

SLOVAKIA LOW CARBON ECONOMY PATHWAYS

Achieving more by 2030





BACKGROUND TO THIS WORK

This report combines macro and micro level analyses to provide an updated picture of Slovakia's energy and CO2 emissions profile with outlook and predictions to 2030. It is based on modelled outcomes from the Institute for Environmental Policy (IEP), which was developed in partnership with the World Bank for the publication of 'A Low-Carbon Growth Study for Slovakia'¹ that will be updated to reflect the latest EU climate and energy policies in 2021. The main quantitative contributions of this work relate to large industrial emitters in Slovakia: (i) an aggregated company-level GHG reductions prediction and (ii) company-level decarbonization trends and projections based on publicly available Emissions Trading Scheme (ETS) data. The buildings and industrial (sub) sectors present the highest potential for Slovakia to meet ambitious 2030 climate commitments and take ownership of 2050 carbon neutrality, and therefore are at the core of this narrative.

CONTRIBUTING AUTHORS:

Slavomir Hubatka, PhD candidate, Technical University of Kosice

Nolan Theisen, Research Fellow, GLOBSEC

SPECIAL THANKS TO:

Maros Halama, Vice-Dean for Research, Innovations & International Relations, Technical University of Kosice

Kristina Mojzesova, Analyst, Institute for Environmental Policy, Ministry of Environment, Slovak Republic



INTRODUCTION

On one hand, Europe's ambitious 2020 climate action agenda has to be considered a huge success, and on the other the real work truly begins. Five years on from the Paris Agreement, all 27 Member States consented to update the bloc's 2030 nationally determined contribution (NDC) to 55%. The European Commission announced the EU climate law for 2050 carbon neutrality in March - becoming the first continent to do - and its ambitious 2030 midterm target (at least 55%) proposed in September was adopted at the December European Council Summit. COVID-19 was a persistent legislative headwind throughout that indeed postponed COP 26 but did not derail the European Green Deal process, which was unofficially adopted as the guiding standard for Europe's green, smart and resilient recovery.² Now the rhetoric will need to be translated into functional implementation at the Member State level for Europe to deliver on its promise.

Like its CEE neighbours with higher energy and carbon intensive economies than wealthier (GDP per capita) Western Member States, Slovakia takes a cautious and pragmatic approach to climate and energy policy, primarily concerned with the prospect of hitherto unprecedented investment needs and the competitiveness of heavy industry threatened by carbon leakage. While CEE countries can be grouped together by broad post-Soviet industrial, bureaucratic and socioeconomic traits, even within the Visegrad 4 energy mixes, resource endowment and economic makeup are nuanced, underlining relative strengths and vulnerabilities. Slovakia does not share Czechia's coal dependency, Poland's industrial heterogeneity, Bulgaria or Romania's offshore wind potential, or Hungary's natural gas storage system.

What is perhaps not appreciated sufficiently in CEE is that while the EU was a first mover, it is far from going it alone towards carbon neutrality by mid-century. With a growing list of pledges from the likes of China (2060), Japan, Korea, South Africa and a new US administration intent on returning to the Paris Agreement, from the private sector and lending institutions, a global consensus is forming around the need for systematic change. This means that current practices in manufacturing and industry will be transformed by stricter regulations and standards. Leaders developing and adopting clean technologies will gain the competitive advantage while laggards clinging to conventional wisdom face dependency and stagnation. China set itself up to become the global powerhouse in solar PV manufacturing following the 2009 global recession and has jumped out in front with lithium ion batteries, but it is not too late for Europe to vie for a share of these markets. For the EU to overcome its slow start, Member States need to work together to create clean technology value chains, markets, and jobs, embracing change and disruption forged by the Clean Energy Package and guided by the European Green Deal.

While the task is daunting, the EU's framework of green, smart and resilient recovery present major opportunities for CEE Member States to lay the foundation for a sustainable growth model that will meet higher 2030 emissions reductions. This will require ownership of the European Green Deal applied to all sectors of the economy through an enabling policy framework for cost-effective investments into green and digital technology innovation and infrastructure deployment.

EXECUTIVE SUMMARY

OBJECTIVE OF THIS REPORT

This report assesses Slovakia's current position, plans and potential for decarbonization over the next decade in order to better define the optimal 2030 low carbon growth path and inform national policies and recovery priorities under negotiation. The findings will form the basis for targeted public-private discussions on implementation of European Green Deal measures in 2021.

KEY FINDINGS

- ▶ Social and political consensus must be built around strategic projects that utilize the EU budget to deliver sustainable and resilient growth, especially underpinning investments in building renovations, green infrastructure and modernizing industrial practices.
- ▶ It is imperative for Slovakia to establish a holistic approach with a singular well-defined low carbon growth pathway taking into consideration the impacts on production and employment in key sectors as part of just transition.
- ▶ As a small, open, industrial-based economy Slovakia will need to adopt concrete policy measures to manage inevitable reallocation of labor by reskilling / upskilling and attracting workers to high quality green jobs.
- ▶ While the European Green Deal requires scaled up investments much of it can be associated with compulsory modernization of old inefficient systems and infrastructure.
- ▶ The role and nature of bioenergy in heating and transport for achieving RES and GHG reduction targets needs to be clearly defined vis-à-vis a realistic assessment of natural gas and electrification.
- ▶ The most important policy focus to 2030 is energy savings through building renovations.
- ▶ For building renovations to deliver decarbonisation and value for money a single and comprehensive data registry must be established with digital standards adopted in the tendering process.
- ▶ Buildings not only produce desirable economic, climate and environmental outcomes but additional co-benefits not factored in (IEP) modelling.
- ▶ Full legislative implementation of the 2016 Clean Energy Package is essential to unlock a decentralization wave aligned with building renovation to enable sector coupling.
- ▶ While the enabling framework needs to be put in place now, savings realized in industry and transport are only actualized after 2030.
- ▶ The planned closure of Novaky coal power plant in 2023 is roughly the GHG reduction equivalent of replacing diesel/petrol cars by 2030.
- ▶ Policymakers should adopt a target percentage of steel tonnage using low or zero carbon methods.
- ▶ If the highest emitting companies reduce CO2 emissions by 10–15% Slovakia can achieve a 21% CO2 reduction by 2030.

OVERVIEW SLOVAKIA

SLOVAKIA NECP

Slovakia's climate targets submitted as part of the 2018 National Energy and Climate Plan (NECP) are represented graphically in Figure 1.

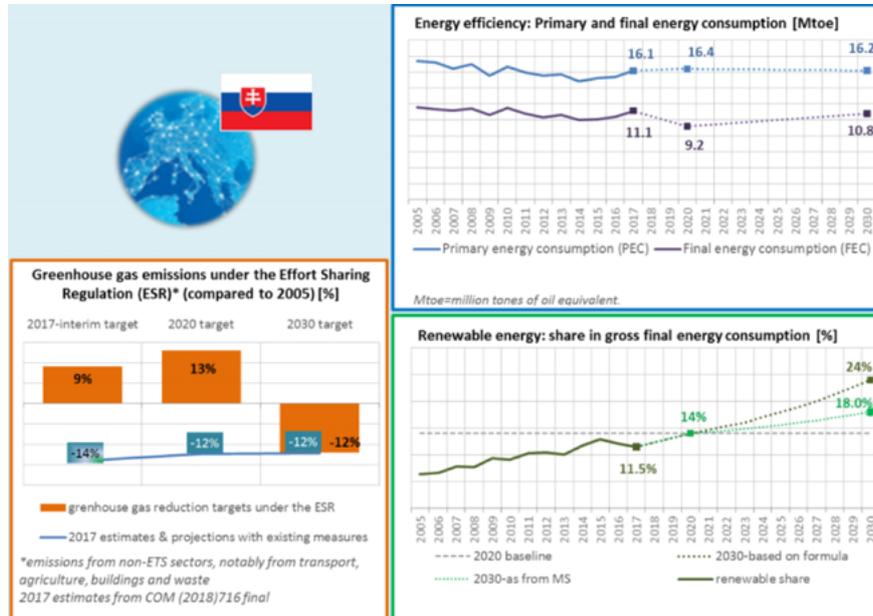


Figure 1: Slovakia National targets and contributions foreseen in the draft National Energy and Climate Plan

Figure 2 compares Slovakia and EU climate targets. In fact, Slovakia has not formally adopted a GHG emissions reduction target. Its Environmental Strategy (2018) proposes a 43% 2030 emissions reduction target from 2005 which equates to 53% from 1990 - in line with the EU's more ambitious 55% target - but was omitted from the NECP.

Targets EU and SK	EU 2030	SK 2030
Greenhouse gas emissions (as of 1990)	(-40%) -55 %	No goals formally set
Emissions in the ETS sector (as of 2005)	-43 %	
Greenhouse gas emissions in non-ETS (as of 2005)	-30 %	-20 %
Share of renewable energy sources (RES) in total	32 %	19,2 %
The share of RES in transport	14 %	14 %
Energy efficiency	32,5 %	30,3 %
Interconnection of electrical systems	15 %	52 %

Figure 2: Slovakia and EU climate targets

The new EU target of 55% GHG emissions reductions will be addressed in forthcoming European Commission legislative proposals for ETS and Effort Sharing Regulation by June 2021. The EU ETS is both Slovakia's primary tool for carbon pricing and a central policy tool to mitigate GHG emissions. The effort sharing regulation has been based on GDP per capita since 2007. It covers all sectors outside the ETS, mostly small-scale emitters (buildings, transport, small energy or industrial emitters, agriculture, and services) representing some 60% of EU GHG emissions. There are a number of EU wide measures, guidelines and legislation related to these industries but Member States hold key competencies to define and implement policies and reduction profiles.³ The Clean Energy Package allows member states to define their own targets for efficiency and renewables provided that they are sufficiently ambitious with respect to the resources and capabilities of the member state and compatible with overall EU targets, with policy instruments backed up by impact assessments.

The challenge with any combined target is using policies that minimize economic costs and distribute the effort fairly among Member States and across sectors. The majority of reductions tend to be achieved in EU ETS sectors, which is reflective of the larger cost-effective potential – mostly in the energy sector - compared to non-ETS. Despite this, Slovakia’s non-ETS GHG reduction target of 20% is very ambitious considering the joint effort sharing regulation prescribes 12%.

RES in transport is set to the EU minimum requirement of 14% and the overall RES target 19.2% corresponds to an indicative target of 27.3% which is the upper technical boundary calculated in the NECP. Still this falls well short of the 24% indicative target calculated according to the formula in Annex II of the Governance Regulation by the European Commission’s.

This is highlighted in the European Commission’s October 2020 assessment of Slovakia’s NECP, summarized in Figure 3. The Commission wants Slovakia to raise its ambition for both renewables and energy efficiency.⁴

	National targets and contributions	Latest available data	2020 target	2030 target	Assessment of 2030 ambition level
	Binding target for greenhouse gas emissions compared to 2005 under the Effort Sharing Regulation (ESR) (%)	-5%	13%	-12%	Ambitious (national target of -20%)
	National target/contribution for renewable energy: Share of energy from renewable sources in gross final consumption of energy (%)	11.9%	14%	19.2%	Unambitious (24% is the result of the RES formula)
	National contribution for energy efficiency: Primary energy consumption (Mtoe)	15.8	16.4	15.7	Low
	Final energy consumption (Mtoe)	11.1	9.0	10.3	Low
	Level of electricity interconnectivity (%)	43%	59%	52%	N/A

Figure 3: European Commission assessment of Slovakia NECP

Finally, Slovakia’s NECP includes past and estimated investments for industry production, with spending in steel more than doubling in the 2036-2050 period compared to 2021-2030. Overall investment needs are much higher in the later periods (2036-2050) than the coming decade, and it is this post-2030 phase that IEP has identified as the most challenging for Slovakia to achieve emissions reductions.

INVESTMENT EXPENDITURE (IN EUR MILLIONS OVER 5-YEAR PERIODS)								
Industry	2011-2015	2016-2020	2021-2025	2026-2030	2031-2035	2036-2040	2041-2045	2046-2050
Steel industry	514.73	1114.75	820.15	872.17	914.30	1826.69	1501.54	2076.10
Metallurgy of non-ferrous metals	59.64	146.28	95.70	160.11	87.34	88.92	37.46	61.13
Chemical industry	53.66	489.76	58.15	87.02	81.75	100.48	117.40	138.23
Building materials	34.00	98.75	65.33	108.30	97.05	102.50	141.99	156.77
Paper industry	428.17	689.13	170.21	213.08	133.89	341.11	234.01	591.49
Manufacture of food, beverages and tobacco	25.61	66.85	68.32	129.03	76.25	135.45	93.01	129.17
Engineering	59.18	153.09	123.50	142.64	121.36	224.03	124.78	173.81
Textile industry	6.74	8.62	7.11	8.08	6.82	15.87	8.40	11.70
Other industries	54.46	155.62	87.78	140.17	92.63	100.91	93.43	155.92
Total	1236.18	2922.85	1496.23	1860.60	1611.39	2935.96	2352.02	3494.32

Figure 4: Slovakia industry expenditure from NECP

INSTITUTE FOR ENVIRONMENTAL POLICY: MODELLING FOUNDATION

The IEP, serving as the in-house research institute for Slovakia's Ministry of Environment, developed an energy and macroeconomic model to help the country navigate the EU's climate and energy policies. 'A Low-Carbon Growth Study for Slovakia' is meant to provide a baseline for the assessment of actions according to their impact on Slovakia's emissions, energy sector and economy. The scenarios therein are designed to inform decisions on how to combine policy instruments aimed at increasing renewables and energy efficiency.

This work was completed after EU RES and EE targets were increased to 30% and 32.5% respectively, unofficially corresponding to 22% and 30% for Slovakia. These targets are back on the table now as part of the new legislative proposal that the European Commission will introduce in June 2021 to meet the higher 55% 2030 emissions reduction target. Nonetheless, the modelling outcomes remain instructive since the ambitious scenarios incorporate an overall GHG reduction of 47% by 2030, squarely in the EU's more ambitious range for Slovakia.

The reference scenario builds on the EU 2016 reference scenario assuming no additional supporting policies after 2020. This leaves the ETS as the singular decarbonization instrument, gradually driving industry away from carbon intensive fuels and processes with energy efficiency improvements based on market forces and the quest for higher productivity growth as factor of industrial competitiveness.

All four decarbonization scenarios lead to 50-53% ETS and 20% non-ETS reductions by 2030. Compared to the reference, investment that would otherwise go to combined cycle gas turbines (CCGT) flows to nuclear. Furthermore, ambitious renewable policies enable the substitution of biomass for CCGT generation and new nuclear generation. This marks emerging trade-off between biomass and RES development in the power sector, though both are needed.

The ambitious decarbonization scenarios increase GDP compared to the reference scenario. However, the structural change of the economy is negative for aggregate labour demand, translating to lower employment in the short term and decreased wages in the long run across all scenarios. Households absorb much of the higher investment levels, especially after 2030, since much of the costs are transferred to consumers, e.g. purchasing efficient energy products, equipment, appliances, and vehicles, which crowds out non-energy investments, which decreases household consumption 3-6% across all scenarios. The decarbonization scenarios do not foresee a significant uptake of electric vehicles until after 2030, driven by implementation of EU policy.

IEP estimates an additional EUR 1 billion per year of expenditures are needed from 2021-2030 across all sectors for Slovakia to meet more ambitious EU climate targets. Out of this, EUR 500 million (EUR 5 billion cumulatively over the period) is from households and EUR 400 million (EUR 4 billion cumulatively over the period) in services for a large volume of deep building renovations. Electrification and new technologies will modernize and reduce fuel costs in transport and industry. Altogether, this will spur economic growth over the 2021-2030 period while displacing some jobs; annual GDP in the ambitious scenario increases on average by 1% compared to the reference scenario GDP and employment falls by (-).14%.

SECTORAL ANALYSIS

Slovakia's largest emitters by sector are industry (24.2%), transport (22.4%) and power and heat generation (17.4%). Iron and steel production accounts for over half of industrial emissions, mostly from the U. S. Steel Košice plant, which is the single largest emitter in the country. From 2006 to 2016, emissions decreased 35% in power and heat generation and 13% in industry, mostly as a result of fuel switching to biofuels. Transport emissions, however, increased by 11%, corresponding to energy demand growth. Road transport accounts for 94% of the total transport emissions, mainly from the combustion of diesel and petrol while rail transport is largely electrified.

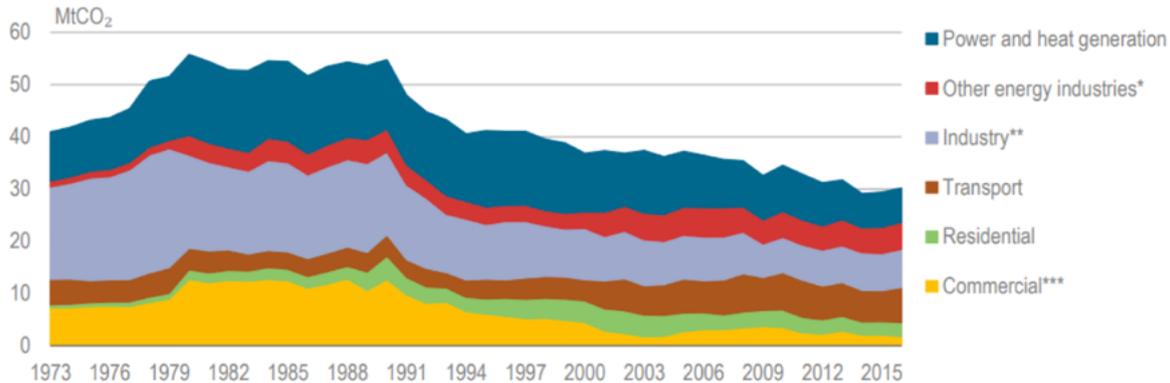


Figure 5: Energy related CO2 emissions by sector 1973-2016

By fuel, coal accounted for 39.5% of the total energy-related CO2 emissions in 2016 – though it has declined significantly from 1990 – followed by oil (31.0%) and natural gas (25.7%). Coal combustion emits the most CO2 in both industry and power and heat generation, whereas oil-related emissions are predominately attributable to the transport sector. In the 2006 to 2016 period, only emissions from oil increased corresponding to growth in transport, raising its share from 22.0% to 31.0%. Natural gas is consumed across the energy system, but mostly in the residential and commercial sectors.

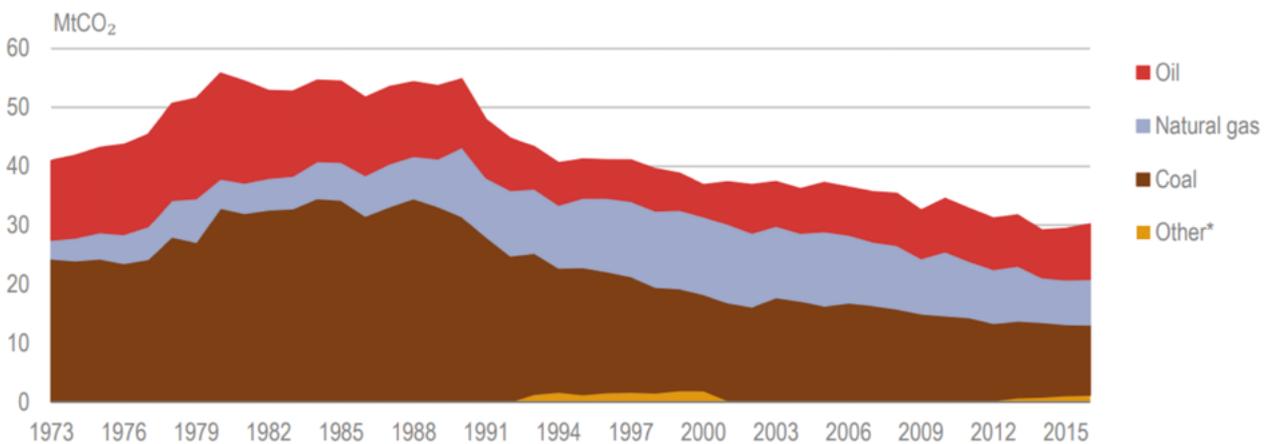


Figure 6: Energy-related CO2 emission by fuel type 1973-2016

Total CO2 emissions are related to the size of the population, economic development, energy intensity of the economy and carbon intensity of the energy supply, as per the equation:

$$CO_2 = population \times GDP/capita \times TPES/GDP \times CO_2/TPES$$

where GDP is the gross domestic product and TPES is the total primary energy supply. Since 1990, the Slovak Republic has seen a clear decoupling between economic growth and carbon emissions, with energy-related CO2 emissions nearly halving as the GDP per capita (in purchasing power parity [PPP]) nearly doubled. The population has remained stable over this period while energy supply has declined, although not as fast as the energy-related

emissions. The Slovak economy thus uses less energy per unit of GDP and emits less CO₂ per unit of energy. From 1996 to 2016, the energy intensity (TPES/GDP) in the country decreased by 56%, the second-largest relative decline among EU member states. Still, the absolute level of energy intensity remains high, mainly because of the country's large energy-intensive industry. In 2016, the Slovak energy intensity was 105 tonnes of oil equivalent/United States dollars (USD) million (GDP in PPP), which is the 13th highest among 30 IEA member countries.

Compared with neighbouring Visegrád 4 countries, the Hungarian economy is slightly less carbon-intensive than Slovakia, whereas both the Czech Republic and Poland have much more carbon-intensive economies owing to the continued dominance of coal.

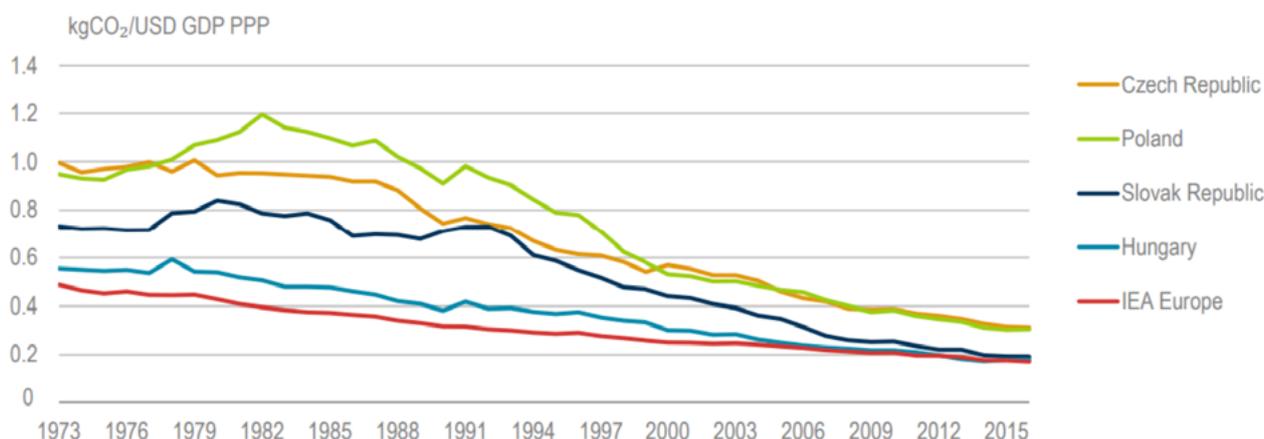


Figure 7: Energy-related CO₂ emissions per unit of GDP in the Slovak Republic and in other selected IEA member countries, 1973-2016

BUILDINGS

If it is true that the cleanest energy is the one that does not need to be produced, in addition to promoting carbon free production it is important to focus on reducing energy consumption itself. Energy efficiency gains are not limited to the buildings sector but it is the non-energy low hanging fruit that will key 2030 decarbonization efforts across CEE and Slovakia.

Labour intensive early stage green construction projects such as insulation retrofits or clean energy infrastructure tend to deliver high multipliers,⁵ with energy efficiency projects generating 2.5x that of fossil fuels according to one prominent study.⁶ They boost employment and spending in the short-run and, in the long-run, conveniently require much less labour for operation and maintenance while contributing to emissions reductions. Despite the ready-made multiplier and comparative advantage to fossil projects, building renovations have limited economic growth upside compared to other sectors.⁷

Experts tend to agree that the ideal rate of building renovation in Slovakia at 3%. To date the highest rate achieved has been 2.5-3% by apartments and family houses, but public buildings lag behind, closer to 1%. According to one 2020 study, the proper renovation of buildings can realistically reduce energy intensity by at least 60%.⁸ To meet a 3% annual target of public buildings renovation Buildings for the Future (BPB) estimates EUR 220 million of annual investment is needed⁹, which will result in energy cost savings and create demand for services and jobs especially from local entrepreneurs and SMEs.

Slovak households will fund the majority of private building renovations with savings and direct financing through energy service contracts, but also indirectly by paying higher prices for consumer goods, causing a net decline in household consumption.

INDUSTRY

As a heavily industrialized country, Slovakia is host to several major emitters. To evaluate their emission level trends, the 30 largest producers of greenhouse gases under the EU ETS were selected for year on year analysis from 2005 to 2019 using Verified Emissions (See Annex 1 and 2). This section categorizes individual Slovak industrial and energy companies according to production activity with the level of emissions based on cumulative figures for 2018.

The largest Slovak industrial emitter is the metallurgical industry, responsible for 44% of total EU-ETS emissions. Construction and engineering industry are a distant second (15%), closely trailed by chemical and heat production (12%).

YEAR	METAL	CHEMICAL	ENGINEERING	HEAT	AUTO	OTHER	TOTAL
2018	57368512	15568913	19493860	15123760	859203	20782019	129196267

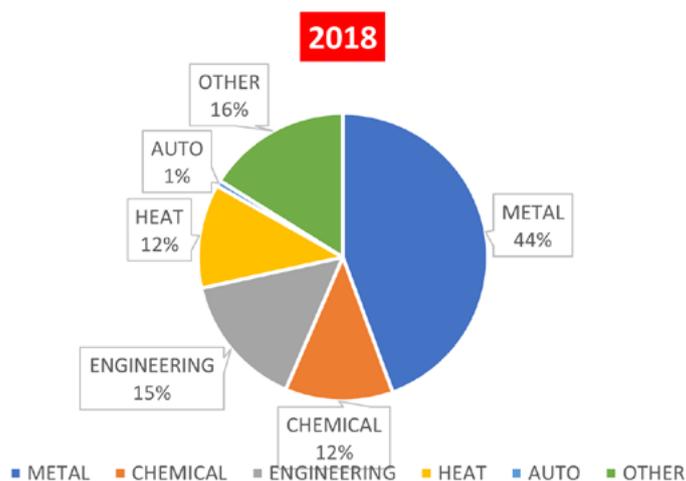


Figure 8: Slovak industry emissions based on EU ETS cumulative numbers 2018

The following prediction was made based on actual activities and further plans covering investment into green technologies and ongoing transformation in selected strategic iron and steel, energy and heat, chemical and automotive companies. It covers, for example, transformation of the Vojany power plant from coal to biomass producing hydrogen, the latest investments of traditional oil and gas companies such as Slovnaft and SPP-distribution into modern energy companies directly and in-directly supporting electro-mobility, energy storage in one site and co-distribution of hydrogen (up to 15 percent) via gas pipeline networks in another, US Steel closing one of three conventional blast furnaces and investing into an electric arc furnace for iron and steel making processes, public pressure on local heat generating companies in big cities supporting a green agenda including Kosice, Nitra, Zilina, and Eustream’s closure of two compressor stations.

YEAR	METAL	CHEMICAL	ENGINEERING	HEAT	AUTO	OTHER	TOTAL
2018	57368512	15568913	19493860	15123760	859203	20782019	129196267
2030	41546276	12455130	19493860	12770158	909203	15936500	103111127

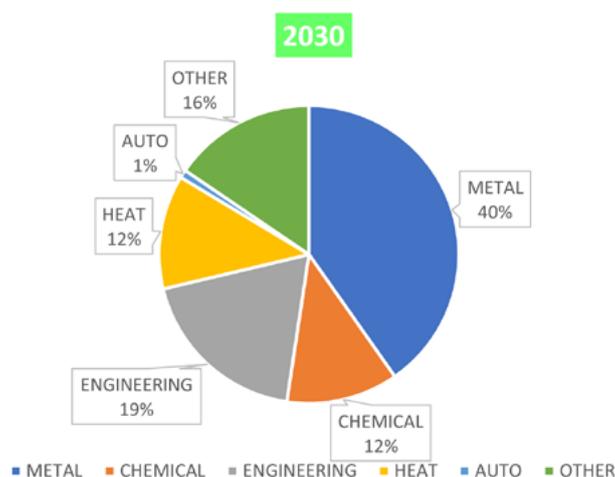
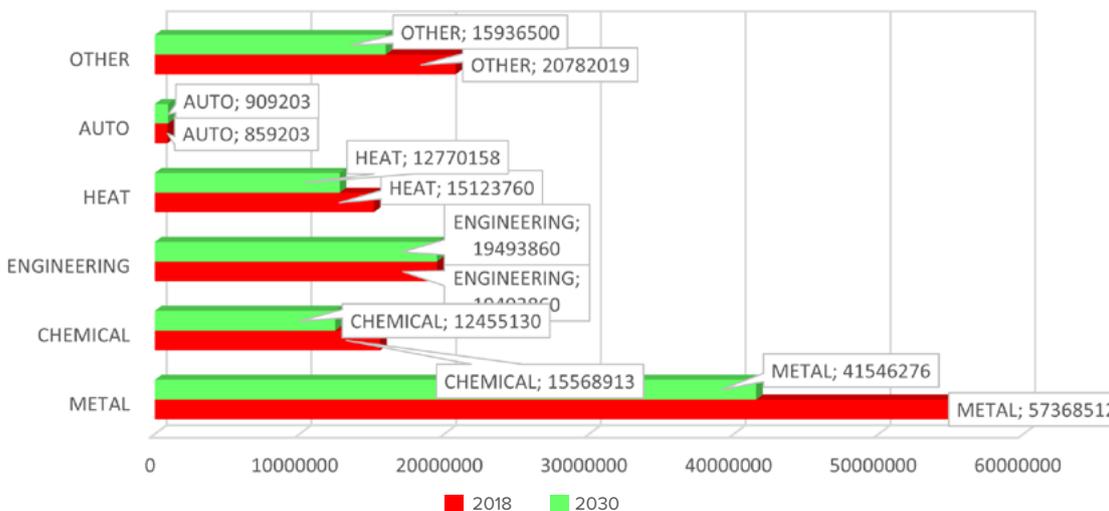


Figure 9: Slovak industry ETS emissions prediction 2030

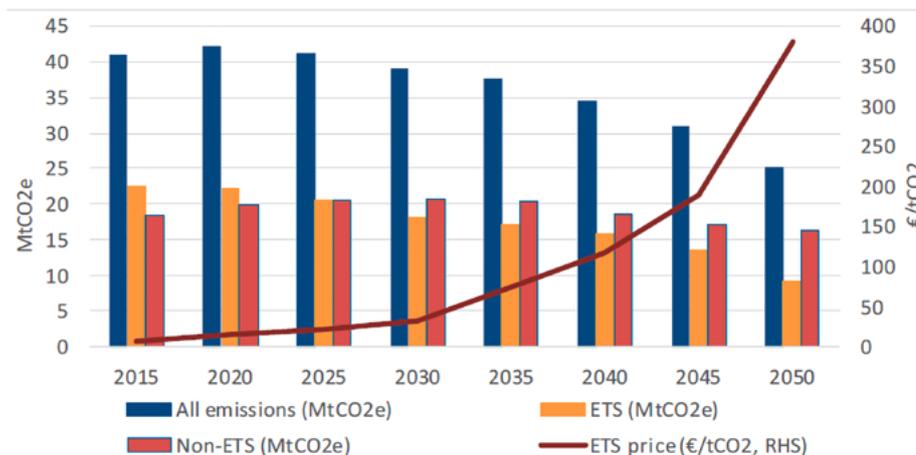
Such radical transformations of highly emitting companies (10-15%) that are also the most important strategic companies to Slovakia's economy can achieve 21% CO2 reduction by 2030. This explains why more ambitious plans for green tech investment across industrial sectors are needed. The rising price of EU ETS allowances is the main driver of the system, translating directly to higher costs for industrial companies.

Actual 2018 vs. Scenario 2030



*2030 prediction subject to change depending on COVID-19 policies and possible factory closures

Figure 10: Slovakia ETS emissions comparison 2018 and 2030



Note: Decarbonization 4 scenario, but other policy scenarios are similar. All emissions is total GHG emissions excluding LULUCF.

Source: Slovak-CGE model results and CPS model results.

Figure 11: EU ETS allowance cost increase prediction

STEEL

The production of iron, steel and non-ferrous metals has a significant presence in Slovakia. The metal industry, mainly iron and steel, is the largest energy-consuming industry, followed by non-metallic minerals. Steel making ranks as one of the three highest CO2 emitting industries, and since production occurs in a limited number of locations – the U.S. Steel Košice steel-mill being the largest single producer of emissions in Slovakia – they are prime candidates for decarbonization. While the industry must adapt to changing circumstances, it can also use this to its advantage to safeguard licensing for continued long-term operation.



Figure 12: U.S. Steel Košice verified emissions based on EU ETS with 2020-2030 prediction

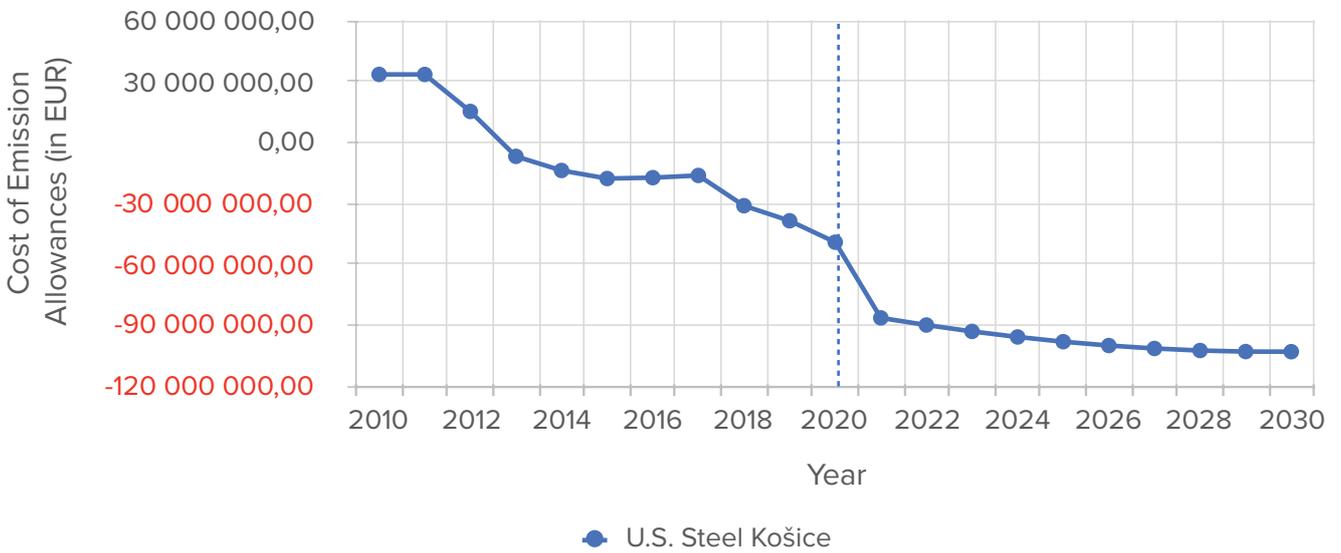


Figure 13: U.S. Steel Košice cost of emission allowances prediction 2020-2030

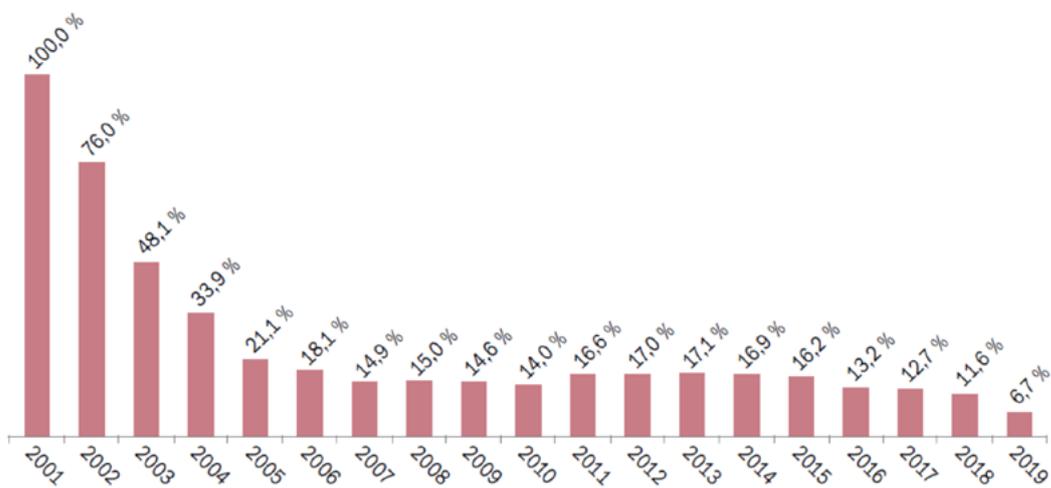


Figure 14: U.S. Steel Košice annual report - Emission reduction in kg/t of steel from 2001 to 2019

The U.S. Steel Company in Košice plans to invest more than \$1 billion into a subsidiary in eastern Slovakia in the next decade. However, the company makes long-term investments conditional on the willingness of the new government to support steel production and the competitiveness of the factory.

Recent studies estimate that on average 14% of the global steel industry is at risk without viable ways to lessen its environmental impact.¹⁰ Consequently, decarbonization should be a top priority for remaining economically competitive and retaining a license to operate. Moreover, long investment cycles of 10 to 15 years, multibillion financing needs, and limited supplier capacities make this issue even more relevant, locking in significant lead times factoring into the decarbonization challenge.

In response, decarbonization measures such as establishing or switching to hydrogen-based (H₂) steel production can be implemented either in forthcoming (greenfield) sites or existing (brownfield) facilities. The latter opportunity requires existing equipment to either be retrofitted or for the facility to be completely rebuilt in order to establish a decarbonized production process. The optimal methods will differ by location and site, depending on a weighted combination of technical feasibility, existing infrastructure, market demands, operating costs (the price of renewable electricity and scrap), and the regulatory environment.

Steel can be produced via two main processes, either using an integrated blast furnace (BF)/basic oxygen furnace (BOF) like U.S. Steel Košice or an electric arc furnace (EAF) like Železiarne Podbrezová.

While integrated players produce steel from iron ore and need coal as a reductant, EAF producers use steel scrap or direct reduced iron (DRI) as their main raw material. However, with the conventional coal-dependent BF/BOF process the predominant production method in Europe, there is a serious need to assess alternative breakthrough technologies to reduce carbon dioxide emissions. Indeed, almost all European steel producers are currently developing decarbonization strategies and running pilot plants to assess different production technologies including:

- ▶ BF/BOF efficiency programs: Improving efficiency and/or decreasing production losses in different ways.
- ▶ Biomass reductants: Using biomass such as heated and dried sugar, energy cane, or pyrolyzed eucalyptus, as an alternative reductant or fuel.
- ▶ Carbon capture and usage: Using emissions to create new products for the chemical industry, such as ammoniac or bioethanol.
- ▶ Higher volume of scrap-based EAFs: Maximizing secondary flows and recycling by melting more scrap in EAFs. EAF producers are more environmentally friendly and flexible to meet demand swings. However, shifting to EAF-based steel production requires a future supply of commercially viable renewable electricity and a ample supply of high-quality steel scrap.
- ▶ Optimize DRI and EAF: This requires boosting usage of DRI in combination with EAF. DRI-based reduction emits less carbon dioxide than the integrated method and enables the production of high-quality products in the EAF.
- ▶ DRI and EAF using hydrogen. This uses green hydrogen-based DRI and scrap in combination with EAFs. The process replaces fossil fuels in the DRI production stage with renewable hydrogen.

Železiarne Podbrezová is the second largest steel producing industrial company in Slovakia. The manufacturing process uses an electric arc furnace that produces much less emissions than a blast furnace and basic oxygen converter. However, their production capacity is significantly lower compared to U. S. Steel Košice.

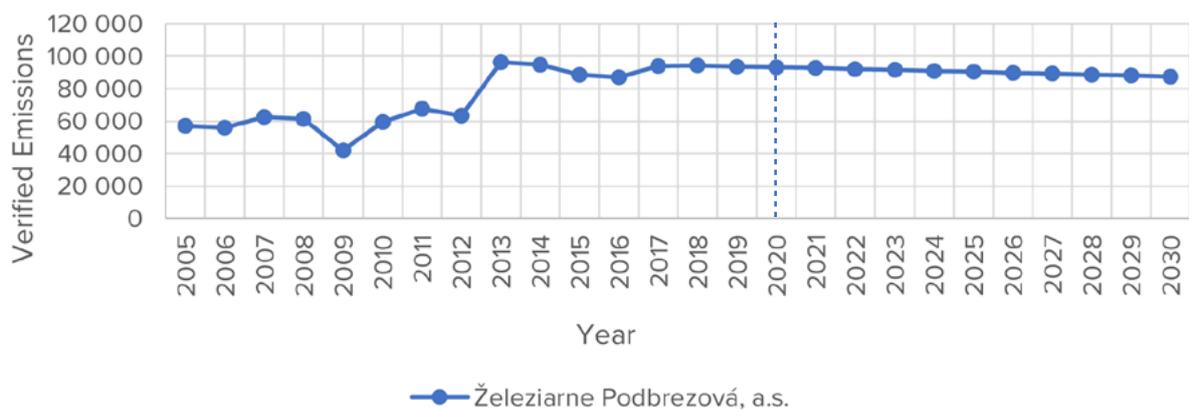


Figure 15: Železiarne Podbrezová verified emissions based on EU ETS with 2020-2030 prediction

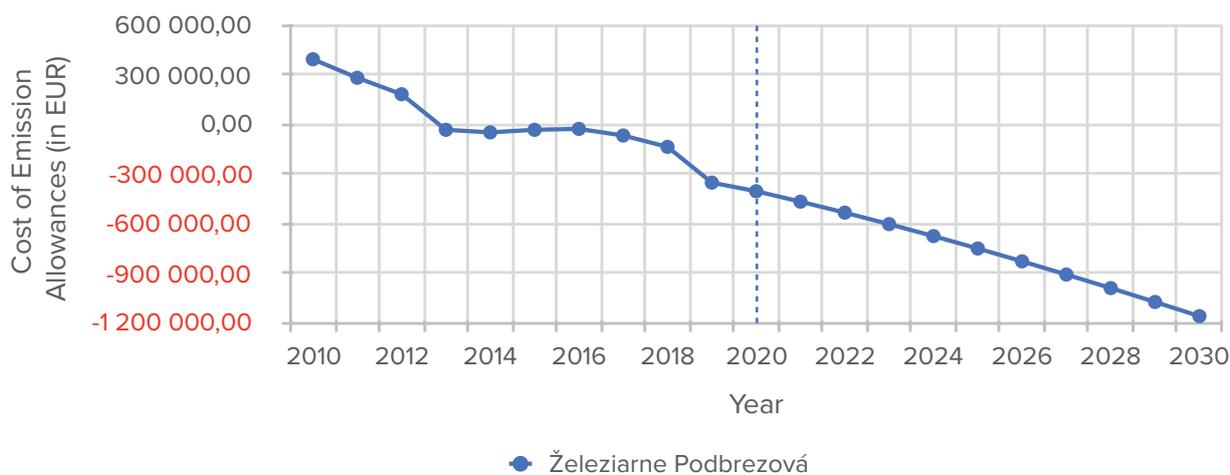


Figure 16: Železiarne Podbrezová cost of emission Allowances prediction 2020-2030

CEMENT

Imbedded within the cement manufacturing process are two major sources of CO₂ emissions. The primary source (60% of total emissions) is the calcination of limestone (CaCO₃), when heated above 900 °C and converted to quick lime (CaO). The secondary source (40% of total emissions) is the burning of coal/fuel to provide the heat required for the calcination and clinkering process. Roughly 900 g of CO₂ is produced as a by-product for every 1 kg of cement produced. This unique process produces significant volumes of CO₂ along with the main product, cement.

Cement producers have targeted fuel consumption as a means of both improving the economy of operation as well as reducing CO₂ emissions. Over the last thirty years, the specific fuel-type consumption of cement manufacturing has fallen by 40%, directly contributing to the reduction of CO₂ emission by the same magnitude.

Furthermore, the coal that is typically used for combustion is increasingly being replaced by alternative fuels like municipal solid waste (MSW), rubber tires, dried sewage sludge, etc. In fact, the industry's best-kept secret is that cement kilns are the last and best resort for recycling almost any waste produced in human society. Since kiln combustion happens at 1500 C, almost anything which has volatile matter could be burnt as an alternative fuel, and the burnt ash is a beneficial additive for the cement end product. Single-use plastics, which have come into focus recently as a pressing global environment issue, are in fact excellent candidates for recycling in cement manufacturing, but additional research and development is needed to work out the intricacies of the process.

Substituting conventional coal with alternative fuel achieves twin benefits by removing harmful waste from the environment as well as reducing process CO₂ emissions in the cement kilns. The biggest stumbling block for wider usage of alternate fuels is turning out to be the cost of transportation. Cement manufacturing is a low margin process which cannot justify the added cost of transporting waste over long distances and it is not economically viable to transport waste over 200 km for burning in cement kilns under current practices.

It bears repeating that cement produces CO₂ as a by-product, meaning that unless the CO₂ is captured, stored or utilized, it is not possible to drastically reduce emissions from a cement plant. Carbon capture technologies such as oxyfuel combustion, chemical looping, and all-electric process heating are in various stages of development. Storing the captured CO₂ is more complex, and presently the most viable option is pumping it into used oil wells and other geological formations. The utilization of captured CO₂ into other beneficial minerals is still in the very early stages.

Nonetheless, these technologies are far from economically viable in today's economy. The average cost of conventional cement production is 58 €/tonne and carbon capture storage (CCS) typically pushes this above 100 €/tonne. With a limited profit margin, investment costs and limited potential for realizing carbon costs, the currently viable selling price for cement is 78 €/tonne.¹¹

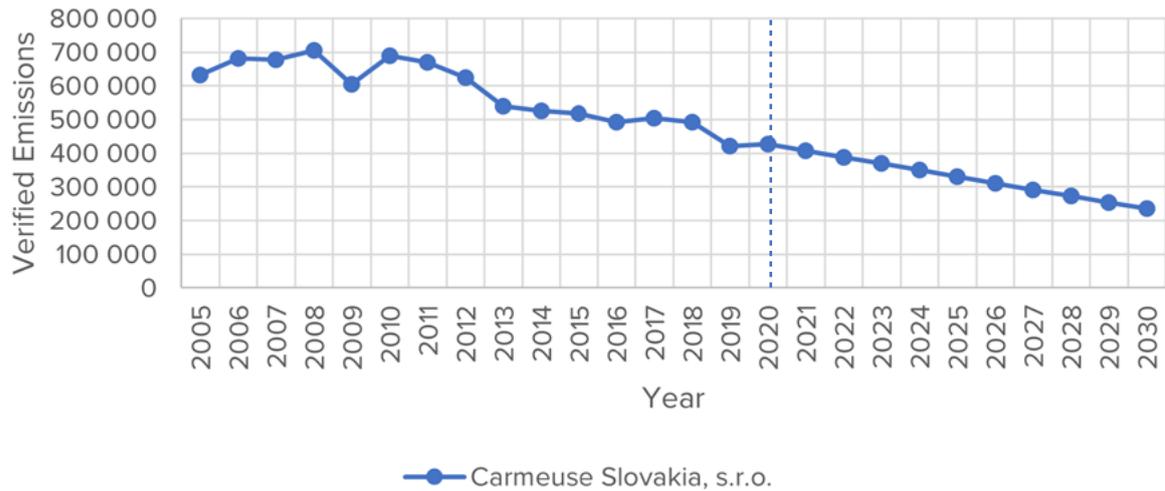


Figure 17: Carmeuse Slovakia (cement) verified emissions based on EU ETS with 2020-2030 prediction

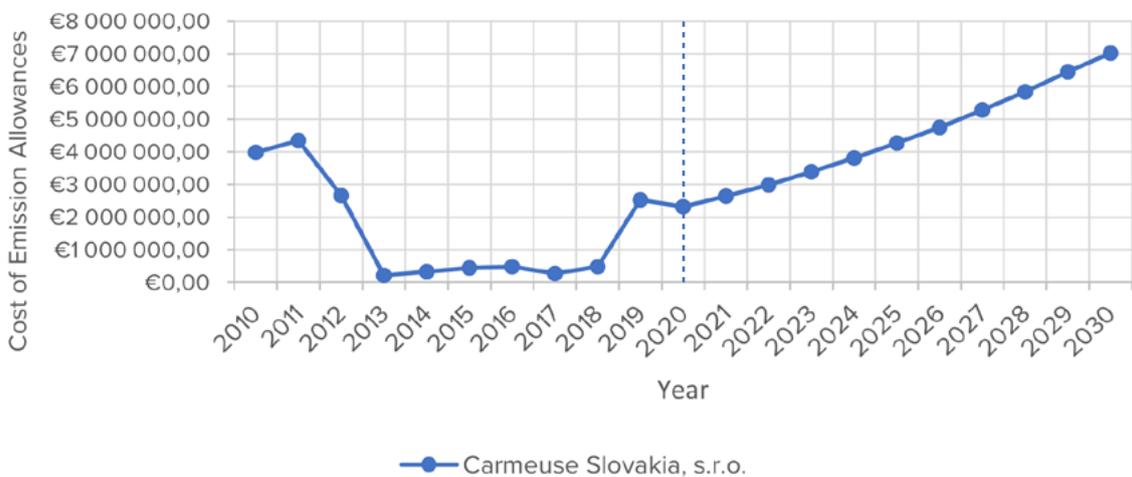


Figure 18: Cost of emission Allowances prediction 2020-2030 Carmeuse Slovakia (cement)

CHEMICALS

The nutrients that crops need to grow can be obtained through organic minerals (e.g. manures, residues or soil organic matter) or mineral fertilizer. It is estimated that without mineral nitrogen fertilizers, 50% of the world's population would not be fed.

While much of the emissions reductions gains from heavy industry will take place after 2030, the production of chemicals and especially their use in domestic agriculture needs to be addressed in the next decade. Work by the International Fertiliser Industry Association (IFA) showed that fertiliser manufacture accounts for approximately 1% of global greenhouse gas emissions. If associated nitrous oxide emissions from applying the fertiliser are taken account of as well, this increases to 2.5%.

Nitrogen fertiliser is produced using the Haber Bosch process which involves combining hydrogen (from steam reforming) with nitrogen (from the air) to create ammonia. The process is very energy intensive, requiring high pressure and high temperature to be most effective, and this comes with a large carbon footprint. Approximately 50% of the GHG emissions associated with nitrogen fertilizers are released during the production process. Along with energy inputs like natural gas, leakage of N₂O occurs during the nitric acid stage of ammonium nitrate production.

Long term solutions are in development to reduce the emissions associated with fertiliser production, including carbon capture and storage, renewable electrolysis (to produce the hydrogen rather than the very energy intensive steam process), or the use of biomass gasification. Biomass gasification uses a biomass-based feedstock to produce a gas mix high in hydrogen to create the ammonia needed. This ammonia is then combined with nitric acid to produce nitrogen fertiliser (ammonium nitrate). Studies investigating biomass gasification have found that the GWP can be reduced by 52% through using this production method.

Along with this energy dense process, the nitrous oxide emissions by-product of the production of nitric acid causes emissions. With improvements in best available techniques, the IPCC estimate that nitrous oxide emissions can be reduced to approximately 0.12 kg/tonne nitric acid.

Duslo, as one of the largest chemicals companies in Slovakia producing industrial fertilizers and nitrogen compounds, should be supported in efforts to decarbonize the above processes.

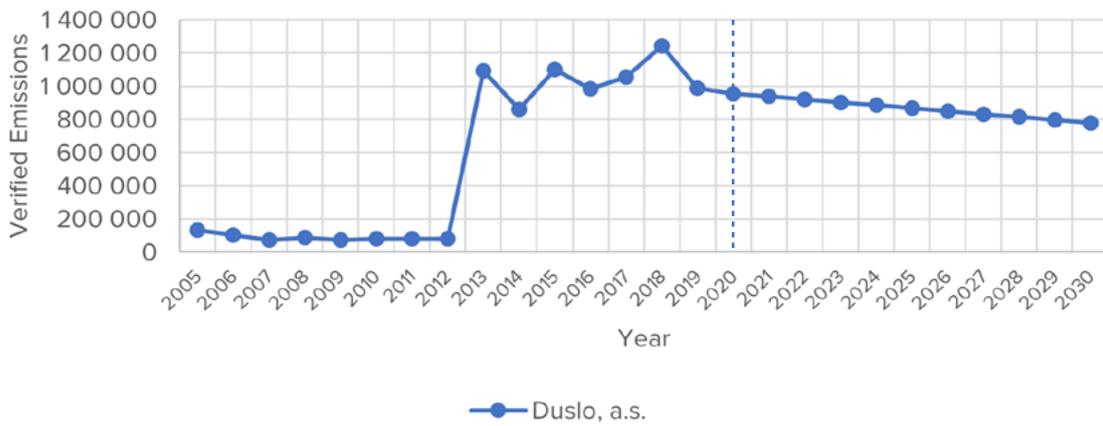


Figure 19: Duslo a.s. verified emissions based on EU ETS with 2020-2030 prediction

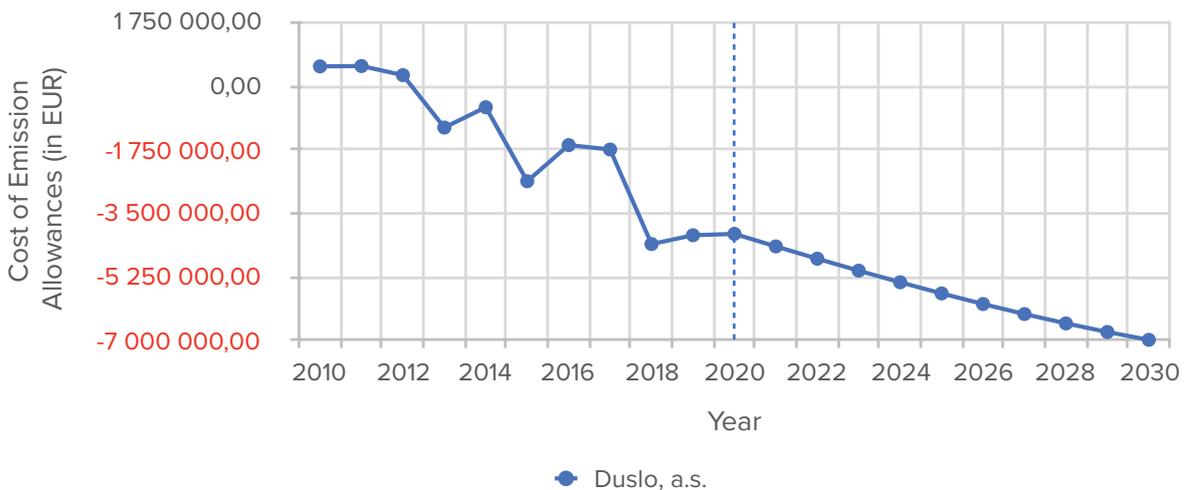


Figure 20: Duslo a.s. cost of emission Allowances prediction 2020-2030



KEYS TO THE LOW CARBON ECONOMY: CCS, HYDROGEN AND CIRCULAR ECONOMY

The industrial and energy intensive nature of Slovakia's economy is widely perceived to be a liability for the energy transition task at hand, and while it certainly poses a decarbonization challenge it is also fertile ground for the development of breakthrough green technologies in difficult to abate sectors – namely CCS, low carbon hydrogen and advanced circular material inputs.

This is in fact the opportunity for Slovakia to get in on the ground floor of innovation and value-added that has eluded it over the last 30 years of FDI led automotive manufacturing growth where factory automation is already cutting into employment. Much in the same way the Slovak Battery Alliance and companies like InoBat and Greenway are beginning to leverage the corporate automotive landscape with applied battery R&D, heavy industry can serve as a laboratory and testing ground for an array of green and digital technologies.

Just as Slovakia can conceivably use its small size to its advantage to fully embrace digitalization in building renovations over the next decade, it can also capitalize on its concentrated industrial landscape by working directly with single large emitters to develop domestic 'in-house' solutions rather importing its climate action. To date, decarbonization efforts have been a patchwork of disjointed, low cost, short sighted fixes. Changing this will require deep reform, buy-in and execution from the new government as never witnessed before; not only is policy reform to open competitive renewable and energy efficiency markets, but fundamental organizational restructuring and coordination to lift the weight of bureaucracy from innovative and mature technologies and the public funding needed to growth them.

In June 2020 the German Federal Government sent out a press release on a French-German Initiative for the European recovery, pledging to increase EU emission reduction targets in 2030 in tandem with a package of efficient EU measures to avoid carbon leakage and also importantly revising State Aid rules in light of the more ambitious climate policy and carbon leakage.¹² The carbon border adjustment mechanism and increased scope for state aid to support green business initiatives will be key European Green Deal measures for Slovakia to advance industrial decarbonization.

A more circular CEE supply chain will help the EU reduce its carbon footprint and dependency on imported raw materials and international supply chains of competitors. This means improving the product design of material intensity, recycling of materials and overall efficiency along with shifting from fossil fuel inputs to electric and green hydrogen. The new government will need to simultaneously ensure protection of industry from carbon leakage through the carbon border adjustment mechanism at the EU level while supporting a framework of national standards and best practices for large industrial companies, their spinoffs, and SMEs in automotive manufacturing and supply chain to embrace circular economy standards.

The next ten years are key to setting industry on the right transformation path for the deployment of CCS and low carbon hydrogen. Even though these are not widely deployed until after 2030, policies need to channel R&D support now to ensure that they will reach a certain maturity level.¹³ Like the auto industry, the last to recognize the trends, anticipate, and adapt, will be left behind. The digitally enabled sharing economy will erode the current model of privately owned personal vehicles in the same way that the circular economy will gradually cut out carbon-intensive materials, substituting steel with carbon fibre and aluminium or cement by timber in buildings.

Yet taking hydrogen as an example, outside of Czechia, Visegrad 4 NECPs do not include many specific hydrogen projects.¹⁴ Hungary mentions concrete hydrogen related objectives in domestic low carbon/renewable hydrogen, and along with Czechia and Slovakia, end use in the transport sector. All but Poland consider using existing methane infrastructure for hydrogen transport and distribution by blending into the public grid in the short and medium term.¹⁵



CONCLUSION

Slovakia deserves praise for achieving a 41% reduction in GHG emissions compared to 1990 levels, one of the highest in the EU over this period, but especially non-ETS sector emissions are trending up. Like its neighbours, Slovakia needs to provide long-term certainty with measurable commitments for business to commit to investments. Meeting the EU-level target of 55%, translating to approximately 52.5% for Slovakia, will require enabling legislation for renewables and energy efficiency, and stricter regulations for persistently problematic sectors like transport and agriculture.

An ambitious 2030 climate policy is a disruptive growth strategy for Slovakia that will deliver benefits far beyond the economy to improve quality of life for all citizens. But to be successful, appropriate and anticipatory just transition and social policies will have to ensure an equitable low carbon economy benefits all levels of society.

ENDNOTES

- 1 'A Low-Carbon Growth Study For Slovakia, The World Bank Macroeconomics, Trade and Investment Global Practice, Institute for Environmental Policy, Ministry of Environment, Slovak Republic, January 2019.
- 2 'European Green Deal must be central to a resilient recovery after Covid-19,' 9 April, 2020
- 3 European Commission, 'COMMISSION STAFF WORKING DOCUMENT, IMPACT ASSESSMENT Document accompanying the Package of Implementation measures for the EU's objectives on climate change and renewable energy for 2020', SEC(2008) 85, 23 January 2008.
- 4 Commission Staff Working Document, 'Assessment of the final national energy and climate plan of Slovakia', European Commission, 14 October 2020.
- 5 Hepburn et al., 'Will COVID-10 fiscal recovery packages accelerate or retard progress on climate change', Oxford Smith School of Enterprise and the Environment, 4 May 2020.
- 6 Garrett-Peltier, H. 'Green versus brown: Comparing the employment impacts of energy efficiency, renewable energy, and fossil fuels using an input-output model', Economic Modelling, 2017.
- 7 'University of Cambridge Institute for Sustainability Leadership (CISL), 'Maximizing the benefits: Economic, employment and emissions impacts of a Green Recovery Plan in Poland', Technical Report, Cambridge, UK: CLG Europe, 2020.
- 8 Halama and Vilcekova, 'Building renovation as a tool for carbon neutrality', 2020
- 9 Hojsik, M., 'Green Recovery Plan: What to do after the global COVID-19 crisis?', renew Europe, 2020.
- 10 Hoffman, C., 'Decarbonization challenge for steel', McKinsey & Company, <<https://www.mckinsey.com/industries/metals-and-mining/our-insights/decarbonization-challenge-for-steel>>
- 11 European Commission, 'Competitiveness of the European Cement and Lime Sectors', Final Report, December 2017. <http://publications.europa.eu/resource/cellar/07d18924-07ce-11e8-b8f5-01aa75ed71a1.0001.01/DOC_1>
- 12 Bundesregierung, 'A French-German Initiative for the European Recovery from the Coronavirus Crisis', 18 May 2020.
- 13 Climact, 'Increasing The EU's 2030 Emissions Reduction Target, How to cut EU GHG emissions by 55% or 65% by 2030', June 2020.
- 14 Hydrogen Europe, 'Hydrogen technologies for energy, climate and environmental policy objectives', PPT
- 15 Fuel Cells and Hydrogen 2 Joint Undertaking, Opportunities for Hydrogen Technologies Considering the National Energy & Climate Plans, August 2020.

Installation name	Account holder name	Verified Emissions entered/updated after deadline of EU ETS Phase Year														
		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
U. S. Steel Košice, s.r.o.	U. S. Steel Košice, s.r.o.	9 057 557	10 127 702	9 659 314	8 900 471	7 555 068	8 445 826	8 493 163	8 012 732	8 397 752	8 962 739	8 646 638	8 867 366	5 961 445	5 969 066	5 023 141
Ferroenergy s.r.o.	Ferroenergy s.r.o.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U. S. Steel Košice, s.r.o. + Ferroenergy s.r.o.	Ferroenergy s.r.o.	9 057 557	10 127 702	9 659 314	8 900 471	7 555 068	8 445 826	8 493 163	8 012 732	8 397 752	8 962 739	8 646 638	8 867 366	5 961 445	5 969 066	5 023 141
SE, a.s., Elektrárne Novky	Slovenské elektrárne, a.s.	2 155 316	2 056 171	2 097 420	2 495 193	2 445 307	2 361 963	2 398 722	2 289 752	2 299 035	2 077 299	2 143 125	1 854 213	1 789 587	1 578 201	1 503 209
Duslo, a.s., Sala	Duslo, a.s.	133 671	101 997	71 886	85 795	73 855	79 964	80 068	78 948	1 093 905	861 598	1 098 236	984 059	1 054 051	1 241 720	965 847
Rafinéria	SLOVNAFT, a.s.	2 292 788	2 190 190	2 250 495	2 249 322	1 375 190	1 012 665	1 086 090	999 190	1 110 700	991 575	1 145 821	1 097 457	1 110 767	1 032 420	962 563
CRH (Slovensko) a.s., cementárni Rohnožnik	CRH (Slovensko) a.s.	837 025	930 465	909 975	902 314	829 313	718 160	825 129	748 385	661 678	820 485	801 642	949 271	927 494	875 541	935 434
TEPARN	SLOVNAFT, a.s.	0	0	0	0	731 039	938 845	862 067	800 815	738 067	572 846	680 975	752 803	729 267	776 743	759 828
SE, a.s., Elektrárne Vojany	Slovenské elektrárne, a.s.	2 646 143	2 615 611	2 005 236	1 583 830	898 417	645 958	573 432	600 273	375 818	375 483	390 409	448 783	617 778	710 588	319 885
Považská cementárň, a.s.	Považská cementárň, a.s.	470 210	504 263	515 975	563 256	456 064	368 804	468 718	507 730	509 418	572 658	566 753	519 922	554 891	529 922	514 710
TEKO, a.s.	TEPARN, a.s.	521 217	537 022	544 697	518 650	497 653	533 007	523 551	490 424	505 477	446 297	429 186	370 382	406 623	412 351	362 694
Petrochemia SPC	SLOVNAFT, a.s.	0	0	0	353 915	373 568	367 453	389 674	458 377	451 374	424 616	383 619	327 779	347 951	358 644	349 297
Carmeuse Slovakia s.r.o., Košice	Carmeuse Slovakia, s.r.o.	417 569	480 063	469 154	504 122	424 171	507 238	389 674	280 646	313 160	250 128	402 664	386 010	389 774	385 284	314 230
Cementárň Turná nad Bodvou, CRH (Slovensko), a.s.	CRH (Slovensko) a.s.	433 082	350 387	445 729	478 594	344 293	238 482	309 228	199 887	251 798	232 864	288 099	323 045	367 607	378 522	428 419
Výroba magnéziového silniku, SMZ, a.s., Jelšava	SMZ, a.s., Jelšava	8 951	7 368	4 207	508 331	336 431	453 069	447 170	372 546	339 286	330 204	304 070	257 250	346 718	368 547	356 539
Výroba hliníka	Slovakia, a.s.	0	0	28 940	24 962	27 412	26 793	25 322	28 793	28 546	289 472	297 246	291 160	295 832	310 232	307 569
Cermetec, a.s.	CEMIMAC, a.s.	352 460	352 701	354 888	355 008	331 114	323 249	331 596	285 163	314 749	332 244	299 683	291 400	291 479	302 672	290 575
OFZ, a.s., prevádzka Široka	OFZ, a.s.	0	0	0	0	0	0	0	0	165 381	223 117	239 924	237 403	293 962	281 704	239 208
Kompresorová stanica 01 Veľké Kapušany	eustram, a.s.	458 935	316 044	362 595	453 730	397 382	405 595	451 004	320 434	346 884	150 949	177 924	284 353	294 413	259 647	343 841
Drogovky, kotol, na zem. plyn, metanový a hnojd. uhlie	Zimská tepelárnska, a.s.	251 719	239 437	235 947	287 050	286 774	265 983	233 874	241 732	229 592	195 785	240 430	248 398	239 988	239 205	225 556
Energética (unická kódy K1, K2)	BUKOZA ENERGO, a.s.	0	0	0	0	0	0	0	0	0	227 630	229 081	213 140	200 038	213 101	199 775
PPC Energy	PPC Energy, a.s.	0	0	0	0	0	0	3 773	1 527	857	796	152	25 088	174 672	173 700	182 942
Veolia Energia Levice, a.s. - plynový cyklus	Veolia Energia Levice, a.s.	0	0	0	48 839	175 718	178 000	187 222	187 451	171 419	174 941	174 104	169 273	127 064	125 022	118 897
Martinská tepelárnska, a.s.	Martinská tepelárnska, a.s.	188 152	195 618	172 422	191 353	181 311	142 111	139 294	134 809	124 322	99 146	118 385	119 240	120 572	119 852	105 280
DOU.VAP s.r.o., pece na výrobu vápna	DOU.VAP, s.r.o.	114 012	133 776	192 850	146 041	115 047	131 048	149 210	127 199	121 832	124 022	88 215	117 416	105 106	112 555	119 658
TEPLAREN Považská Bystrica, s.r.o.	EPLAREN Považská Bystrica, s.r.o.	49 241	49 029	42 040	41 527	50 726	61 683	119 210	115 686	130 047	119 849	132 002	132 718	140 035	112 286	125 425
Carmeuse Slovakia, s.r.o., (Slavec)	Carmeuse Slovakia, s.r.o.	214 139	200 900	207 403	201 117	180 298	181 382	211 107	172 249	114 441	131 109	115 275	105 930	113 282	107 624	106 355
Zvolenská tepelárnska, a.s. (TPA a TdB)	Zvolenská tepelárnska, a.s.	218 378	205 329	166 829	161 775	166 296	164 124	137 547	125 479	111 196	95 078	96 610	98 811	97 324	100 081	99 745
Čalimí spol. s r.o., závod Tisovec	Čalimí, spol. s r.o.	80 387	76 548	90 011	119 301	101 271	119 731	96 936	110 548	98 187	97 382	88 290	100 200	97 380	98 153	95 280
Závesiarne Podbrezová, a.s.	Jedne Podbrezová, a.s. skladište Zr	57 053	56 127	62 371	61 540	42 116	59 530	67 747	63 485	96 419	94 778	88 542	88 852	94 141	94 343	93 775
FORTISCHEN a.s.	FORTISCHEN a.s.	0	0	0	0	0	0	0	0	87 830	82 793	80 196	91 834	96 839	91 741	82 032

30 Slovakia's largest emitters based on the EU ETS

ANNEX 2

Installation name	Account holder name	DECREASE											INCREASE										
		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019							
U S Steel Košice, s.r.o. Ferroenergy s.r.o.	U S Steel Košice, s.r.o. Ferroenergy s.r.o.	/	11,81%	-4,62%	-7,23%	-15,68%	11,78%	0,56%	3,76%	-4,71%	6,73%	-3,53%	2,55%	-32,77%	0,13%	-15,85%							
U S Steel Košice, s.r.o. Ferroenergy s.r.o.	Slovenské elektrárne, a.s.	/	11,81%	-4,62%	-7,23%	-15,68%	11,78%	0,56%	3,76%	-4,71%	6,73%	-3,53%	2,55%	-32,77%	0,13%	-15,85%							
SE, a.s., Elektrárne Noveky Dústo, a.s. Sála	Dústo, a.s.	/	-4,60%	2,01%	18,96%	-2,00%	-3,41%	1,56%	-4,54%	0,41%	-9,64%	3,17%	-13,48%	-3,49%	-11,81%	-4,75%							
Rafinéria	SLOVNAFT, a.s.	/	-23,70%	-29,52%	19,35%	-13,92%	8,27%	0,13%	-1,40%	1285,60%	-21,24%	27,47%	-10,40%	7,11%	17,80%	-20,61%							
CRH (Slovensko) a.s., cementárň Rítohrad Teplárň	CRH (Slovensko) a.s. SLOVNAFT, a.s.	/	-4,47%	2,75%	-0,05%	-38,86%	-26,36%	7,25%	-8,00%	11,16%	-10,73%	15,56%	-4,22%	1,21%	-7,05%	-6,77%							
SE, a.s., Elektrárne Volany Považská cementárň, a.s.	Slovenské elektrárne, a.s. Považská cementárň, a.s.	/	11,16%	4,25%	-0,79%	-13,82%	-13,40%	14,89%	-9,30%	-11,59%	24,00%	-2,30%	18,42%	-2,29%	-5,60%	6,84%							
TEKO, a.s.	SLOVNAFT, a.s.	/	-	-	-	28,43%	8,18%	-	-7,11%	-7,84%	-22,39%	15,38%	-3,13%	13,89%	6,51%	-2,18%							
Petrochemia SPC Carnause Slovakia s.r.o., Košice	Slovenské elektrárne, a.s. Považská cementárň, a.s.	/	-1,15%	-23,24%	-21,02%	-43,28%	-28,10%	-11,23%	4,68%	-37,39%	-0,09%	3,98%	14,95%	37,66%	15,02%	-54,97%							
SE, a.s., Elektrárne Volany Považská cementárň, a.s.	Považská cementárň, a.s. Teplárň Košice, a.s.	/	7,24%	2,32%	9,16%	-19,03%	-19,13%	27,09%	8,32%	0,33%	12,41%	-1,03%	-8,26%	6,73%	-2,87%	-2,87%							
TEKO, a.s.	Teplárň Košice, a.s.	/	3,03%	1,43%	-4,78%	-4,05%	7,10%	-1,77%	-6,33%	3,07%	-11,71%	-3,84%	-13,70%	9,78%	1,41%	-7,19%							
Petrochemia SPC Carnause Slovakia s.r.o., Košice	SLOVNAFT, a.s. Carnause Slovakia, s.r.o.	/	-	-	7,45%	7,45%	-	7,45%	-27,98%	11,59%	-20,13%	31,05%	6,15%	3,07%	11,55%	-12,69%							
Cementárň Turňa nad Bodvou, CRH (Slovensko), a.s. Výroba magnetitového slínku, SMZ, a.s. Jelšava	CRH (Slovensko) a.s. SMZ, a.s. Jelšava Slovakia, a.s.	/	-19,09%	27,21%	6,92%	-27,76%	-30,73%	29,66%	-35,36%	25,97%	-7,60%	22,97%	12,91%	13,79%	2,91%	13,24%							
Výroba hliníka Cemnac, a.s.	CEMNAČ a.s.	/	-17,69%	-42,90%	11982,98%	-8,83%	11,60%	-2,26%	-5,49%	1031,61%	1,02%	2,30%	-2,68%	-7,91%	6,30%	-3,26%							
OFZ a.s., prevádzka široká Kompresorová stanica O1 Veľká Kopušany	OFZ a.s. eustream, a.s.	/	0,07%	0,62%	0,03%	-6,73%	-2,38%	2,58%	-14,00%	10,38%	5,56%	-9,80%	-1,05%	23,82%	-4,15%	-15,10%							
Dvojitý kôl, na zem plyn nahový a hnedé uhlie Energetika (uhňná kôl) K1, K2)	Zimská tepelárňa, a.s. BIKOZA ENERGO, a.s.	/	-31,14%	14,73%	25,13%	-12,42%	2,07%	11,20%	-28,95%	8,25%	-56,48%	17,87%	59,82%	3,54%	-11,81%	32,43%							
PPC Energy Veolia Energia Levice, a.s. - paroplynový cyklus	PPC Energy, a.s. Veolia Energia Levice, a.s.	/	-4,88%	-1,46%	21,65%	-7,06%	-0,30%	-12,07%	3,36%	-5,02%	-14,72%	22,80%	3,31%	-4,59%	0,93%	-5,71%							
Matinská tepelárňa, a.s. DOLVAP s.r.o., pece na výrobu vápna	Matinská tepelárňa, a.s. DOLVAP, s.r.o.	/	-	-	-	-	-	-	-59,53%	-43,88%	-11,79%	-79,89%	16405,263%	596,24%	-0,56%	5,32%							
TEPLAREN Považská Bystrica, s.r.o. Carnause Slovakia, s.r.o. (Slavec)	TEPLAREN Považská Bystrica, s.r.o. Carnause Slovakia, s.r.o.	/	17,34%	44,16%	-24,27%	-21,22%	13,91%	13,86%	-14,75%	-4,22%	1,80%	-28,87%	33,10%	-10,48%	7,37%	6,03%							
Zvolenská tepelárňa, a.s. (TĽA a TrĽB) Cehiti spol. s r. o., závod Tisovec	Zvolenská tepelárňa, a.s. Cehiti spol. s r. o.	/	6,18%	3,28%	-3,07%	-10,35%	0,60%	16,39%	-18,41%	-33,56%	14,56%	-12,08%	-8,11%	6,94%	-4,99%	-1,18%							
Železiarne Podbrezová, a.s. FORTSCHEM a.s.	Železiarne Podbrezová, a.s. FORTSCHEM a.s.	/	-4,28%	16,98%	32,54%	-15,11%	18,23%	-19,04%	14,00%	-11,18%	-0,82%	-8,31%	12,22%	-7,80%	2,83%	-0,34%							
/	/	/	-1,62%	11,12%	-1,33%	-31,56%	41,35%	-13,80%	-6,29%	51,88%	-1,70%	-6,58%	-1,91%	8,39%	6,22%	-0,60%							
/	/	/	-	-	-	-	-	-	-	-	-5,73%	-3,14%	14,54%	5,43%	-5,26%	-10,58%							

