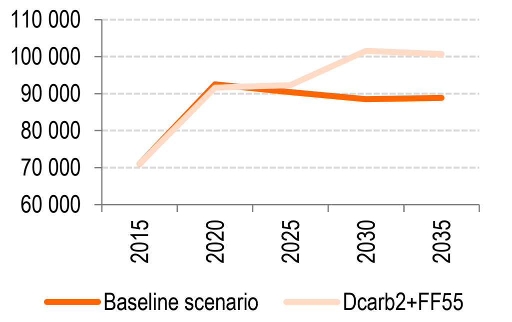


Source: IEP according to Our World in Data

Model, available to the IEP as a result of its work with the World Bank on the preparation of the Low Carbon Strategy, is used to analyse the impacts of more ambitious targets. It is a country-level energy model called Compact-PRIMES for Slovakia (CPS) that describes the behaviour of the energy sector, including all entities that handle energy, such as industry, electricity generation, the third sector, households and transport. The effects on energy security are examined by comparing the baseline reference scenario and the decarbonisation scenario Dcarb2+FF55. The Dcarb2+FF55 scenario is based on the decarbonisation scenario 2 (called Dcarb2) from the Low Carbon Study and from the Fit for 55 package includes an extension of the ETS to the household and transport sectors and stricter emission standards in transport. For more on the scenarios, see Box 2. It is not possible to model all measures, so the whole package is assumed to have an even larger positive impact on these indicators.

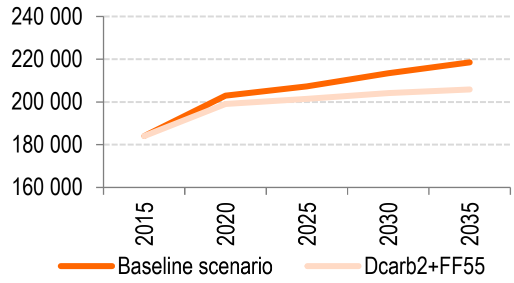
In 2030, total energy consumption in the Dcarb2+FF55 scenario is expected to be more than 4% lower than in the baseline scenario. Total energy consumption in Slovakia should also grow under the Dcarb2+FF55 scenario, but growth should be slower than in the baseline scenario. **The biggest difference under Dcarb2+FF55 is expected to be in imports, which are should be lower by 18% in 2030.** Primary energy production is expected to be higher by 15% compared to the baseline scenario.

Graph 49: Primary energy production (GWh)



Source: IEP according to the CPS model

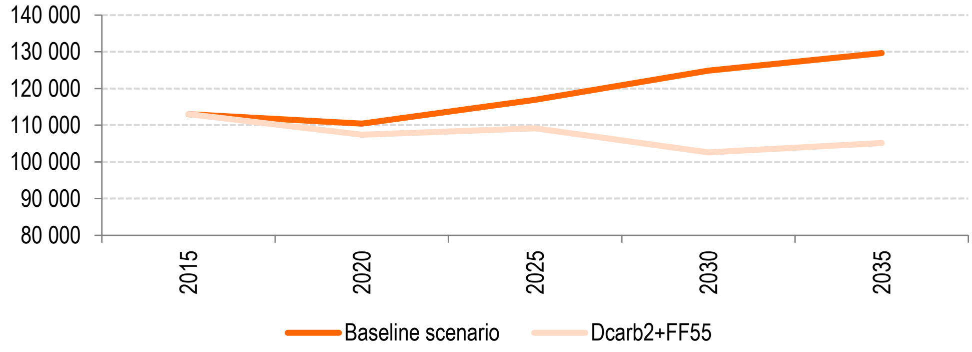
Graph 50: Total energy consumption in the SR (GWh)



Source: IEP according to the CPS model

The decrease in imports reduces dependence on the external environment and supports energy production in Slovakia, which increases the energy security of the Slovak Republic. Reducing imports can reduce dependence on the external environment in the event of crises or energy shocks in the markets. Unlike other countries, Slovakia has a well-diversified energy mix, which contributes to energy security in the event of a shortage of some types of fuel or raw materials. Imports should only decline under Dcarb2+FF55, as the baseline scenario assumes import growth of more than 10% by 2030.

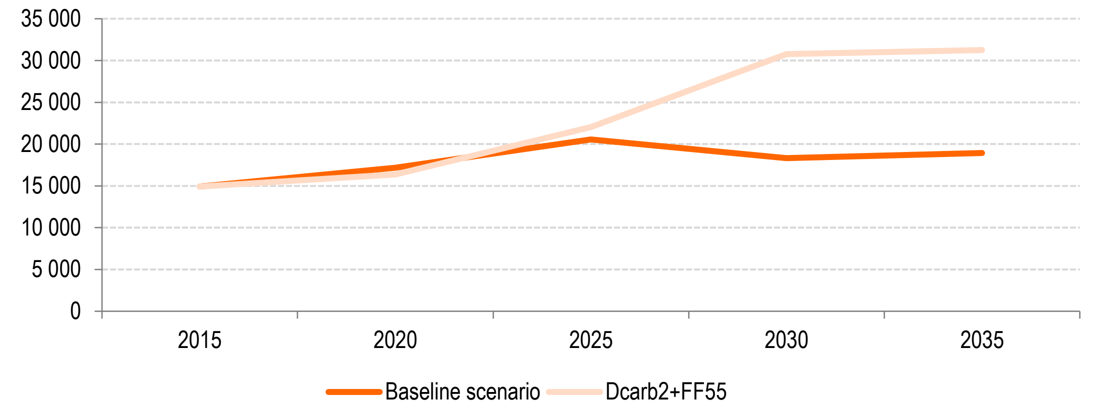
Graph 51: Development of net imports in Slovakia (GWh)



Source: IEP according to the CPS model

In terms of energy security, the biggest problem for Slovakia is the lack of gas and oil on the territory of the Slovak Republic. Originally, 100% of the gas had been imported from Russia, but after the 2009 gas crisis Slovakia invested in building a two-way gas flow from Austria and the Czech Republic. Connecting the gas systems of Poland (Gaz-system a.s.) and Slovakia (Eurstream) should also contribute to regional security, providing Slovakia with another alternative route for transporting gas from the Norwegian continental shelves as well as LNG from around the world. It is expected to be completed in 2022. In the future,the growth of energy from biomass and waste is possible. Most of the biomass and waste comes directly from Slovakia and thus does not need to be imported. Based on the Dcarb2+FF55 scenario, biomass energy is projected to almost double by 2030 compared to 2020.

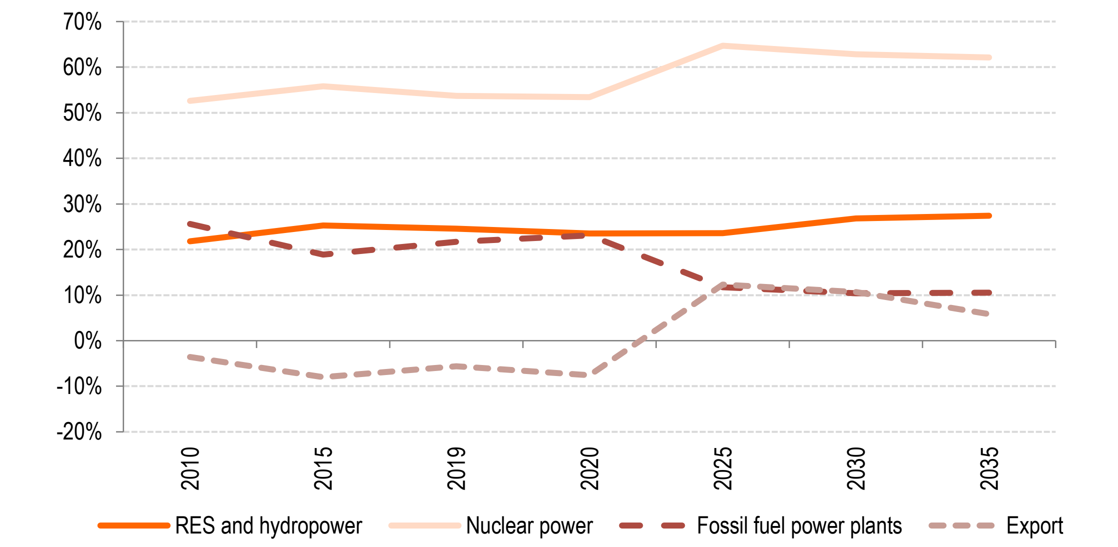
Graph 52: Evolution of biomass and waste consumption by scenario (GWh)



Source: IEP according to the CPS model

Together with renewables, Slovakia could achieve almost 90% emission-free electricity generation. More than half of Slovakia's electricity comes from emission-free nuclear power plants. After the shutdown of the Nováky power plant and the connection of the third and fourth units of the Mochovce nuclear power plant, the share of electricity from nuclear power has the potential to reach above 60% and may remain at this level in the coming years. The share of renewables together with hydropower could rise from 23% today to almost 27% by 2030. Electricity generation from fossil fuels should account for around 10% to 12% in 2030, roughly half the share in 2020. **Slovakia could export more than 10% of the electricity it produces once the third and fourth units of the Mochovce nuclear power plant are connected.**

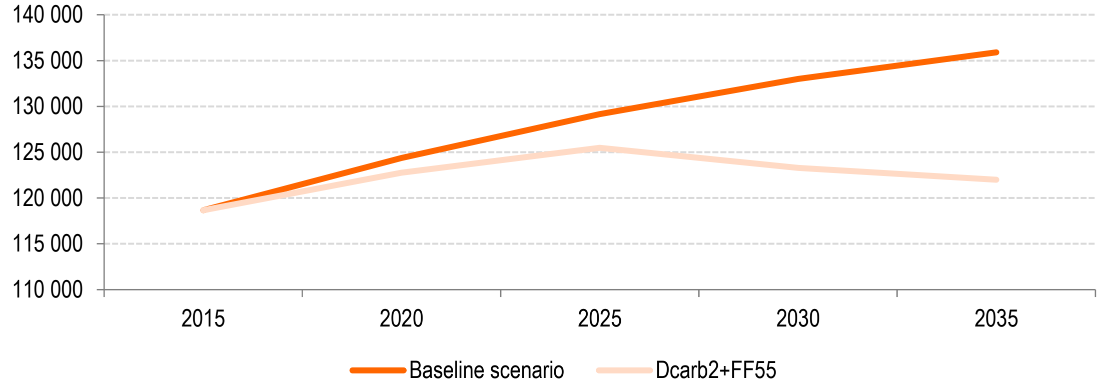
Graph 53: Share of electricity generation by source



Source: IEP according to Ministry Of Economy and SEPS

The total fuel consumption in 2030 is expected to remain at about the same level as in 2020, but the share of individual fuels will change. The Dcarb2+FF55 scenario forecasts a decline in fossil fuels and an increase in renewables. The share of renewables and electricity should grow more significantly. Conversely, oil consumption should decline slightly and solid fuels and gas consumption more strongly. Overall, there should be a lower negative environmental impact from these fuels. **Without the Dcarb2+FF55 scenario, total fuel consumption is projected to grow by 7%, driven mainly by growth in oil and gas.** Again, the use of solid fuels is projected to decline, but the growth of renewables is projected to be very small.

Graph 54: Development of total fuel consumption in Slovakia (GWh)



Source: IEP according to the CPS model

3.2 Transition to a low-carbon economy and leadership in the fight against climate change

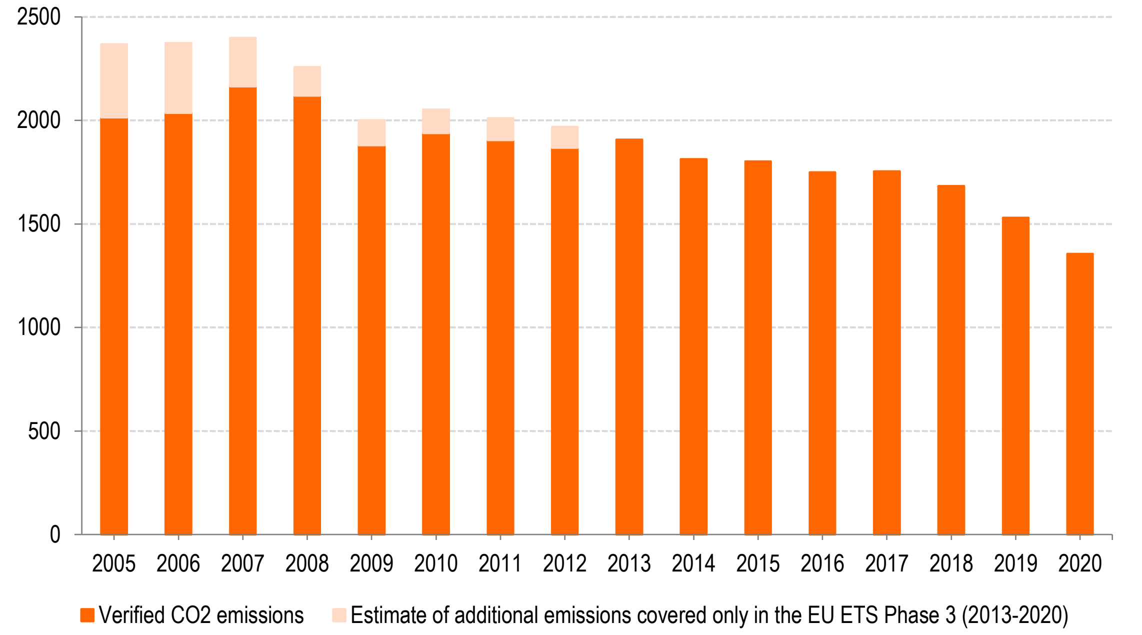
The commitment to achieve carbon neutrality in 2050 will stimulate economic activity and investment towards the development of low-carbon technologies in order to achieve the benefits of this transformation, such as energy savings, the conservation and sustainable use of natural resources and the reduction of pollution.

3.2.1 Increasing global competitiveness in low-carbon technologies

The increasing intensity of climate change impacts forces countries around the world to adopt climate policies that will be implemented more extensively and earlier in the EU. The introduction of emissions trading is considered to be one of the most effective economic instruments for reducing emissions. The ETS scheme has evolved over time, with emissions in the covered sectors already reduced by 42.8% over the period. According to the World Bank, a number of major economies are introducing or considering carbon pricing schemes (e.g. emissions trading in the PRC, emissions trading or carbon tax in Turkey or Brazil, carbon tax in South Africa, etc.).

A carbon tax will enhance the competitiveness of European businesses and stimulate innovation in low-carbon technologies. A number of non-European major economies are now more cost competitive as businesses there are not subject to the same environmental rules. Carbon pricing should also have a negative impact on their competitiveness and cost-effectiveness due to the often-high emissions intensity of the energy sector, which will be a positive incentive for European businesses. In non-European countries, carbon pricing has yet to be implemented under pressure from climate change impacts. Actors in Europe will already be able to control their own costs through decarbonisation as the relative price of carbon rises. Decarbonisation investments made in advance will thus pay back European businesses in the shorter term.

Graph 55: Historical development of emissions in sectors covered by the EU ETS (Mt CO_2eq.)



Source: EEA

The introduction of a carbon tax should support important domestic industries. Steel production can be given a strong incentive for long-term sustainability thanks to both the investment plans presented and the carbon tax. The introduction of a carbon tax can contribute to steel production growth of up to 23% compared to the baseline scenario. At the same time, a EUR 1.3 billion investment plan has been presented which should result in a significant greening of US Steel, which represents the steel production sector. Aluminium production will also be positively affected, potentially growing by almost 3%, which could mitigate the risk of ceasing the production of aluminium in Slovakia. There will be a marginal increase in output in the cement sector, but value added should increase by around 0.33%, making firms more productive. In connection with the imposition of the tax and the growth of domestic production, an increase in product prices is also expected for industries that are consumers of steel or aluminium, in particular the automotive and construction industries. Since the inputs in question are, in principle, not substitutable, the market will absorb these price increases through the prices of final goods.

Meeting the energy efficiency target will support the overall competitiveness of the economy. Currently, the energy market is facing price rises directly on the stock exchanges, on which the final prices for consumers, including tariffs and charges, depend. This price increase therefore increases the incentive to make investments that save energy consumption. At the same time, the payback period for investments is also significantly reduced and the investment is returned earlier through energy savings.

In particular, industrial enterprises can be positively incentivised to invest in increasing energy efficiency. The specific investment intensity of energy saving projects in this sector is relatively lower than in the buildings or transport sectors, for example. The increased incentive to invest in competitiveness also stems from the fact that the industry is not entitled to regulated energy prices, so it has to bear higher market prices in the short term. Only 9 energy-intensive enterprises are eligible for compensation from the state aid scheme. Rising energy prices will also spur the household sector to make savings, particularly in building renovation, as the alternative to fuel switching is to increase energy savings. From the point of view of the national economy, greater control over cost trends, which are strongly influenced by energy, will be achieved through the evaluation of investments aimed at energy efficiency.

The emission intensity of energy production will be further reduced, thereby mitigating negative climate change impacts. In the context of the overall strategy of shifting energy consumption towards electricity, the share of energy needs supplied by low-emission technologies will increase. According to OKTE, in 2020, the emission intensity of electricity production from all sources was around 155 g CO_2/kWh, which ranks among the lowest in the EU. On the policy horizon of the Fit for 55 package, new zero-emission nuclear sources will come on stream and their share of electricity generation will exceed 60%. At the same time, there is scope for increasing the share of RES, which may not be evident at present for both wind and geothermal. Achieving around a quarter share of RES would require between EUR 300 and EUR 600 million depending on energy prices, while the implementation of the European energy package will significantly stimulate the spontaneous integration of small local RES. Provided adequate investment in the development of the transmission system, this creates room for a significant increase in both energy security and self-sufficiency. More significant development of additional geothermal potential can contribute to reducing the emission intensity of heat and cold production, which will also be supported by the expected decrease in the cost of investments in heat pumps due to technological progress. This would reduce the pressure to use biomass, which conflicts with nature conservation interests.

3.2.2 Estimation of the additional costs required for decarbonisation

The Marginal Abatement Cost Curve (MACC) has become a popular tool for green policy decision-making around the world in recent years. The MACC is a graph that allows you to compare decarbonisation options across different areas of the economy. The principle of the approach is to support measures that are the cheapest in terms of unit cost per tonne of CO_2eq abated. The specific MACC for Slovakia was developed at the end of 2021 in cooperation with Value for Money Department, IEP and BCG. This takes different approach to costs and emissions reductions than in the other chapters, so the values cannot be added together.

Through targeted measures, Slovakia can meet the 55% greenhouse gas reduction target by up to EUR 5 billion cheaper than the Low Carbon Study's main decarbonisation scenario. The MACC approach provides insight on how to decarbonise as cheaply as possible. Meeting the 55% decarbonisation target would cost EUR 2.7 billion according to the MACC, while the main decarbonisation scenario achieves a 47% greenhouse gas reduction in 2030 compared to 1990 for around EUR 8 billion. The same applies to Fit for 55 - as it is a set of specific measures, the resulting costs will be higher than if it is done purely on a cost-by-cost basis as in the MACC.

The MACC approach focuses exclusively on GHG emissions without broader environmental targets such as the share of renewable energy, energy efficiency, energy security or the share of CO_2 reduction in selected sectors. For example, due to Slovakia's low-carbon energy mix, renewable electricity sources do not feature in any of the measures defined in the MACC. Therefore, the MACC has lower costs without the need for large investments in RES and cogeneration. The MACC also does not take into account the interactions between the different measures, their secondary effects and assumes the status quo on which it is based. For example, the MACC approach assumes stable production in the industry and does not consider the possible evolution of technologies in the industries. There is also a difference in the approach to modelling, the MACC uses a 'bottom-up' approach, i.e. based on individual projects, and the Low Carbon Study, on the other hand, uses a 'top-down' approach, i.e. based on economic modelling. **Therefore, a combination of both models and their results is most appropriate.**

By 2030, it is possible to implement measures that will reduce gross emissions[20] by more than 30% compared to the status quo. Two emission reduction targets are identified - a 55% reduction (compared to 1990), which corresponds to the 2030 EU-wide target, and a 67% reduction, which corresponds to the reduction with all available measures, excluding CCS (carbon capture and storage). The largest reductions are possible in the industrial sector, which is also the biggest polluter. Significant savings can also be achieved in electricity and heat generation and transport, but in transport a significant part of emissions will

[20] Total emissions net of LULUCF removals

remain unremoved by 2030. It should also be noted that in order to achieve 55% reductions, it is necessary to aim for slightly more ambitious targets than just 55% reductions due to possible imperfect implementation.

Table 32: Emission reductions by sector by 2030 according to MACC ($ktCO_2eq.$)**

	Reduction of emissions			
	55 % target	67 % target	Cumulative	Gross emissions today*
Industry	2,078	6,229	8,308	16,466
of which: steel	*636*	*6,190*	*6,826*	*9,243*
of which: petrochemicals	*985*	*39*	*1,024*	*1,973*
of which: building materials	*387*	*0*	*387*	*3,672*
of which: chemical industry	*70*	*0*	*70*	*1,578*
Transport	388	1,268	1,557	7,915
Electricity and heat production	2,558	95	2,653	4,764
Buildings	119	0	119	4,604
Agriculture	185	248	433	3,124
Other	285	0	285	3,083
Waste	116	0	116	1,645
LULUCF (not landfills)	0	147	147	269
Total	5,729	7,887	13,617	41,870

***Only MACC measures selected that do not overlap with other measures in the Fit for 55 package*

** - 2016-2019 average* *Source: BCG: Value For Money Department*

The estimated costs of decarbonisation measures are divided between point source emissions and decentralised sources of emissions. Measures for point sources (e.g. electric arc furnaces in the steel industry) require one-off capital expenditure (CAPEX) and are mainly applied to industrial emissions. They also entail less implementation risk and quick implementation. Decentralised sources (e.g. fleet electrification, insulation) require annual recurrent investments (OPEX) and long-term change in the habits of individual consumers. They are more difficult to implement, require long-term planning and do not deliver emission reductions immediately. For example, infrastructure support for electric cars will take several years to have a significant impact on emissions, as the consumer fleet cannot be replaced immediately.

Reducing emissions by 67% by 2030 would require more than EUR 4 billion beyond the already analysed measures. The estimated cost of decarbonisation according to the marginal cost curve varies depending on the target set. The Table below presents a rough estimate of Slovakia's decarbonisation costs according to the targets of 55% and 67% emission reductions by 2030. Due to implementation risks, it is recommended to aim for more ambitious targets. The Table includes total CAPEX costs for point source emissions (not taking into account OPEX). For decentralised emission sources, net costs are included, i.e. less potentially reduced current expenditure (e.g. for fuel and energy savings). The costs are calculated from all relevant sectors, excluding measures found elsewhere in this document.

Table 33: Rough estimate of decarbonisation costs by 2030 according to MACC* (EUR million)

	55 % reduction		67 % reduction (cumulative with 55 %)	
(EUR million)	CAPEX - point sources	CAPEX + OPEX - decentr. sources	CAPEX - point sources	CAPEX + OPEX - decentr. sources
Transport	0	1,722.5	0	2,249.19
Industry	522.6	0	1,983.6	0
of which: steel	*59.18*	*0*	*1,426.8*	*0*
of which: petrochemicals	*393.6*	*0*	*487.6*	*0*
of which: building materials	*62.3*	*0*	*62.3*	*0*

of which: chemical industry	*6.9*	*0*	*6.9*	*0*
Electricity and heat production	225.3	231.2	300.3	231.2
LULUCF	0	0	0	94.8
Buildings	0	79.14	0	79.14
Agriculture	0	8.9	0	71.7
Waste	14.0	0	14.0	0
Other	2.2	-860.6	2.2	-860.6
Total	764.0	1,181.5	2,300.1	1,866.4
	1,945.5		4,166.5	

**Only MACC measures selected that do not overlap with other measures in the Fit for 55 package.*

Source: BCG, Value for Money Department

The sectors with the highest gross costs are transport and industry. Among industrial sectors, the steel industry requires the most resources, especially for the 67% reduction in emissions - almost EUR 1.5 billion, equivalent to more than a third of the total cost. The heat and power generation sector also contributes significantly. This sector includes measures that address both point (improving the efficiency of heating plants) and decentralised sources of emissions (insulation of buildings with central heating supply). The 'other' sector has a significant negative cost, which includes a measure to stop supporting coal mining in the Nováky mine and is associated with a reduction in subsidy expenditure (in the tariff for operating the system), which leads to significant savings.

Decarbonisation will require support from public sources. This support should consist of recurrent expenditure for decentralised emission sources and reimbursement of part of the capital expenditure for point sources. The amount of support needed depends to a large extent on external factors, in particular allowance prices, alternative investments, the price of electricity, gas, and etc. For example, an increase in allowance prices increases the incentive for companies to decarbonise from their own resources and thus reduce their expenditure on emission allowances. The decision of companies to decarbonise also depends on the availability of alternative investments that can offer companies a higher return on capital employed.

3.2.3 The impact of electromobility on the automotive industry

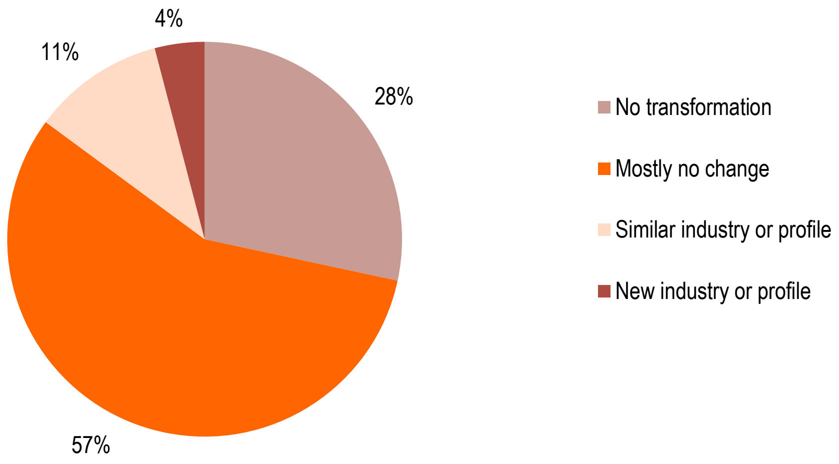
The tightening of CO_2 emission limits and the gradual transition to clean electric cars will threaten jobs in the European car industry less than expected. Although some jobs are going to be lost, many new jobs will be created in the electromobility value chain, especially in battery cell manufacturing and charging infrastructure (Dudenhöffer, 2021). Although electromobility will only have a moderate impact on the total number of jobs in the automotive industry in Europe, some job transformation is expected.

Workers who manufacture internal combustion engines will be most affected by the transition to clean electric cars. Up to 630,000 jobs are expected to be lost in the EU. However, demand for batteries, charging infrastructure and other services will create over 580,000 jobs in the future. The battery supply chain will be the largest source of new job growth (Kulhmann, et al., 2021).

Electromobility will have only a modest impact on the total number of jobs in the automotive industry in Europe. Around 1.6 million jobs will not require any transformation, job requirements may change slightly and on-the-job retraining of workers is going to be necessary. Around 610 thousand jobs will move to a similar sector and/or employment profile (e.g. workers from gearbox manufacturing will move to electric motor assembly). Retraining of workers will be necessary and some will have to move from one workplace to another. Around 225,000 jobs will move to another sector or to a new job profile (e.g. employees from the automotive industry will have to move to battery cell production). The retraining of workers and the relocation of workplaces will also be necessary in Slovakia. The remaining 3.2 million jobs out of a total of 5.6 million by 2030 will remain largely unchanged, allowing workers to perform related tasks without special retraining.

Slovakia can expect to lose 1.6% of direct jobs in the transition to electric vehicles [21] (Kulhmann, et al., 2021).

Graph 56: Impact of electromobility on the EU automotive industry (% of employment in the sector)



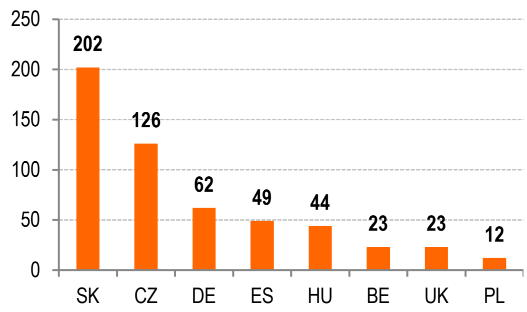
Source: IEP according to Kuhlmann et al., 2021

Slovakia is gradually breaking down a number of barriers for investment in the production of electric vehicles. The risk for changing production programmes in favour of electric cars was the lack of attractiveness for battery cell production. Potential investors located their operations within the region mainly in Hungary and Poland. Slovakia was less attractive due to high electricity prices and the lack of readiness of industrial parks with the necessary size, infrastructure and settled ownership. The competitive disadvantage was eliminated by the granting of a discount of up to 95 % on the tariff for system operation (TPS). Several State Industrial Parks are currently being prepared to enable the rapid establishment of new strategic investors. Concern decisions to relocate production programmes to other countries may be a continuing risk, as internal pressures to reduce costs and increase efficiency are very strong. Slovakia may have a disadvantage in providing investment incentives[22], which may receive higher investment support in neighbouring countries. The scope for investment incentives may be limited by fiscal targets. Given the high concentration of production in western Slovakia and in the wider CEE region, companies operating in Slovakia are interested in investing in local production facilities.

[21] The 4 automakers together with Tier-1 suppliers employ approximately 177 thousand employees. The total number of direct and indirect jobs linked to the automotive industry amounts to 270 thousand. Approximately 2.8 thousand jobs could thus be lost.

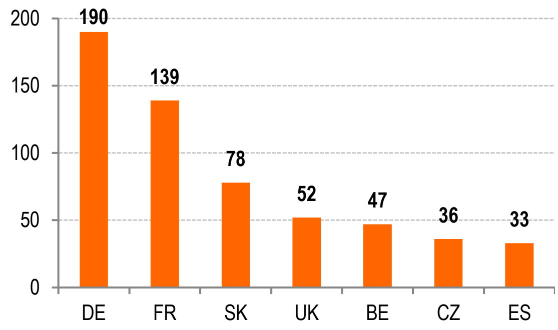
[22] According to the amended rules for the provision of investment aid, its intensity may reach 30 % in western Slovakia (except for the Bratislava region), 40 % in central Slovakia and 50 % in eastern Slovakia. However, the backbone of the automotive industry, which is vehicle manufacturers, is concentrated only in western Slovakia and partly in central Slovakia.

Graph 57: Number of cars produced per thousand inhabitants, 2020



Source: IEP according to SARIO (Slovak Investment And Trade Development Agency), 2022

Graph 58: Slovakia produced the 3rd highest number of electric cars in the EU in 2020 (in thousands of units)



Source: IEP according to CATI, 2021

The battery cell manufacturers' interest in Slovakia is both a positive and negative risk. Given the concentration of automotive production and its gradual transition to electromobility[23] the interest of manufacturers in investments is natural. In the long term, such production will strengthen the sustainability and competitiveness of the automotive industry. The demand for lower electricity prices is based on the fact that battery cell production is extremely energy intensive. A typical gigafactory may require an installed capacity of 200 to 400 MW, which may prevent the arrival of other major investors, as their energy needs could overload the transmission system. According to SARIO (Slovak Investment and Trade Development Agency), it is realistic that Slovakia will attract 1 to 2 battery cell manufacturers. **The investments may actually jeopardise the achievement of the energy efficiency target in industry, as there will be a significant increase in energy consumption.**

Risks related to the qualifications of workers and supplier structure are being reduced quite organically. As part of the corporate strategy, manufacturers focus on training workers in affiliated training institutions (e.g. JLR training academy in Nitra or Kia training centre in Gbeľany). In the context of the transition to electro-mobility, in many cases this is a change of operation, so retraining is organised in-house and also in cooperation with the public sector in the framework of dual training. The change in the supplier structure will be less pronounced in the case of multinational enterprises, which have sufficient capital and are already diversifying their production programmes. In the case of companies such as Magna PT (production of gearboxes in Kechnec, Košice-surrounding), there will probably be a gradual change of production, as this enterprise also has an electronics production plant in the same industrial park. However, some of the domestic companies which are highly specialised in components for internal combustion vehicles (e.g. specific components for gearboxes or internal combustion engines) may disappear.

3.3 Indirect impacts of the Fit for 55 package

The implementation of the Fit for 55 measures will also lead to indirect impacts, not all of which can be quantified. In the area of price level impacts, the most significant impact of the extension of the ETS to new sectors is estimated. The transport sector will also have an impact on the public sector budget.

[23] In 2020, almost 78,000 electric cars were produced in Slovakia, placing the domestic industry third in Europe behind Germany (190,000) and France (139,000).

3.3.1 Impact of the introduction of the EU ETS in the fuel sectors on the price level

The extension of the EU ETS to the road transport and building heating sectors will lead to an increase in consumer prices of fossil fuels depending on the price of emission allowances. The fuels that will be affected by the extension of the EU ETS form a significant part of the consumer basket of goods and services, through which the Statistical Office of the Slovak Republic monitors price growth. In the transport sector it is petrol, diesel and LPG, in the heating sector it is natural gas and lignite. Coal, which is also included in the new system, is not included in the consumption basket. In 2022, these items account for 6.2% of total household consumption. For low-income households (defined by the Statistical Office as the bottom 25% of households ranked by income) and pensioners, the share is slightly higher (6.4% and 6.5% respectively), mainly due to the higher share of heating expenses.

Table 34: Weights of fossil fuels in the consumption basket in 2022 (%)

	Total	Pensioners	Low-income households
Petrol	2.1	1.4	2.0
Diesel	0.7	0.5	0.7
LPG	0.1	0.0	0.1
Total fuels	**2.8**	**1.9**	**2.8**
Brown coal	0.2	0.2	0.3
Natural gas	3.2	4.3	3.3
Heating total	**3.3**	**4.5**	**3.6**
Total fossil fuels	***6.2***	***6.5***	***6.4***

Source: Statistical Office Of The Slovak Republic

The increase in the prices of these goods, as well as the impact on the overall increase in the price level, will depend primarily on the price of emission allowances. Allowance prices in the new scheme are expected to be initially lower than those in the EU ETS but will gradually converge towards their levels. The increase in consumer fuel prices can thus be divided into two phases - an initial spike in 2026 in response to the introduction of the new scheme, and a gradual increase in the following years in response to rising emission allowance prices. The following calculations of the impact on inflation consider three scenarios depending on the initial allowance price as well as the price assumption in 2035.

The first scenario assumes an initial allowance price of EUR 55/tCO_2, which is based on the allowance price in the new German ETS in 2025. The price will gradually converge towards the EU ETS price and reach 90 EUR / tCO_2 in 2035. The second scenario expects the possibility of a faster convergence, with the allowance price catching up with the EU ETS in 2035 and ending at EUR 105/ tCO_2. The third scenario illustrates the possibility that allowance prices are close to the EU ETS price of EUR 75/ tCO_2 at introduction.

Table 35: Predicted emission allowance price scenarios (eur/tCO_2)

	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Scenario 1	55	58.9	62.8	66.7	70.6	74.4	78.3	82.2	86.1	90
Scenario 2	55	60.6	66.1	71.7	77.2	82.8	88.3	93.9	99.14	105
Scenario 3	75	78.3	81.7	85.0	88.3	91.7	95.0	98.3	101.7	105

Source: Assumptions of IEP, IFP

The following Table shows, for each scenario, the expected price increase in 2026 when the scheme is introduced, the average annual increase between 2027 and 2035, as well as the cumulative price increase over the whole period under consideration. However, for natural gas, unlike the other items, maximum prices are set by the Regulatory Office for the Network Industries based on a formula that takes the average of daily future gas contract prices over the previous period and are usually adjusted once a year on 1 January. The calculation assumes that the price of emission allowances is already being taken into account for the 2026 price.

Table 36: The impact of the introduction of the ETS on prices of individual items (%)

	Scenario 1 55-90			Scenario 2 55-105			Scenario 3 75-105		
	2026	2027-35	cumul.	2026	2027-35	cumul.	2026	2027-35	cumul.
Petrol	8.8	0.6	14.3	8.8	0.8	16.7	12.0	0.5	16.7
Diesel	10.4	0.6	17.0	10.4	0.9	19.18	14.1	0.5	19.18
LPG	11.7	0.7	19.12	11.7	1.0	22.4	16.0	0.6	22.4
Brown coal	36.9	1.8	60.4	36.9	2.5	70.5	50.4	1.4	70.5
Natural gas	23.7	1.3	38.8	23.7	1.8	45.3	32.3	1.0	45.3

Source: calculations of IEP, IFP

The initial increase in fuel prices is about half of the drop and subsequent increase in prices caused by the pandemic. According to the input/output analysis, fuels represent a major part of costs only in the land transport sector (about 13%), in some sectors their share ranges from one to five percent (agriculture, mining, metal production, waste collection, warehousing and auxiliary transport activities, postal services), and in most sectors it is less than 1%. With such price increases, significant second-round effects in the prices of other goods and services are, therefore, not expected.

Table 37: The impact of ETS implementation on CPI level (p.p.)

	Scenario 1 55-90			Scenario 2 55-105			Scenario 3 75-105		
	2026	2027-35	cumul.	2026	2027-35	cumul.	2026	2027-35	cumul.
Petrol	0.2	0.01	0.3	0.2	0.02	0.3	0.2	0.01	0.3
Diesel	0.1	0.00	0.1	0.1	0.01	0.1	0.1	0.00	0.1
LPG	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00	0.0
Total fuels	**0.3**	**0.02**	**0.4**	**0.3**	**0.02**	**0.5**	**0.4**	**0.01**	**0.5**
Brown coal	0.1	0.00	0.1	0.1	0.00	0.1	0.1	0.00	0.1
Natural gas	0.8	0.04	1.2	0.8	0.06	1.4	1.0	0.03	1.4
Heating total	**0.8**	**0.04**	**1.3**	**0.8**	**0.06**	**1.6**	**1.1**	**0.04**	**1.6**
Total fossil fuels	***1.1***	***0.06***	***1.8***	***1.1***	***0.08***	***2.1***	***1.5***	***0.05***	***2.1***

Source: calculations of IEP, IFP

The introduction of the ETS for fossil fuels in the transport sector could increase inflation by 1.1 to 1.5 pp in 2026, depending on the initial price of emission allowances. Up to 70% of this increase would be attributed to the price of natural gas. In subsequent years, the rise in allowance prices would contribute between 0.05 and 0.08 p.p. per year to headline inflation. We expect the cumulative impact by 2035 to be between 1.8 and 2.1 p.p. However, these calculations are static, calculated from current weights, and do not assume a shift away from conventionally powered cars towards electric cars, nor lower natural gas consumption resulting from buildings insulation. **The ultimate impact on the price level in the long run may therefore be lower.**

Because of the higher share of heating expenditure, the impact on prices is expected to be slightly higher for low-income and pensioner households - cumulatively by 0.1 pp for low-income households and 0.3-0.4 pp for pensioner households by 2035. **However, in the long run, the inflation rate depends mainly on the ECB's monetary policy,** so relative prices may be affected in particular. The ECB's response to higher expected inflation will slow economic growth, which will put a brake on the growth of other prices of goods and services.

3.3.2 *The impact on the public sector*

Many of the effects of measures of expected increases in the prices of goods and services will be fiscally neutral. The increase in the price of fuels and products will be in the nature of imposing a tax, as both ETS revenues and consumption taxes are public revenues. The purchase of goods and services by public sector organisations will therefore be associated with higher expenditure, which will also be revenue, although there will be transfers between public sector organisations. The state or local government budgets will bear the main negative impacts, while the higher carbon price expenditure becomes revenue for the dedicated fund.

Meeting the Fit for 55 targets implies the need for additional public investments. The public administration will have to proceed with more intensive renovation of its building stock to contribute to energy savings, which may require an additional EUR 3.1 billion outside the EU funds. The Recovery Plan allocates EUR 213 million for the renovation of public and listed buildings. The investments secured under the Recovery Plan in the field of energy efficiency also include the construction and renovation of hospitals or courts. As part of the AFIR regulation, the State will also have to increase investment in alternative fuel infrastructure. The targets for charging infrastructure along the trans-European corridors are relatively unambitious and the private sector is actively making investments, reducing the relative need for public support. However, the State as a shareholder will also have to invest in charging infrastructure at airports, which will be required by the AFIR.

The extension of the ETS to the road transport and buildings sectors will also have significant impacts on public administrations. In the buildings sector, expenditure related to the provision of the energy needs of publicly managed real estate is expected to increase. Rising fuel prices in road transport will be reflected in the provision of public services such as urban or suburban public transport, waste management, ambulance services, but also in the routine operation of service vehicles. The chapters of the state budget spent around EUR 33 million on transport fuels in 2019. Given the typical fuel mix and scenarios for the ETS price in the road transport sector, expenditure could increase by between EUR 2 and EUR 6 million. The impact on the general government balance would be neutral as it would be a transfer within the public administration.

Table 38: Increase in expenditure by the state budget sections on the purchase of transport fuels (EUR million)

	Expenditure on fuel for transport purposes (2019)	Price of emission allowances (eur/t CO2)				
		35	55	75	90	100
State budget	32.95	2.01	3.16	4.31	5.17	5.74

Source: IEP according to RIS

Regional governments will bear the increase in expenditure associated with the provision of public transport services. The price of a separate ETS for the buildings and road transport sectors is assumed to converge to the price of existing emission allowances. At the current price of ETS futures at the level of EUR 90 per tonne of CO_2, securing the suburban bus transportation services would require increased expenditure of around EUR 26.3 million. As the emission allowances are expected to trade at EUR 100, the additional expenditure of the Higher Territorial Unit could amount to up to EUR 29.2 million.

Table 39: Increase in expenditure of the Higher Territorial Units on regional bus services (million euro per year)

	Price of emission allowances (EUR /t CO_2)

	Output in 2019 (mio. train-set km)	35	55	75	90	100
Bratislava	25.8	0.72	1.13	1.53	1.84	2.05
Trnava	43.0	1.19	1.87	2.56	3.07	3.41
Trenčín	47.3	1.31	2.06	2.81	3.37	3.75
Nitra	51.1	1.42	2.23	3.04	3.64	4.05
Žilina	52.0	1.44	2.26	3.09	3.71	4.12
Banská Bystrica	60.4	1.67	2.63	3.59	4.30	4.78
Prešov	34.1	0.95	1.49	2.03	2.43	2.70
Košice	54.8	1.52	2.39	3.26	3.91	4.34

Source: IEP according to Ministry of Transport and Construction of the Slovak Republic

The annual impact on the largest cities can potentially reach up to almost EUR 10 million. While regional transport is provided by buses of standard length, a significant volume of urban public transport services is also provided by articulated vehicles, which is associated with higher expected fuel consumption. At the same time, alternatively fuelled buses still have a relatively low share of total performance. Almost 57 % of services within the 6 largest cities is covered by the transport company of the capital city, the other 22 % is provided by the Košice City Transport Company. At the current price of emission allowances, the capital city's expenses would increase by approximately EUR 4.9 million and in the case of Košice it would be EUR 1.9 million. The other cities would bear an increase in expenditure of approximately EUR 1.8 million. If the emission allowances price reache a long-term realistic level of EUR 100 per tonne, expenditure would increase by EUR 5.4 million in the capital, EUR 2.1 million in Košice and EUR 2 million in the other cities.

Table 40: Increase in spending on public transport by the largest cities (EUR million per year)

	Output in 2019 (mio. train-set km)	Price of emission allowances (EUR /t CO_2)				
		35	55	75	90	100
Bratislava	51.3	1.90	2.98	4.07	4.88	5.43
Nitra	7.0	0.26	0.41	0.56	0.67	0.75
Žilina	3.1	0.12	0.18	0.25	0.29	0.33
Banská Bystrica	4.4	0.16	0.26	0.35	0.42	0.46
Prešov	4.6	0.17	0.27	0.37	0.44	0.49
Košice	20.2	0.74	1.12	1.60	1.92	2.13

Source: IEP according to Ministry of Transport and Construction of the Slovak Republic

We assume that the increase in costs will be fully passed on to the customer of the transport services. In the context of rising fuel prices, transport companies are likely to increase their demand for a subsidy from the customer, as this would be an eligible cost. The impact of extending the ETS to cover buildings and road transport would therefore be purely a budgetary impact in the area of public transport. In the case of a partial transfer of the burden to passengers through an increase in the transport fare, the public sector would bear the majority of the burden. Given the severely limited ability of local governments to influence their own revenues, such an increase in expenditure would entail an excessive budgetary burden.[24]

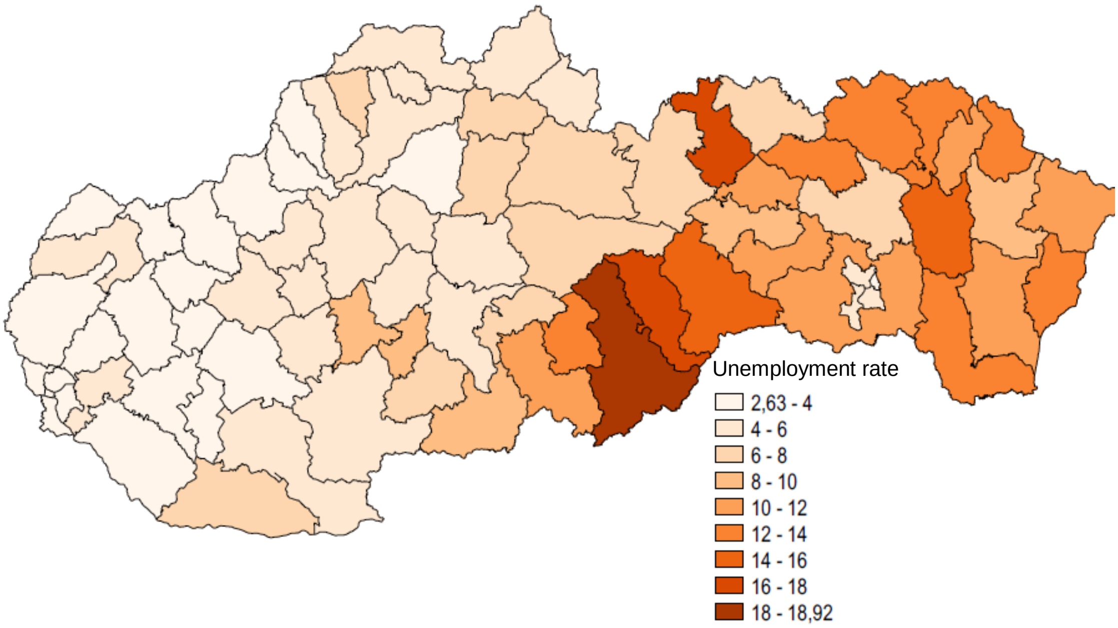
3.4 Necessary measures to mitigate negative social impacts

Increased fossil fuel prices will have significant social and distributional impacts that will be regionally uneven. The intensity of the impacts will be primarily defined by the socio-economic indicators of the region and the availability of alternatives to cushion the increase in fuel prices. A higher risk of deepening energy and fuel poverty can be assumed primarily in the Prešov, Košice and Banská Bystrica regions. Large parts of these regions also have insufficient coverage and quality of railway infrastructure, which could form the backbone of alternative transport to work. Income levels will also have a significant influence on the

[24] The solution could be effective state subsidy schemes or recycling of investment resources through the use of guaranteed energy services.

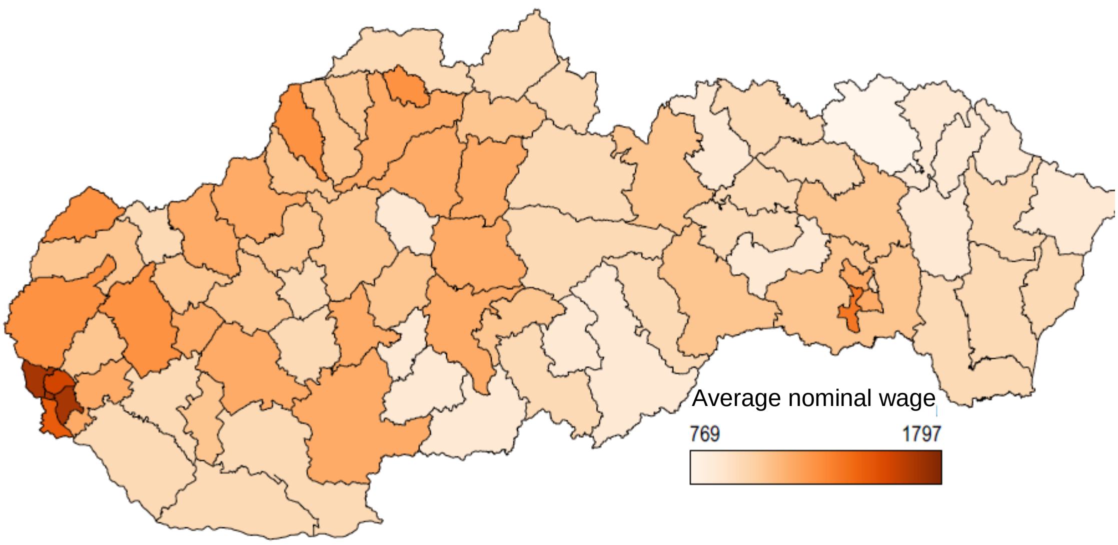
intensity of the impact, with lower income households feeling the impact of rising fuel prices more intensely. The possibility of switching to cheaper fuel will be influenced by the gasification of the region, but mainly by the availability of support. The support should particularly consider households at risk of energy and fuel poverty, as they often do not have access to bank loans or guarantees and do not have the social skills to access support schemes.

Map 2: Average unemployment rate 2016-2020 (%)



Source: IEP according to Statistical Office Of The Slovak Republic

Map 3: Average nominal wage 2016-2020 (in EUR)



Source: IEP according to Statistical Office Of The Slovak Republic

A Social Climate Fund has been established to mitigate the negative impacts of selected parts of the Fit for 55 package. The maximum financial allocation for Slovakia will be EUR 1.7 billion, representing 2.36% of the total allocation. Member States should contribute at least 50% of the total estimated costs. The Fund will operate from 2025 to 2032 and will be linked to the National Energy and Climate Plans (NECPs). Vulnerable groups are defined as those people who spend a substantial part of their income on energy and transport, or those who do not have access to affordable mobility and transport alternatives in certain locations. Only measures and investments directly targeted at vulnerable households, micro-enterprises or transport users will be eligible for funding from the Fund (European Commission, 2021).

Box 6: Social Climate Fund

Social Climate Fund aims to reduce the impact of the new EU ETS on the prices of fossil fuels. As these impacts can disproportionately affect vulnerable households and micro-enterprises as well as vulnerable transport users, the European Commission has proposed the introduction of a Social Climate Fund. The Fund should provide funding to Member States to support domestic policies aimed at addressing these impacts. This should be in the form of temporary compensation (direct payments to citizens - income support) or in the form of investments in climate action to reduce dependence on fossil fuels (e.g. building insulation, energy efficiency, access to zero-emission transport, etc.) (WWF, 2021). The new fund complements existing budget instruments that focus on investments and skills related to the transition to a low-carbon economy.

The Social and Climate Fund will operate from 2025 to 2032 and will be linked to the National Energy and Climate Plans (NECP). In the first two years it will overlap with the Recovery and Resilience Plan. It also builds on the Just Transition Fund, whose aim is to provide support to territories facing serious socio-economic challenges resulting from the transition to climate neutrality (European Commission, 2021).[25] The Fund and social climate plans will be linked to and framed by the planned reforms and commitments made in the National Energy and Climate Plan. Under the climate governance framework, Member States are required to update their integrated NECPs in 2023.

The Fund shall provide financial support to Member States to finance the measures and investments set out in their national energy and climate plans. Under the Energy Union Governance Regulation, Member States are required to update their integrated NECPs in 2023. The updated NECP is to be valid from summer 2024 until 2029, when a new NECP is to be developed. The disbursement of support is conditional on the achievement of milestones and targets for actions and investments to be set by Member States in their NECPs. The milestones and targets are in line with the EU's climate goals and include - energy efficiency, building renovation, low to zero emission mobility and transport, a general reduction in greenhouse gas emissions and a reduction in the number of vulnerable households (especially households suffering from energy poverty), vulnerable micro-enterprises and vulnerable transport users, including in rural and remote areas. However, the Fund will only support measures and investments that correspond to the "no significant harm" principle set out in Article 17 of Regulation (EU) 2020/852 (European Commission, 2021).

Member States will have until June 2024 to publish their "social climate plans" for approval by the Commission, setting out how they will spend the allocated money. Member States can only include measures and investments that directly benefit vulnerable households, micro-enterprises or transport users in their estimated total costs. The EC identifies 6 specific areas which measures, and investments proposed by Member States must cover:

1) **support building renovation,** especially for those in the worst performing buildings, including in the form of financial support or fiscal incentives, such as the deductibility of renovation costs from rents, irrespective of the ownership of the buildings concerned;

[25] The implementation of the Social Climate Fund through the Member States' NECP will also be consistent with the policies and actions supported by various other EU instruments that support a socially just transition. These include, for example, the Action Plan for the Implementation of the European Pillar of Social Rights, the European Social Fund Plus (ESF+), the Just Transition Mechanism under Regulation (EU) 2021/1056, Member States' long-term building renovation strategies under Directive 2010/31/EU of the European Parliament and of the Council, and the European Observatory on Fuel Poverty (European Commission, 2021).

2) **contribute to decarbonisation,** including the electrification of heating, cooling and cooking in buildings, and the integration of renewable energy, which contributes to achieving energy savings;
3) **support public and private enitites** in developing and delivering affordable energy efficiency solutions and appropriate financing instruments in line with the social objectives of the Fund;
4) **provide access to zero- and low-emission vehicles and bicycles,** including financial support or fiscal incentives for their purchase, as well as appropriate public and private infrastructure, including charging and refuelling; for support related to low-emission vehicles, a timetable for phasing down support shall be provided;
5) **provide free access to public transport** or adapted tariffs for access to public transport, as well as promote sustainable on-demand mobility and shared mobility services;
6) **support public and private actors in the development and provision of affordable zero- and low-emission mobility** and transport services and the use of attractive active mobility options for rural, island, mountainous, remote and less accessible areas or for less developed regions or territories; including less developed suburban areas.

The total financial coverage of the Fund for the period 2025-2032 will be EUR 72.2 billion at current prices, which would be close to 25% of the expected revenues from the inclusion of the road transport and buildings sectors in the new EU ETS. The Commission plans to propose an amendment shortly to complement the Multiannual Financial Framework Regulation 2021-2027 to take into account the additional Union expenditure of EUR 23.7 billion for the period 2025-2027. The expenditure should be earmarked in advance to allow for a smooth transition to the new ETS scheme. However, the amount of EUR 48.5 billion for the period 2028-2032 will depend on the availability of funds within the annual ceilings of the current multiannual financial framework.

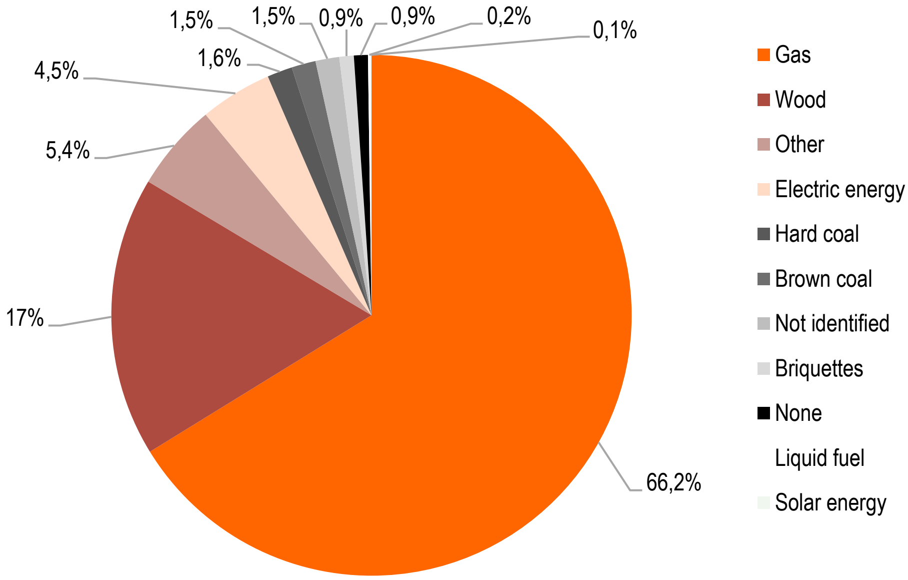
According to the European Commission's calculations, the maximum financial allocation for Slovakia will be EUR 1.7 billion at current prices, which is 2.36% of the total Social Climate Fund. Between 2025 and 2027, the maximum financial allocation for Slovakia will be EUR 558 million and from 2028 to 2032 it will be EUR 1.142 billion. Slovakia can thus submit an application for a financial contribution from the Social Climate Fund up to the maximum financial allocation. Member States should contribute at least 50% of the total estimated cost of their social climate plans. In addition, Member States may use the revenues from auctioning their allowances in accordance with Chapter IVa of Directive 2003/87/EC for their national contribution to the total estimated costs.

3.4.1 Mitigating the impact of increased prices of selected heating fuels

Approximately 50 %[26] of households living in apartment building are already heated by energy already covered by the ETS. These are mainly households connected to district heating systems, for which the price should not increase. The remaining households heated with gas and coal will see their energy prices rise. Up to two thirds of households in Slovakia heat with natural gas. In order to mitigate the negative impacts of extending the EU ETS, it will be advisable to replace coal boilers with gas boilers in areas where gas is available. Where gas is not available, from an environmental point of view it is advisable to use electric heating or wood heating or wood alternatives, which will not be covered by the ETS as they are considered carbon neutral.

[26] Estimate from the MINISTRY OF ECONOMY OF THE SLOVAK REPUBLIC according to the Slovak Association of Heat Producers.

Graph 59: Heating of Slovak households by fuel



Source: IEP according to Slovak Hydrometeorological Institute And Statistical Office Of The Slovak Republic

It will be most cost-effective for households that currently heat their unrenovated homes with coal to insulate them and switch to wood heating. Where a gas connection is available, gas heating may also be appropriate, but this will also be subject to the ETS. Fuel switching to electricity is only profitable in the very long term. A considerable part of the population also heats with electricity (especially the districts of Liptovský Mikuláš, Senec and Dunajská Streda) and, especially in south-western Slovakia, the installation of solar energy equipment may also be appropriate. In this case, however, it is region-specific, so it can be assumed that households will primarily switch to biomass or gas. **With the exception of switching to electricity, households will also achieve significant savings compared to the current costs associated with heating their homes.**

Table 41: Fuel switching from coal to other fuels (non-renewed family houses)

Annual cost of coal today (euros)	1,287			
Annual cost of coal with ETS (EUR)	1,930			
Investment cost of renewal (eur)	12,936			
Switching from coal to...	**Gas**	**wood pellets**	**Wood**	**electricity**
Investment cost of switching to a given fuel (EUR)	6,000	5,900	3,820	3,430
Annual cost of a given fuel after refurbishment and with ETS (EUR)	669	458	347	1,480
Annual saving compared to the increased price with ETS (EUR)	1,261	1,472	1,583	450
Annual saving compared to today (EUR)	517	729	840	-293
Return on total investment (in years)	15	12.8	10.6	36.3
Return on household investment with 50% support (in years)	7.5	6.4	5.3	18.2

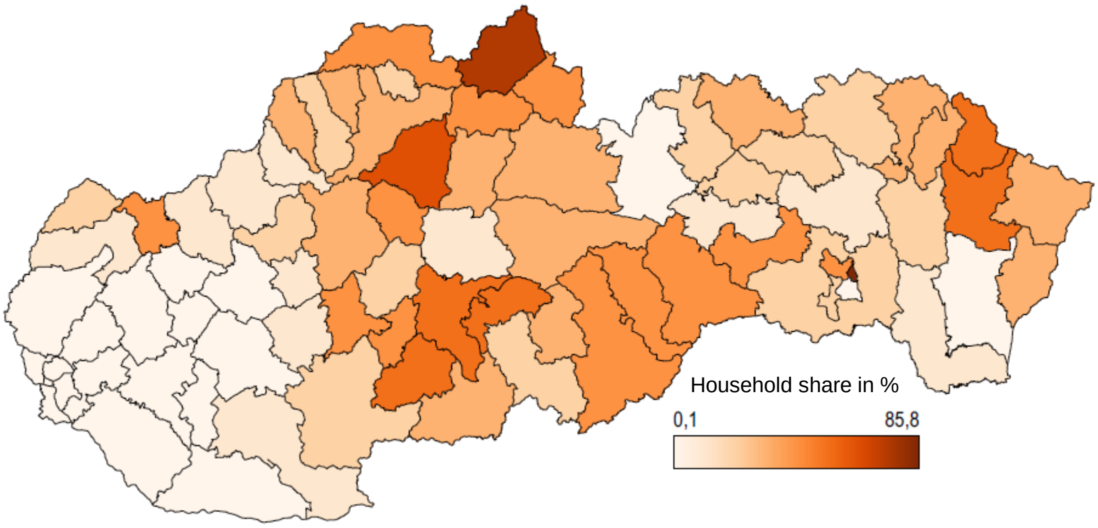
Source: IEP by oplyne.info and energy-portal [27]

Switching to biomass heating has a negative externality in the form of dust particles. When wood is used as fuel, the amount of PM_{10} and $PM_{2.5}$ particulate matter emitted in 2 days is the same as that emitted

[27] Methodology to calculate-to be filled

by a car in a year (Lawrence, Sokhi, & Pavindra, 2016). $PM_{2.5}$ can reach the alveoli of the lungs and are responsible for over 1,500 premature deaths per year and are linked to up to 5% of all deaths in Slovakia. The economic cost of premature deaths is estimated at 5.3 billion euros per year or 6.9% of GDP, where the direct cost is more than half a billion euros (Antalová & Markandya, 2021). The European Commission has opened infringement proceedings against Slovakia for non-compliance with the limit levels for PM_{10} and $PM_{2.5}$ in the air. Domestic heating accounts for up to 77% of air pollution by particulate matter (MoEW, 2020). For these reasons, wood heating is banned or restricted in some cities, particularly in the USA and Britain (BBC, 2020).

Map 4: Proportion of households heating with solid fuel [28]



Source: IEP according to Statistical Office Of The Slovak Republic

The only solution to reduce particulate matter emitted from solid fuel combustion is to replace old heating appliances with new ones. They have to meet stricter standards, are more efficient and thus produce fewer emissions. Certified boilers have significantly less heat loss due to the use of new materials, more even combustion, which reduces PM and less chimney fouling, and significantly better sealing, which prevents the penetration of dust particles into households. The main benefit of the new boilers is that they produce less greenhouse gases and that they produce up to 80% less $PM_{2.5}$ compared to the old boilers.

Poor quality or poorly processed firewood is also a problem for heating with wood. Firewood has significantly higher emissions if it is not dried properly. In 2019, the UK adopted a strategy (Department for the Environment UK, 2019), which aims to reduce airborne particulates by 46% by 2030, which includes phasing out wood heating in locations where other alternatives such as gas exist. In places where gas or electricity cannot be used for heating, heaters not directly burning wood, but rathe burning other wooden fuels are going to be installed. Examples of wooden fuels are wood pellets or briquettes, which are made from properly dried wood and have a higher calorific value than conventional wood.

A possibility to reduce the production of fumes and increase the efficiency of heating is to reduce heat losses. This can be done by insulating both old and newer buildings. A fully insulated house can reduce consumption by up to 70%, and a fully insulated apartment by up to 43%. Reducing the amount of energy needed for heating also reduces the amount of fuel and emissions associated with heating. The insulation of buildings is also part of the Renewal and Resilience Plan, in which EUR 528 million will be allocated to improving the energy performance of family homes between 2022 and 2026. According to the data of the Statistical Office of The Slovak Republic from the 2021 Census of Population, Houses and Flats, 60 % of

[28] In addition to coal, solid fuel also includes wood or briquettes.

family houses and 79 % of apartment houses have undergone at least partial renovation, primarily by replacing windows. Only 31 % of family houses and 56 % of flats have had their envelope renewed, which represents a great potential for further renovation. **In the case of insulation, even households that heat with gas can significantly reduce their heating costs.**

Table *42*: Fuel switching from gas to other fuels (non-renewed family houses)

Annual cost of gas today (EUR)		1,620	
Annual cost of gas with ETS (EUR)		2,045	
Renewal investment costs (eur)		12,936	
Switching from gas to...	**Electricity**	**Wood pallets**	**wood**
Investment cost of switching to a given fuel (EUR)	3,430	5,900	3,820
Annual cost of a given fuel after refurbishment and with ETS (EUR)	1,480	458	347
Annual saving compared to the increased price with ETS (EUR)	565	1,587	1,698
Annual saving compared to today (EUR)	140	1,162	1,273
Return on total investment (in years)	29.0	11.9	9.19
Return on household investment with 50% support (in years)	14.5	5.9	4.9

Source: IEP according to ZSE, oplyne.info and energie.portal

In the case of already renovated houses, it will only be possible to achieve savings by switching to biomass. This applies both to those households that now heat with coal and those that heat with gas. However, the payback period for heating with wood pellets is more than twice as long as for heating with wood. In the case of a switch from coal to wood pellets, home heating costs can be expected to be around 11% higher than today, but still significantly lower than for coal heating after the introduction of the ETS for buildings. For the calculations we have assumed an ETS price of EUR 75/tCO_2e. If the ETS price was higher, the payback would be shorter. At the same time, it would mean higher revenues for the Social Climate Fund.

Table 43: Fuel switching from coal to other fuels (renovated family houses)

Annual cost of coal today (euros)		412
Annual cost of coal with ETS (EUR)		635
Switching from coal to...	**Wood**	**Wooden pallets**
Investment cost of switching to a given fuel (EUR)	3,820	5,900
Annual cost of a given fuel after refurbishment and with ETS (EUR)	347	458
Annual saving compared to the increased price with ETS (EUR)	288	177
Annual saving compared to today (EUR)	65	-46
Return on total investment (in years)	13.3	33.3
Return on household investment with 50% support (in years)	6.6	16.7

Source: IEP according to ZSE, oplyne.info and energie.portal

Table 44: Fuel switching from gas to other fuels (renovated family houses)

Annual cost of gas today (EUR)		542
Annual cost of gas with ETS (EUR)		669
Switching from gas to...	**Wood**	**Wooden pallets**
Investment cost of switching to a given fuel (EUR)	3,820	5,900

Annual cost of a given fuel after refurbishment and with ETS (EUR)	347	458
Annual saving compared to the increased price with ETS (EUR)	322	211
Annual saving compared to today (EUR)	195	84
Return on total investment (in years)	11.8	27.9
Return on household investment with 50% support (in years)	5.9	13.9

Source: IEP according to ZSE, oplyne.info and energie.portal

Approximately 50% of households living in apartment buildings are already under ETS and including the rest will level the terms. There will be an increase in costs in those apartments that are not under central heating and therefore not under ETS, as unlike centrally heated households, they do not pay for ETS today. In the case of non-renovated apartment building, there could be significant savings after insulation, although the savings for flats tend to be lower than for houses.

Table 45: Household costs in apartment buildings without central heating supply

Annual heating costs today (EUR)	462
Annual heating costs with ETS (EUR)	591
Investment costs for renewal (EUR)	6,800
Annual cost of heating with ETS after renewal (EUR)	337
Annual savings (EUR)	254
Return on investment (in years)	26.8
Return on investment with 50% support (in years)	13.4

Source: IEP according to ZSE, oplyne.info and energie.portal

Heat pump heating is also an eco-friendly heating option. However, this alternative is very expensive and switching to a heat pump is more than 2 times more expensive than switching to gas, with costs almost comparable to gas heating. The lifetime of heat pumps is stated to be 15 years, but the return on investment is in the range of 14-18 years. For these and other reasons, the heat pump is an alternative suitable only for a relatively small part of the population, especially in the southern warmer Slovak regions.

Changing the heating method will also have an impact on the amount of gas and biomass consumed. If all households living in houses with gas heating options used this option, household consumption would increase by 11%, an overall increase of around 4%. To offset the increase in gas consumption, 11,500 gas-fired homes would need to be rebuilt, which is also in line with the Recovery and Resilience Plan target. There are still 34,000 coal-fired households in Slovakia. In the most pessimistic scenario, if all these households switched to wood heating, an additional 411 thousand m^3 of wood would need to be extracted, representing an increase in extraction of 5.5%. The estimate is based on the average renewal rate of buildings, but it is likely that households heating with coal will have a higher renewal potential.

3.4.2 Measures to reduce energy poverty

Energy poverty in Slovakia has so far been addressed only in the context of a sharp increase in energy prices for households and exclusively in the form of ad-hoc measures. The last time such a situation arose was at the beginning of 2022, when, according to data from the Regulatory Office for the Network Industries, average prices in 2022 rose by 13.5% compared to 2021 for electricity, 22.1% for gas and 8.6% for heat supplied through district heating systems. The energy poverty issue is the responsibility of the Regulatory Office for Network Industries. In February 2020, the Regulatory Office for the Network Industries presented a Concept for the Protection of Energy Poverty Eligible Customers, the Concept was not approved by the Government and no systematic measures have been taken. Currently, the Regulatory

Office for the Network Industries is preparing a new concept, which is expected to be presented in autumn 2022.

Average price growth can hide considerable variability in price growth for different types of households. For electricity and gas, it depends on what the household uses the energy for. For example, for gas, average prices rose by 9.1% in 2022 for households using gas for cooking only, but by up to 23.8% for households using gas for cooking, hot water and heating. For heat, the situation is even more complicated. Unlike electricity and gas, where all households fall under the regulated segment, for heat prices are regulated only for households connected to the district heating system. For households with so-called residential boiler rooms (owned by the owners of the flats), the prices of heat production are not regulated. For regulated households, the period in which heating plants purchase the energy inputs needed for heating and hot water may play a significant role in the price (the strategy of purchasing natural gas in 2021 has proven to be key).

Low-income households are more affected by energy price increases than high-income households, as the share of energy expenditure in their total expenditure is higher than that of high-income households. Low energy efficiency results in high energy consumption, thus putting the households concerned at a disadvantage compared to households with similar incomes but higher energy efficiency in housing and heating. **These households often do not have the resources to invest in energy efficiency measures, do not have access to bank loans or guarantees, and do not have the social skills to access support schemes.**

Box 7: Definitions of energy poverty

There is no official definition of energy poverty in Slovakia. The Act on Regulation of Network Industries defines it broadly as "*a condition where the average monthly household expenditure on electricity, gas, heating and hot water consumption constitutes a significant proportion of the average monthly household income"*. In practice, however, it is difficult to set up a definition that clearly defines fuel poverty on the basis of quantitative income and expenditure criteria and, on the other hand, correctly targets those groups of households that actually face the greatest risk of vulnerability. Therefore, also according to the Slovak Academy of Sciences study, of the five countries analysed that systematically address this phenomenon, only the UK has clear and implementable definitions of energy poverty, with different definitions at central and local level (Dokupilová, Gerbery, & Filčák, 2020).

The Energy Efficiency Directive of the Fit for 55 package proposes a definition of energy poverty as a household's lack of access to energy services that underpin a decent standard of living and health, including adequate heating, cooling, lighting and electricity for appliances in the relevant national context, existing social policy and other relevant policies. The resulting definition from this proposal will need to be transposed into Slovak legislation.

The general definition of energy poverty is that it results from a combination of low income, a high proportion of net income spent on energy and poor household energy efficiency. Another important characteristic is that households in energy poverty are unable to keep their homes sufficiently warm. It is problematic to define energy poverty solely on the basis of an income threshold, as not only low-income households suffer from energy poverty, but also lower-middle-income households. However, setting the threshold at a higher level than low-income households runs into the problem that support could be disproportionately high relative to the cost to the public budget. A logical step is therefore to set a limit for the combination of total disposable income and household energy expenditure, for example determining the minimum income limit to be left to the household after deducting energy expenditure.

However, this step brings a number of complications. Firstly, genuinely poor households tend to conserve energy as much as possible and therefore their energy expenditure does not reflect their actual need for ensuring sufficient heat in the home. Secondly, high energy expenditure is often linked to an inappropriate household energy mix, wasteful consumption or energy-inefficient housing (old houses, leaks, unattractive windows, etc.), which may also be in conflict with environmental objectives (coal heating). Thirdly, these indicators show the situation at present and do not take into account other important factors that led to it. In addition, low-income households that met the energy poverty criteria but that have already invested in improving the energy efficiency of their homes may already have lower energy expenditures today but may have previously had to take out a loan to do so or have used up a significant part of their savings.

All of these application issues argue in favour of the view that energy poverty cannot be separated from overall poverty, and therefore in some cases it may be more effective to focus on indicators of poverty as a whole, which takes into account not only current income and expenditure but also overall assets and housing condition. The authors of the study in question, the Slovak Academy of Sciences, recommend that households whose energy costs per m^2 exceed the national median and whose income level is below the 30th percentile should be considered energy poor. Alternatively, households could be considered to be at risk of energy poverty if they are left with less than 1.5 times the subsistence minimum after energy costs and at the same time their energy costs per m^2 of living space are higher than the national median (Dokupilová, Gerbery, & Filčák, 2020).

Using data from the 2015 Family Accounts, the authors of the study calculate that 14.5% of households are at risk of energy poverty under the first definition. The most affected region would be the Košice region with 19% of households in energy poverty, followed by the Banská Bystrica region (15.4%) and the Trnava region (14.3%). The majority of the population at risk of energy poverty lives alone (32%) or in a couple (50%), and the majority live in flats with an area of close to 50 m^2, which they also own. 8.8% of households meet the conditions of the second definition. Most of them live in separate family houses which they owners. Most of them (20%) live in small villages with up to 1000 inhabitants. Up to half of the households consist of one (20% of cases) or two (30%) household members (Dokupilová, Gerbery, & Filčák, 2020).

The disadvantage of both definitions is their focus on current costs, which are not optimal. Energy costs could be much lower, which is due to the energy inefficiency of buildings or equipment used in the home. On the contrary, some households have energy costs much lower than might be expected. This may be due to inadequate heating due to lack of finance. There are also general objections to the very notion of 'energy poverty', where only the notion of 'poverty' per se is preferred. The preference for addressing 'energy poverty' by, for example, subsidising energy may lead to a situation where a proportion of people will still be living in energy inefficient apartments and will not have sufficient resources, for example, for food.

Based on the above characteristics of energy poverty and examples from abroad, economic policy measures to alleviate energy poverty could focus on three main areas:

- **Investment measures to improve energy efficiency** by combining simple and cheap approaches with those that require higher investments. These range from more efficient indoor lighting, door and window painting, reflective foils for radiators, thermometers, replacing domestic appliances and replacing inefficient heating systems (using renewable energy where possible), to deep renovation of buildings. In some cases, it may be more profitable to relocate people and create a social housing system using new passive houses**. Households at risk of energy poverty, who may not have**

sufficient resources to co-finance investments, will require a special approach, either through increased support or a bank loan. The EBRD provides guarantees to commercial banks that develop a favourable banking product for higher risk clients. It is appropriate to continue established schemes in this area (e.g. to build on the renovation of buildings by the Slovak Environmental Agency in the framework of the Recovery and Resilience Plan).

- **Provision of financial support for the poorest and most affected by energy poverty.** The proposal for a Regulation of the European Parliament and of the Council establishing the Social Climate Fund includes a provision proposing the possibility of using part of the Fund's resources to provide direct financial support to low-income households in energy poverty. However, in the current debate, a significant proportion of net contributors to the EU budget are opposed to such an option, as it would in practice mean promoting energy inefficiency in homes, which is contrary to the philosophy of the Fit for 55 package.
- **Improving awareness of the measures** and improving the access of affected households to participate in the Social Climate Fund measures. This could include e.g. existing and planned regional and local energy centres.

Decisions on energy poverty measures should be preceded by work on defining energy poverty in Slovakia, which, however, in view of the above facts, will not be able to include a single definition of energy poverty based on quantitative indicators. Rather, it should be a comprehensive set of indicators used in combination with an assessment of the individual situation of low-income households in terms of the energy efficiency of their homes. As EU funding is likely to be used to a large extent for investments in improving energy efficiency in dwellings, it is important to consider that **poor households are not the type of applicants that participate in demand-oriented calls**. Therefore, a strong cooperation and competence of local authorities in this area seems to be an essential part of the effective allocation of such resources.

Particular attention will need to be paid to households at risk of energy poverty, heating with coal or gas and living in houses that have already been renovated. Possible investments in insulation or replacement of boilers may be ineffective if similar investments and therefore savings have already been made in the past. Based on the EU SILC 2020 survey, almost 800 000 people in Slovakia were at risk of poverty or social exclusion. This represented 14.8% of the total population of Slovakia (Statistical Office of the Slovak Republic, 2021). The Long-term Strategy for the Renewal of Buildings 2020, which is part of the Integrated National Energy and Climate Plan of the Slovak Republic until 2030, states that more than 67.87% of flats in residential buildings have been renovated nationwide (Ministry of Transport and Construction of the Slovak Republic, 2020). It can be assumed that households in higher income groups were more likely to have had the financial means for renovation, and the population at risk of energy poverty represents a rather large potential for building renovation. It can be assumed that this population group should not be large, but it is necessary to target both renovation and fuel indicators in the context of energy poverty mapping.

An essential prerequisite for the implementation of energy poverty instruments is the development of a draft concept and its subsequent adoption by the Government of the Slovak Republic. It sets out protection and assistance instruments directly for vulnerable customers or indirectly through the definition of public policies - in particular in the field of social support or through special instruments implemented through the definition of tasks in the exercise of price and non-price regulation in network industries. It is expected to start in 2023, with associated data collection[29] for informed assessment of eligibility for energy poverty protection instruments, including better targeting of Social Climate Fund measures from 2025 onwards.

[29] The Regulatory Office For Network Industries is currently exploring the possibility of creating an anonymised universal subscriber identifier. Implementation can be expected at the earliest from the start of the new regulatory period (i.e. 2023). If put into practice, the identifier would allow to target individual public policies with regard to actual energy consumption by customers. If the database is linked to the databases of other state and public administration bodies, the concept has the potential to become a tool for targeted assessment of the eligibility for assistance of a consumer at risk of energy poverty.

3.4.3 *Mitigating the impact of increased transport fuel prices*

Higher population and job densities mean lower travel distances to work and for recreation, as well as a higher likelihood of good public transport. In Slovakia, the best public transport accessibility is in the west of the country. According to the 2015 National Mobility Survey, approximately 30% of trips are made to get to work or school (Kováč & Hlavatý, 2020). People living in rural areas make the fewest, but longest, trips (Table 46).

Table 46: Length of roads in Slovakia by type of agglomeration

Type	Average journey length (in km)	Momentum (number of trips per person per day)
Nuclear village	12.5	2.3
Small towns	10.9	2.3
Medium towns	10.4	2.4
Large cities	10.8	2.5
Rural municipality	13.3	2.1

Large city - from 50 thousand inhabitants; Medium city - 20 thousand - 50 thousand inhabitants; Small city - up to 20 thousand inhabitants. inhabitants; core municipality - within 30 min access distance from regional centres as defined by KURS.
Source.Kováč & Hlavatý, 2020

Rural municipalities and municipalities in regions where people travel far for work would be most affected by changes in fuel prices (Trnava, Banská Bystrica). According to social security and health insurance data, in 2018, 64% of the population worked in the same municipality as they lived, while 36% commuted to another district (Table 47). The Bratislava and Košice regions have the highest number of people living and working in the same municipality or district.

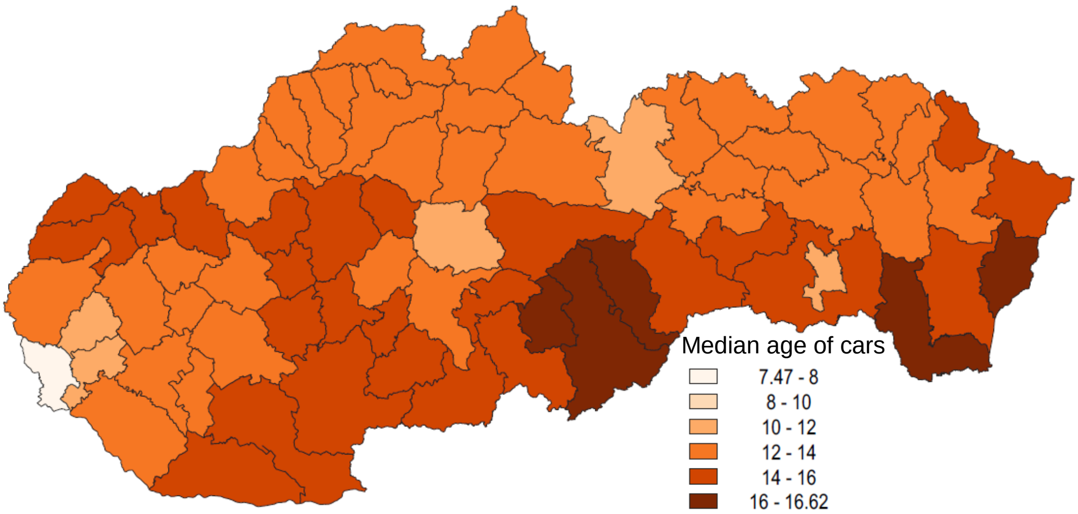
Table 47: Commuting to work

Region	Population with a job in the municipality of residence	Population with a job in another district
Bratislava	83 %	17 %
Košice	67 %	34 %
Nitra	60 %	40 %
Prešov	60 %	40 %
Žilina	58 %	42 %
Banská Bystrica	56 %	44 %
Trenčín	56 %	44 %
Trnava	52 %	48 %

Source: Value For Money Department according to the Financial Policy Institute

The oldest cars can be found in southern Slovakia, in Záhorie, Ponitrie and on the border with Ukraine. Poltár, Rimavská Sobota, Trebišov and Sobrance are the districts with the highest median age of vehicles, which is twice the age of cars in Bratislava. It can be assumed that the residents of these districts will be the most affected by transport poverty, as they already lack the means to renew their vehicles.

Map 5: Median age of cars in districts of the Slovak Republic



Source: Ministry Of Interior Of The Slovak Republic, IEP own processing

Investments should be concentrated in regions where there is a high potential for deepening energy poverty. Criteria for targeting support should be the state of local infrastructure, socio-economic characteristics such as unemployment or wage levels, but also the state of individual car transport vehicles. The increase in fuel prices has a greater impact on economically less developed regions, where there are also insufficient alternatives, e.g. in the form of reliable railway transport with attractive timetables.

- **In rail transport,** more intensive maintenance will be carried out to increase line speeds, making train travel more attractive. Additional investment is needed in the electrification of prospective lines and the purchase of electric units to increase the availability of rail transport but also to improve environmental parameters.
- It is possible to extend electric traction in **public transport facilities.** Electric and trolleybus lines are only in the largest cities, which have both the highest public transport accessibility and a better socio-economic position, and these are very expensive infrastructure investments.
- **Electric buses** can be suitably integrated into public transport in medium-sized and smaller cities where radius constraints are less pronounced, and both their purchase and the development of the necessary infrastructure should be encouraged. A possible lack of interest of local authorities in the development of bus transport is a risk, as the ordering of services could represent a high budgetary burden. For this reason, some cities are already using regional transport services funded by Higher Territorial Unit, with bus routes stopping within the given cities and serving cities internally.

Table 48: Cities potentially suitable for supporting public transport expansion (transformed scale with score*)

City	Availability of public transport	Unemployment rate	Average wage	Average age of cars	Total score
Rožňava	4	4	3	4	15
Snina	3	4	4	4	15
Vranov nad Topľou	4	4	4	3	15
Rimavská Sobota	3	4	4	4	15
Zlaté Moravce	4	2	4	4	14
Kežmarok	4	4	4	2	14
Trebišov	4	4	4	1	13
Nové Mesto nad Váhom	3	2	4	4	13

Šahy	4	3	2	4	13
Brezno	3	3	3	4	13
Humenné	2	4	4	3	13
Levoča	3	4	3	3	13
Čadca	3	3	4	3	13
Spišská Nová Ves	2	4	3	3	12
Levice	3	3	2	4	12

** data from a sample of 60 cities were transformed into a scale from 0 to 1, with scores assigned in each indicator according to quartiles from 1 to 4*

Source: IEP according to Value For Money Department And Statistical Office Of The Slovak Republic

Box 8: Transport poverty and social exclusion

Transport poverty is the lack of access to different means of transport or to necessary services, or the lack of ability to use transport due to high prices and/or low incomes. Transport poverty is closely linked to energy poverty, and they share common causes: low incomes, high fuel prices, and low energy efficiency of owned means of transport (Mattioli, Lucas, & Marsden, 2017). Transport poverty is often experienced in a sudden way, as a consequence of a deterioration in one of the three above mentioned factors that contribute to it.

Households prioritize spending on travel to work over other activities, even over home heating or buying food (Jouffe & Massot, 2013), (Deutsch, Guio, Pomati, & Silber, 2015), (Deutsch, Guio, Pomati, & Silber, 2015). Lack of physical and affordable transport accessibility is correlated with higher unemployment in the territory, lower participation in education and training, poorer eating habits, and lower use of public health services and higher rates of social exclusion (Mattioli, Lucas, & Marsden, 2017), (Lucas, Stokes, Bastiaanssen, & Burkinshaw, 2019), (Lucas, Stokes, Bastiaanssen, & Burkinshaw, 2019). Typically, vulnerable groups - marginalised communities, single-parent households, people with disabilities - are particularly affected by abrupt changes (Lucas, Stokes, Bastiaanssen, & Burkinshaw, 2019), (Lucas, Stokes, Bastiaanssen, & Burkinshaw, 2019), but we do not have relevant data on transport options for these groups in Slovakia.

Appropriate solutions depend on the local context. Policies recommended in the literature include:

- creating and monitoring transport poverty indicators that are able to capture changes quickly,
- reducing tax levies for people living in regions with lower transport accessibility,
- discounted/free public transport tickets for low-income groups (Lucas, Tyler, & Christodoulou, 2009),
- low-interest loans for the purchase of selected vehicles,
- incentives to scrap old cars, by purchasing new fuel efficient or electric cars,
- targeted densification of the population,
- increased subsidies for public transport in low-income regions,
- training on eco-driving of cars, which reduces consumption,
- investment in cycleways (Lucas & Pangbourne, 2014).

3.4.3.1 Rail transport

In terms of accessibility, the network of railway lines in Slovakia is relatively dense (3,627 km), thus providing a large theoretical transport potential not only for long-distance but also for suburban public passenger transport. The analysis carried by the IDP (Hlavatý, 2022) shows that in villages within a 50-minute train journey to a regional city, 766.45 potential passenger live within 1.5 km (15-20 minutes walking distance) of a railway station. A survey of the Železničná spoločnosť shows that it carries an average of 263 thousand passengers daily. In the morning commute, an average of 17.45 thousand passengers use the train to regional cities. The number of passengers actually transported is thus only a fragment of the theoretical potential.

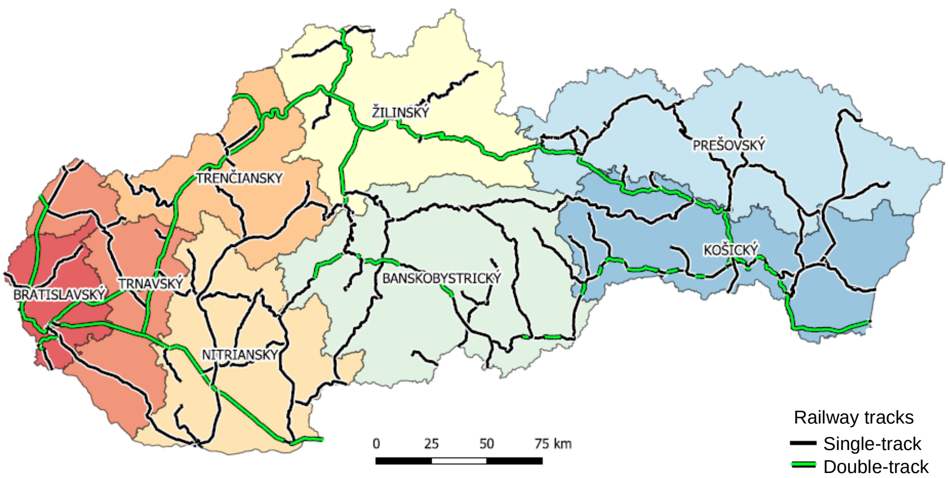
Table 49: Identified theoretical potential (for commuting to regional cities)

Region	Theoretical number of passengers (thous.)
Bratislava	148.57
Banská Bystrica	46.71
Košice	89.08
Nitra	39,155
Prešov	68.93
Trenčín	116.46
Trnava	132.74
Žilina	124.41
Total	**766.45**

Source: IDP

The availability of comfortable railway infrastructure is geographically uneven, while districts with the potential for high fuel poverty are also problematic. The availability of rail infrastructure is relatively dense, depending on the level of development and urbanisation of the region, but its technical level lags behind that of developed countries. While, for example, when commuting to Žilina, it is potentially possible to serve approximately 18% of the region's residents within 50 minutes, but only 7.2% when traveling by train to Banská Bystrica, and only approximately 5.9% of the region's residents when traveling to Nitra. In addition, the lines within the commuting distance to Nitra and Banská Bystrica are non-electrified and single-track. Double-track lines have higher line speeds and by being multi-track, their capacity increases. In Slovakia, there is a lack of high-speed railway operation, there are large sections without electrification and low track speeds (Hlavatý, 2022). In order to increase the potential of passenger rail transport, it is necessary to increase line speeds, which can only be done through improving the quality of individual lines, i.e. by their reconstruction or modernisation, or by building new lines (Hlavatý, 2022). In the long term, the shortage of train drivers also negatively affects the operation of railway transport in Slovakia.

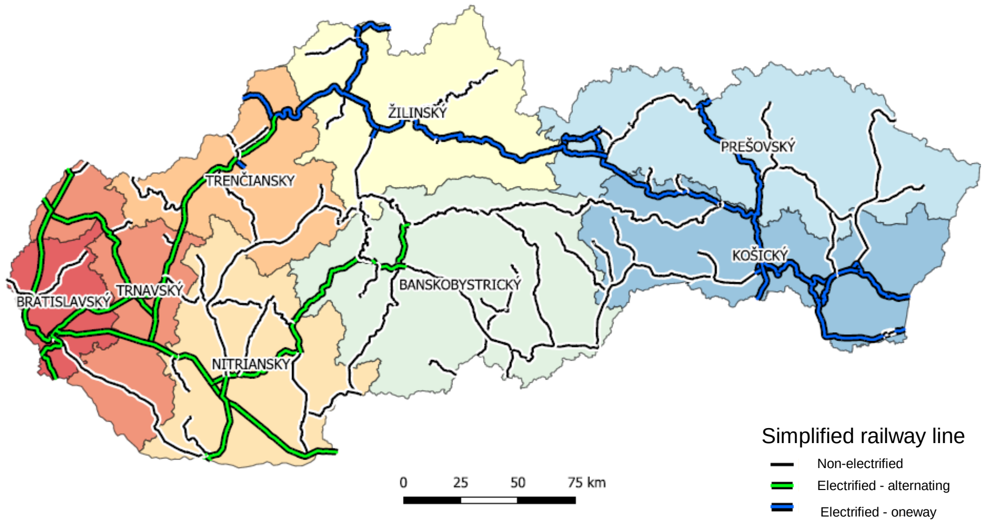
Map 6: Railway track map in Slovakia



Source: IDP according to ŽSR

The technical level of the railway infrastructure in Slovakia lags behind the developed countries. In Slovakia, the initial state of the basic railway infrastructure requires, as a priority, to ensure such a technical condition that allows full and safe operation. Up to 35% of the railway infrastructure is in an unsatisfactory condition, high-speed infrastructure is completely absent, electrification of lines at 44% is below the EU average. The poor condition is the result of 30 years of accumulated investment and maintenance debt.

Map 7: Electrification of lines in Slovakia



Source: IDP according to ŽSR

In February 2022, the Government of the Slovak Republic approved the Schedule of preparation and construction of railway infrastructure projects, which follows the list of priorities. Investment projects in the total amount of almost EUR 4.5 billion are planned until 2030. Of these, 22% are under implementation, 33.8% are under preparation and 44.2% are new targeted projects. The investment plan takes into account the criteria of operational and technical need (e.g. removal of capacity bottlenecks or inadequate condition), socio-economic impacts (including environmental impacts), international commitments (interoperability), efficiency, financial feasibility and sustainability**.** The Renewal and Resilience Plan, which will support projects for the development of low-carbon and environmentally friendly railway transport in the Slovak Republic in the amount of EUR 611 million until 2026, also contributes to faster renewal of the railway infrastructure. In addition to providing the basic infrastructure, the renewal and stabilisation of the rolling stock is an essential need for the railways. Resources are mainly provided by the EU Structural Funds, with EUR 45.1 million allocated for the purchase of 5 ecological rolling stocks in the Slovak Railways Renewal and Resilience Plan.

Table 50: Estimated amount of investments in railway infrastructure projects (EUR million)

Projects	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
Under construction	175.6	368.9	354.7	80.7	2.9					
In preparation	6.4	82.6	186.1	254.1	406.9	407.5	115.6	55.0		
New targeted		21.9	31.9	36.6	97.7	117.1	332.0	439.17	444.3	455.8
Total	**182.0**	**473.4**	**572.7**	**371.4**	**507.5**	**524.6**	**447.6**	**494.7**	**444.3**	**455.8**

Source: Timetable for preparation and construction of railway infrastructure projects (2022)

Table 51: Indicative prices of railway infrastructure (EUR million)

Reconstruction or modernisation of lines (km)	6.25
Dispatching of lines (km)	1.18
Acquisition of ecological rolling stock (pcs)	9.06
Procurement of intermodal units (pcs)	0.016
Purchase of electric trainsets (pcs)	6.61

Purchase of hydrogen trainsets (pcs)	13.3
Purchase of trams (pcs)	2.45
Purchase of locomotives (pcs)	4.63

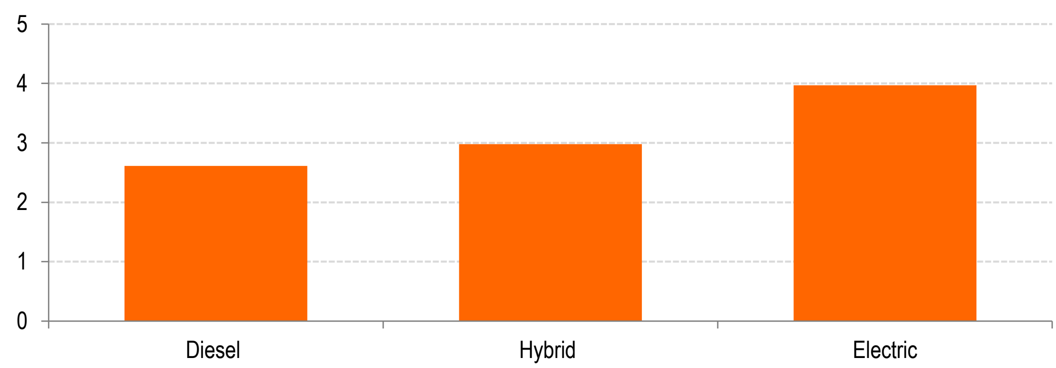
Source: IDP according to the Recovery and Resilience Plan

3.4.3.2 Electromobility in public transport

Bus transport in Slovakia currently dominates transport performance and the operation of buses with alternative propulsion is limited. Three of the four urban public transport companies operate electric buses (DPB (Public Transport Bratislava), DPMK (Košice Public Transport Company) and DPMŽ (Transport Enterprise of the city of Žilina)), hybrid vehicles are operated in Žilina. CNG buses are also operated in Bratislava and Košice. In the capital, buses accounted for 69% of vehicle kilometres in 2018, and 58% of local kilometres (Dopravný podnik Bratislava, 2019). In Košice, in the same year, buses accounted for 82% of vehicle kilometres and 69% of local kilometres (Dopravný podnik mesta Košice, 2019). Electric buses are regularly or occasionally deployed on less capacity and shorter routes (e.g. 80 and 94 in BA, 18 in KE), but also on generally less busy routes (53 and 66 in BA, 20 in KE) and in hilly parts of cities (41 and 43 in BA, 32 and 35 in KE). Diesel buses are also preferred in regional transport due to the flexibility of operation.

There are several barriers to expanding the use of electric buses. The disadvantage of electric buses is their higher purchase price, which can be twice as high as the diesel alternative. Currently, electric buses are not price competitive, but their prices are gradually decreasing (Quarles, Kockelman, & Mohamed, 2020). However, their operating and maintenance costs are lower (Mohamed, Ferguson, Garnett, & Kanaroglou, 2016). Similar to electric cars, charging infrastructure needs to be paid for and built. For public transport operation, the range of the bus is a crucial parameter, which is fundamentally lower in the case of electric buses due to battery capacity, charging cycles or the use of heating and cooling (Li J.-Q. , 2014). By reducing the range and the necessary charging, the potential transport capacity is reduced, which significantly reduces the transport performance. Higher number of buses also creates higher space requirements in depots.

Graph 60: Total cost of ownership (TCO) of buses by propulsion (in USD/km)

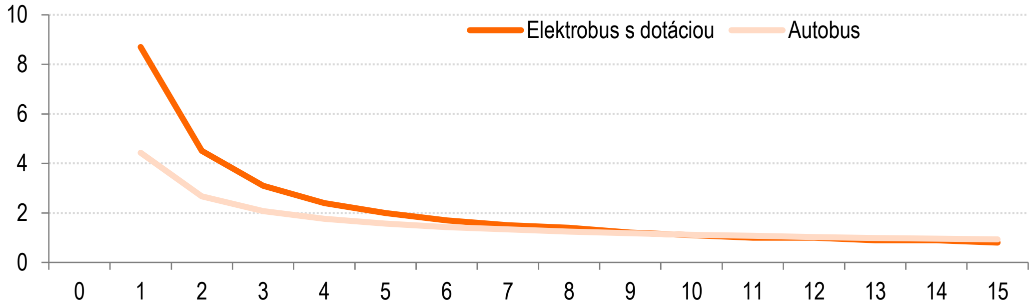


Source: IEP according to (Mohamed, Ferguson, Garnett, & Kanaroglou, 2016)

If electric buses had no limited range, the payback period would be 7 years even without the subsidy. A simple model compares the cost of vehicle purchase, propulsion and maintenance. It abstracts from the cost of infrastructure provision, which would skew the results more against the electric bus. The assumptions are based on implemented procurement by DPB and DPMK (bus manufacturer SOR Libchavy); maintenance costs were determined based on a study comparing the costs and benefits of bus fleet electrification (Quarles, Kockelman, & Mohamed, 2020). For the same annual mileage, the total cost of the bus and the electric bus will be equal even without the subsidy in 7 years. However, this is not a realistic assumption - transport companies need to maximise performance relative to customer requirements.

Taking into account the difference in range, the operation of electric buses is non-refundable and would require a 40% subsidy. The electric bus can perform one service without charging, with a range of 140-160 km[30], which is about half that of the conventional version. This makes the operation of the fleet substantially more expensive in practice, as a higher number of electric buses is needed to provide the same performance. Due to current limitations, it is assumed that two electric buses are required per diesel bus to maintain service timings (Miles & Potter, 2014). Subsidies of 40% (approximately 200 thousand euros) can compress the payback to 10 years. However, the calculation abstracts from other costs such as building charging infrastructure or increased vehicle storage costs.

Graph 61: Cost of diesel and electric bus with 40% subsidy (in euros/km in each year)



** with an annual mileage of 60,000 km for a diesel bus and 36,000 km for an electric bus*

Source: IEP

The average range of electric buses is gradually increasing. Suburban buses, which are already in common use abroad, can have a range of up to 500 km without recharging under ideal conditions (Table 52). For example, the Van Hool TDX25E type of electric bus is built specifically for the US market, where it will be used mainly for employee commuting and regular passenger transport. However, the range depends on many factors such as the driving style of the driver, the geographical conditions and topography of the route, the weather and others. The time of year also makes a difference to the range. During the winter and summer months, more energy is used to heat and cool the bus, which causes the battery to discharge faster and therefore a lower range compared to optimal conditions.

The energy density of batteries, as a key parameter, is reaching its limits. For this reason, extending the range requires enlarging the batteries themselves, thus reducing the space for passengers. The energy density of the battery is crucial because the higher the energy density, the higher the usability due to higher capacity (Qiao, et al., 2021). Electric buses are equipped with batteries of varying capacities ranging from 160 kWh to over 480 kWh (Pamula & Pamula, 2020). For example, the Van Hool TDX25E double-decker electric bus has a capacity of only 18 people on the lower deck due to the storage of a battery in the rear with a capacity of up to 676 kWh, allowing an average range of between 300 and 500 km (VanHool.be, 2021).

Table 52: Comparison of types of electric suburban buses

Bus type	Bus size (m)	Average range (km)	Capacity of persons	Battery capacity (kWh)
Van Hool TDX25E	13.7	300 - 500	69	676
Yutong TCe12	12	320	50	281
J4500 CHARGE coach	13.9	320	56	544
BYD C9	12	250	50	324

[30] Many commercially available electric buses also have more than double the range due to higher capacity batteries (Grijalva & Martínez, 2019) (Grijalva & Martínez, 2019). The daily range of a standard bus is approximately 300 km (imhd.sk, 2017) (imhd.sk, 2017).

BYD C8	10.6	250	46	324

Source: IEP

An electric bus produces fewer greenhouse gas emissions and the unit cost of reducing them is in the hundreds of euros. Estimates of emission reductions range from 22% (Mao, Li, & Zhang, 2020) or 38% (Rupp, Rieke, Handschuh, & Kuperjans, 2020) to 78% (Falcao, Teixeira, & Sodré, 2017). However, some studies do not take into account the indirect emissions from the energy sector that are associated with vehicle charging. A model calibrated to Mexican conditions estimates annual CO_2 savings of 27% at a cost of USD 750 per tonne. The relatively low savings are due to the high emissions intensity of the Mexican energy mix. Relative emission savings are also reduced by charging in night cycles (Rupp, Rieke, Handschuh, & Kuperjans, 2020). Assuming the Slovak energy mix, CO_2 savings of approximately 69% over a 15-year horizon are achievable for comparable buses. A mid-life battery replacement is also assumed. With a subsidy of EUR 200,000, the average cost to the state of reducing CO_2 emissions by one tonne is approximately EUR 256.

Table 53: Unit cost of each mode of transport after taking into account transport capacity

	Bus	Electric bus	Trolleybus	Tram
Annual mileage (km)	60 thous.	36 thous.	60 thous.	60 thous.
Vehicle price (eur)	250 thous.	300 - 700 thous.	435.6 thous.	2.3 mio.
Vehicle lifetime		15 years		30 years
Passenger seating capacity	97	93	100	352
Cost of operation without infrastructure (cent/seat/year)	1.0	0.8	0.6	0.2
Life cycle cost without infrastructure (cent/seatkm)	1.3	2.8	1.1	0.6
Operational transport emission intensity (tonnes CO_2/place/year)	0.661	0.100	0.193	0.101

Source: IEP

Leaving aside the need to build additional infrastructure, an electric bus is about twice as expensive per seat-kilometre as a standard bus. The cost of the annual operation is highest for buses, slightly lower for electric buses and the trolleybus is the cheapest of the three. The life-cycle cost per local kilometre is highest for the electric bus, mainly due to the significantly lower potential mileage. The least costly capacity transport system is tram traction, assuming no new infrastructure is needed. **However, it can be expected that in the future, with advances in technology and increasing range, this cost disadvantage may be significantly reduced.**

After accounting for the cost of the complete infrastructure, tram traction is, according to available sources, the least expensive per local kilometre. When expanding the tram transport network, investments of 10 to 30 million euros per kilometre of new line should be expected. In the case of trolleybus traction, an additional kilometre of the network will require a cost of EUR 500 to 800 thousand. The subsidy from the EU funds is usually conditional on the replacement of a continuous bus line with electric traction. Depending on the propulsion, the vehicles also require charging or refuelling infrastructure, depots, handling lines and a maintenance base. The order in this case is the same as in the calculation of the cost of operation (Alku, 2019). This means that building new tramway lines may make sense on major arterial routes with high capacities to guarantee the use of higher transport capacities.

3.5 Alternative funding of the impacts of the Fit for 55 package

The Social Climate Fund will not cover all the potential negative impacts of the Fit for 55 climate package. The Slovak Republic has other sources of funding available. A brief overview of these can be found in the table below, and a comprehensive version with a more detailed description of each source can be found in the Annex.

Table 54: Overview of other resources to cushion the negative impacts of the package

Impact	description of investments	Funds
increase in heating expenditure	Insulation	Recovery and Resilience Plan
		Operational Programme Slovakia
		JTF*
	replacement of boilers	Recovery and Resilience Plan
		Operational Programme Slovakia
	reinforcement of the electricity network	Recovery and Resilience Plan
		Operational Programme Slovakia
		JTF*
		Modernisation Fund
	gasification	-
Increased spending on transport fuels and the introduction of CO_2 standards	charging stations	Recovery and Resilience Plan
	emission-free buses	JTF*
		Operational Programme Slovakia
	emission-free trams	Operational Programme Slovakia
	development of train transport	Recovery and Resilience Plan
		Operational Programme Slovakia
	development of public bus transport	Operational Programme Slovakia
	other infrastructure	JTF*
		Operational Programme Slovakia
the impact of a carbon tax on:		
agriculture	greening of agriculture	Common agricultural policy
		JTF*
automotive industry	increasing material efficiency	Operational Programme Slovakia
construction	increasing material efficiency	-
industry	decarbonisation (reduction of greenhouse gas emissions)	Operational Programme Slovakia
		Modernisation Fund
steel production	increasing material efficiency	-
	decarbonisation	Recovery and Resilience Plan
		JTF*
aluminium production	increasing material efficiency	-

	decarbonisation	Recovery and Resilience Plan JTF*
* For Just Transition Funds (JTF), only regions are eligible: Horná Nitra, Banská Bystrica Self-Governing Region, Košice Self-Governing Region		

Source: Ministry Of Investments, Regional Development And Informatization

3.6 Limits of the feasibility of some of the measures in the package

Meeting the decarbonisation target in non-ETS sectors may be significantly jeopardised. In transport, further increases in motorisation are rightly expected, while the current practice of buying used older vehicles from abroad will continue to influence emissions trends in the sector due to lower purchasing power. Potentially, greenhouse gas emissions in transport could increase by 4 million tons of CO_2e per year compared to 2018, which is almost a tenth of all emissions in that year. An increase in total emissions is also likely in the small energy and industrial sectors, including construction. A more significant decrease in emissions from waste, taking into account known and potential additional measures, does not have the potential to offset these increases, given the small share of the sector. Based on these assumptions, the original ESR target of -12%, which was voluntarily increased to -20%, will not be met either. The higher target of -22.7% in the Fit for 55 package is therefore at significant risk of being met without substantial action in transport.

More widespread development of electromobility continues to face significant barriers to meeting both decarbonisation and energy efficiency targets. Under the CO_2 standards for vehicles, not only new combustion vehicles but also hybrid vehicles should be banned from 2035. Although there is a sharp year-on-year growth in the number of electric vehicles in Slovakia, this is growth from a low base. Electromobility appears to be the only available and sufficiently widespread alternative to combustion vehicles in the coming decades, although the possible rapid development of other technologies is also acknowledged. For this reason, however, reducing both greenhouse gas emissions and energy consumption in road transport requires the creation of a long-term sustainable public support scheme that targets the most significant barriers to the expansion of electromobility. In addition to direct support, including infrastructure development, achieving the targets may also require the adoption of indirect support measures, e.g. through the tax system.

The energy savings target can be very ambitious with current technologies, without major industrial companies pulling out its production from Slovakia. The structure of Slovak industry is characterised by several energy-intensive industries and large enterprises. Energy audits have identified a savings potential of at most 2.8 TWh. However, known investments are likely to cause an overall increase in energy consumption. The transformation programme of the US Steel Košice steel plant will be associated with an increase in electricity consumption of around 2 TWh, while heat consumption will decrease by 35%. Following the transformation of the automotive industry, it is also reasonable to assume a significant increase in energy consumption due to investments in battery cell production with an annual capacity of approximately 60 GWh. The largest of the potential investors has declared an annual energy consumption of approximately 2.2 TWh, while Slovakia could potentially be the destination of 2 investment projects in this area. On the other hand, the contemplated closure of aluminium production at Slovalco could reduce electricity consumption by almost 3 TWh in the event of a complete shutdown. The lack of projects with a short payback period that would be accepted by the corporate management requires more public support. At the current level of technology and industry structure, the achievement of the energy savings target is in jeopardy.

The potential for spontaneous renovation of buildings is decreasing, which also has a negative impact on the achievement of the energy efficiency target. Compared to 2014, the annual number of significantly renovated apartment buildings has fallen by around half, with 71% already renovated to some degree. Thus, renovation is running up against the limits of the willingness and interest of owner-occupied communities to apply for resources to undertake renovation. The rate of significant renovation of houses has been relatively stable at around 1,300 houses per year, with around 53 % of around 900,000 houses having been renovated to some extent. Higher final energy consumption savings targets will also require a significant increase in investment activity. Given the high specific investment intensity of the projects, there will be increased demands for public support for investment, and the co-financing rate must be sufficiently incentive based, if the target is to be met. Demographics will not affect the achievement of the target to a greater extent at the 2030 horizon, rather its significant impact is expected at the 2050 horizon of the carbon neutrality target.

Slovakia has room to increase the share of RES, but investments face certain barriers. In electricity generation, RES are limited mainly by the high share of nuclear power, which will be further increased by the completion of Mochovce. The stability of the grid may be disrupted by the RES that are the cheapest and most widespread in the world, i.e. solar and wind energy. Heat generation is dominated by biomass and transport is dominated by biofuels and increasing the share of these sources may conflict with nature protection. The potential of geothermal energy remains under-exploited, facing both administrative obstacles and insufficient support. Although wind power is an intermittent resource, it is more balanced than solar power in terms of transmission grid operation. Given the proximity of Austria to areas with large-scale wind electricity production, it is reasonable to expect higher investments in this resource. Based on the scenarios, a realistic share of RES in final energy consumption of up to 25% by 2030 against the proposed EU-wide target of 40% is estimated.

Without a change in the approach to forest management, Slovakia faces a decline in natural carbon sinks. Currently, the structure of Slovak forests is characterised by high forest age, which is also facing the negative consequences of calamities and pests. According to the current approach, these forests are suitable for regeneration and replanting, but this significantly reduces their ability to sequester carbon for decades to come. This approach may have a negative impact on meeting both the sink sub-target of -6.8 $MtCO_2eq$ and the overall net emissions reduction target of 55%, as a smaller proportion of all emissions will be sequestered in the country.

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Annex: Comprehensive overview of alternative financing options for the impact of the Fit for 55 package

Table 55: Overview of other sources of mitigation (comprehensive version)

Impact	Investment description	Funds	more detailed description	specific activities	Recipients
increase in heating expenditure	insulation	Recovery and Resilience Plan	Component 2	Improving the energy performance of family houses	Owners of older family houses, who self-help or contractor implement the renovation of the family house by improving the thermal insulation properties of the building envelope and replacing inefficient sources of heat and hot water with high-efficiency equipment, or installation of new equipment using renewable energy sources or waste heat as part of the ventilation. SME enterprises engaged in the insulation of houses installing heat sources and RES
				Restoration of public historic and listed buildings	Owners of historic and listed public buildings - state owners and local authorities, public institutions
		Operational Programme Slovakia	Specific objective RSO2.1 Promoting energy efficiency and reducing greenhouse gas emissions	Measure 2.1.1. Improving energy efficiency in enterprises	enterprises, in particular SMEs; public administration bodies, including the Ministry of Economy of the Slovak Republic, or contributory or budgetary organisations established by it
				Measure 2.1.2. Reducing the energy performance of buildings	owners of flats and non-residential premises in residential buildings throughout the territory of the Slovak Republic (regardless of the legal form); legal entities that derive their legal personality from a church or religious society; public administration entities, including the Ministry of Economy of the Slovak Republic, or contributory or budgetary organisations established by it.
		JTF*	Pillar 2: A sustainable environment	Reducing greenhouse gas emissions through energy efficiency in public buildings	Owners of public buildings

	replacement of boilers	Recovery and Resilience Plan	Component 2	Improving the energy performance of family houses	Owners of older family houses, who self-help or contractor implement the renovation of the family house by improving the thermal insulation properties of the building envelope and replacing inefficient sources of heat and hot water with high-efficiency equipment, or installation of new equipment using renewable energy sources or waste heat as part of the ventilation. SME enterprises engaged in the insulation of houses installing heat sources and RES
		Operational Programme Slovakia	Specific objective RSO2.1 Promoting energy efficiency and reducing greenhouse gas emissions Measure 2.1.1 Increasing energy efficiency in enterprises	Measure 2.1.1. Increasing energy efficiency in enterprises	Enterprises, in particular SMEs; public administration bodies, including the Ministry of Economy of the Slovak Republic, or contributory or budgetary organisations established by it
	strengthening the electricity grid	Recovery and Resilience Plan	Component 1	Investments in the construction of new sources of electricity from RES	Business entities
				Investments in the modernisation of existing RES electricity sources ("repowering")	Business entities - operators of existing electricity generation facilities.
				Investing in increasing the flexibility of electricity systems for higher RES integration	Businesses and Renewable Energy Communities (RECs) under Directive (EU) 2018/2001
		Operational Programme Slovakia	Specific objective RSO2.2 Promote renewable energy in accordance with Directive (EU) 2018/2001, including the sustainability criteria set out therein	Measure 2.2.1 Support for the use of RES in enterprises based on active electricity consumers, self-consumers of energy from RES and communities producing energy from RES	enterprises at the level of final energy consumers; communities producing energy from renewable sources ; public administration entities, including the Ministry of Economy of the Slovak Republic or budgetary or contributory organisations established by it; non-governmental non-profit organisations
				Measure 2.2.2. Promoting the use of RES in energy supply systems	businesses (energy infrastructure)

				Measure 2.2.3. Promotion of the use of RES in households (innovation of the project "Green Households")	households; public administration entities, including the Ministry of Economy of the Slovak Republic or budgetary or contributory organisations established by it; legal entities deriving their legal personality from a church or religious society.
		JTF*	Pillar 2: A sustainable environment	Development of sustainable energy in the region based on RES	SMEs, LEs, municipalities, cities, municipal regions, universities, research institutions, non-profit organizations, government organizations and other entities
		Modernisation Fund	support for the replacement of coal combustion in CZT (central heat and cold supply), increasing energy efficiency in heat production and supply (heat accumulation + smart technologies), including the reconstruction of pipelines	State aid schemes for the modernisation of energy systems, including energy storage and energy efficiency improvements (Ministry of Environment of the Slovak Republic scheme for heating)	heat producers or heat and power producers (SMEs, large enterprises)
			promotion of the use of electricity production from renewable energy sources (RES - photovoltaics, hydropower, geothermal energy...) with the aim of increasing the share of RES in the gross final energy consumption of the Slovak Republic	State aid schemes from the Modernisation Fund to support the production of electricity from renewable energy sources	SMEs and large enterprises

			promotion of the use of heat production from RES	State aid scheme to support the production of heat from RES (State aid scheme/individual projects)	heat producers or heat and power producers
			increasing energy efficiency in the production of electricity from RES (including increasing energy efficiency in hydropower plants)	Individual project - Gabčíkovo hydroelectric power plant - reconstruction and modernisation of turbogenerators in order to increase energy efficiency	Water Management Construction, State Enterprise
	Gasification	-	-	-	-
Increased spending on transport fuels and the introduction of co2 standards	charging stations	Recovery and Resilience Plan	Component 3	Supporting the development of infrastructure for alternative propulsion	Enterprises with state shareholding, business entities, municipalities, higher territorial units and organisations established by them
	emission-free buses	JTF*	Pillar 2: A sustainable environment	Promoting sustainable local transport	Local carriers, municipalities, cities, municipal counties
		Operational Programme Slovakia	Specific objective RSO2.8 Promote sustainable multi-modal urban mobility as part of the transition to a zero carbon economy	Measure 2.8.1. Development of public transport	Dopravný podnik mesta Košice, a. s.; Dopravný podnik mesta Prešov, a. s.; Dopravný podnik mesta Žiliny, a. s.; Železnice Slovenskej republiky; Ministry Of Transport And Construction Of The Slovak Republic; carriers (bus transport); Pro-Danubia - Association of Municipalities for Local Transport on the Danube; Higher Territorial Unit, cities and municipalities (public passenger transport);
	emission-free trams	Operational Programme Slovakia	Specific objective RSO2.8 Promote sustainable multi-modal urban mobility as part of the transition to a zero carbon economy	Measure 2.8.1. Development of public transport	Dopravný podnik mesta Košice, a. s.; Dopravný podnik mesta Prešov, a. s.; Dopravný podnik mesta Žiliny, a. s.; Železnice Slovenskej republiky; Ministry Of Transport And Construction Of The Slovak Republic; carriers (bus transport); Pro-Danubia - Association of Municipalities for Local Transport on the Danube; Higher Territorial Unit, cities and municipalities (public passenger transport);
	development of train transport	Recovery and Resilience Plan	Component 3	Developing low-carbon transport infrastructure	ŽSR, Local governments, Municipalities, Higher Territorial Unit, Contributory organization whose founder is a higher territorial unit or municipality, falling within the territory of Sustainable Urban Development,

					Ministry Of Transport And Construction Of The Slovak Republic
		Operational Programme Slovakia	Specific objective RSO2.8 Promote sustainable multi-modal urban mobility as part of the transition to a zero carbon economy	Action 3.1.2. Removing key bottlenecks in the railway infrastructure through the modernisation and development of main railway lines and junctions	ŽSR; ŽSP; MoT SR; intermodal/combined transport operators; Transport Authority; intermodal/combined transport operators, central state administration bodies and entities contributing to the implementation and fulfilment of the objectives of measure 3.1.2.
	development of public bus transport	Operational Programme Slovakia	Specific objective RSO2.8 Promote sustainable multi-modal urban mobility as part of the transition to a zero carbon economy	Measure 2.8.1. Development of public transport (construction and modernisation of rail public transport lines, renewal and modernisation of mobile means of rail public transport, construction and modernisation of transfer terminals and interception car parks, construction and modernisation of technical base for repair and maintenance of public transport fleet);	Dopravný podnik Bratislava, a. s.; Railways of the Slovak Republic; Ministry Of Transport And Construction Of The Slovak Republic; carriers (bus transport); Pro-Danubia - Association of Municipalities for Local Transport on the Danube; Higher Territorial Unit, towns and municipalities (public passenger transport); central bodies of state administration and entities contributing to the implementation and fulfilment of measure 2.8.3.
				Measure 2.8.3. Sustainable mobility in the Bratislava region (construction and modernisation of public passenger transport infrastructure - lines, transfer terminals, intercepting car parks, service base)	Dopravný podnik Bratislava, a. s.; Railways of the Slovak Republic; Ministry of Transport and Construction of the Slovak Republic; carriers (bus transport); Pro-Danubia - Association of Municipalities for Local Transport on the Danube; Higher Territorial Unit, cities and municipalities (public passenger transport); central state administration bodies and entities that contribute to the implementation and fulfilment of measure 2.8.3.
	other infrastructure	JTF*	Pillar 2: A sustainable environment	Reducing greenhouse gas emissions in transport and buildings	Public administrations and local authorities
		Operational Programme Slovakia	Specific objective RSO2.8 Promote sustainable multi-modal urban mobility as part of the transition to a zero carbon economy	Measure 2.8.2. Promotion of cycling (creation and revitalisation of multifunctional public spaces, expansion and modernisation of the network of footpaths and cycle roads, cycle lanes, development of shared bicycle systems, bicycle parking facilities)	- Higher Territorial Unit and cities and municipalities beyond sustainable urban development (cycling); - central government bodies and entities that contribute to the implementation and fulfilment of measure 2.8.2.

the impact of a carbon tariff on:					
agriculture	greening agriculture	Common agricultural policy			
		JTF*	Pillar 1: Economic diversification	Support for the development of SMEs (Business development in sustainable agriculture)	SMEs
automotive industry	increasing material efficiency	Operational Programme Slovakia	RSO Specific objective 2.6 Promote the transition to a resource-efficient and circular economy	Measure 2.6.1. Support for selected waste prevention activities	Ministry of Environment of the Slovak Republic or budgetary or contributory organisations established by it; central government entities; local government entities; private sector entities.
Construction	increasing material efficiency	-	-	-	-
industry	Decarbonisation (reducing greenhouse gas emissions)	Operational Programme Slovakia	Specific objective RSO2.1 Promoting energy efficiency and reducing greenhouse gas emissions	Measure 2.1.4. Promoting the effective introduction of alternative drives in enterprises	enterprises; public administration entities, including the Ministry of Economy of the Slovak Republic, or contributory or budgetary organisations established by it.
		Modernisation Fund	promoting the substitution of coal combustion in industrial energy and technology, increasing energy efficiency in industry	State aid schemes for improving energy efficiency and reducing emissions in industry (industrial scheme)	Industrial enterprises in EU ETS
steel production	increasing material efficiency	-	-	-	-
	Decarbonisation	Recovery and Resilience Plan	Component 4	Decarbonisation of industry	Industrial enterprises
		JTF*	Pillar 2: A sustainable environment	Promoting clean energy, the circular economy and the decarbonisation of industry	ETS enterprises (if eligible), Large enterprises
aluminium production	increasing material efficiency	-	-	-	-
	Decarbonisation	Recovery and Resilience Plan	Component 4	Decarbonisation of industry	Industrial enterprises

		JTF*	Pillar 2: A sustainable environment	Promoting clean energy, the circular economy and the decarbonisation of industry	ETS enterprises (if eligible), Large enterprises
* For Just Transition Funds (JTF), only regions are eligible: Horná Nitra, Banská Bystrica Self-Governing Region, Košice Self-Governing Region					

Source: Ministry Of Investments, Regional Development And Informatization