HUNGARY

Decarbonisation of the Industrial Sector- Sustainable Finance as an Opportunity?

REVIEW OF THE HARD-TO-ABATE SECTOR'S DECARBONISATION IN VISEGRAD 4

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Equilibrium Institute

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Hungary's heavy industry has lost a lot of its significance in the past thirty years with the structural changes in the country's economy. Although the share of steel, cement, and chemical production from Hungarian gross value added is relatively small (2,3 percent)[1], these industries are extremely energy- and greenhouse-gas-intensive, so we cannot see a real decoupling of emissions from production. This means that these industries need to be both modernised and rethought: investments in existing technologies reducing greenhouse gas emissions but also in research and development of new technologies can turn climate neutrality into reality.

As fossil fuels still represent approximately sixty percent of the Hungarian energy mix and forty percent of the Hungarian electricity mix, increasing energy efficiency in the industrial sector is vital to move closer to decarbonization.

Decarbonization of the industrial sector is considered as one of the most difficult tasks for realizing a net zero emissions economy.

Decarbonization of the industrial sector is considered as one of the most difficult tasks for realizing a net zero emissions economy. When analysing the barriers that hinder decarbonization efforts, we took a closer look at the policy barriers, the technological barriers and the financial barriers.

A general barrier to concrete industrial decarbonisation roadmaps is the lack of details, timing, and dedicated funding options for decarbonisation. Clear, predictable, and reliable policy environment is key to motivate industry actors in taking steps towards greening their production. Strategies need to be translated into action plans and the forward-looking Hungarian Climate Act needs to be supplemented with concrete actions, deadlines, and funding options.

Steel, cement and the chemical sectors all have their specific barriers, but a common point is the lack of research and development

[1] Value added at factor costs from total business economy for NACE 20, 235 and 241. *Source: Hungarian Central Statistical Office (HCSO).*

We can see that public finance is simply not focusing on heavy industry decarbonization at all, neither via EU funds, nor via its own budgetary resources.

into new, low-carbon or carbon-free technologies. Emission-reductions are mostly realized through energy efficiency projects but there is no viable solution for reducing process emissions, meaning the emissions that occur as a by-product of the chemical processes happening during production.

Both in the cement and in the steel sector there is a significant gap between the demand for and the supply of skilled workforce needed. Thus, skilling and reskilling for the green transition is of utmost importance, because no financial capital and no technology will be enough if the human capital is missing from the sector.

With regards to financial barriers, they are perfectly visible in both public and private finance, thus they can be defined as obstacles to the implementation of decarbonization technologies.

We can see that public finance is simply not focusing on heavy industry decarbonization at all, neither via EU funds, nor via its own budgetary resources.

In general, green private finance is still in its infancy but has growth potential. The central bank's green capital requirement programme is set to phase out soon and actors of the market do not know what to prepare for. The central bank should give a clear signal to the stakeholders that its green programme will go on, giving an important impetus to the further development of the green capital market.

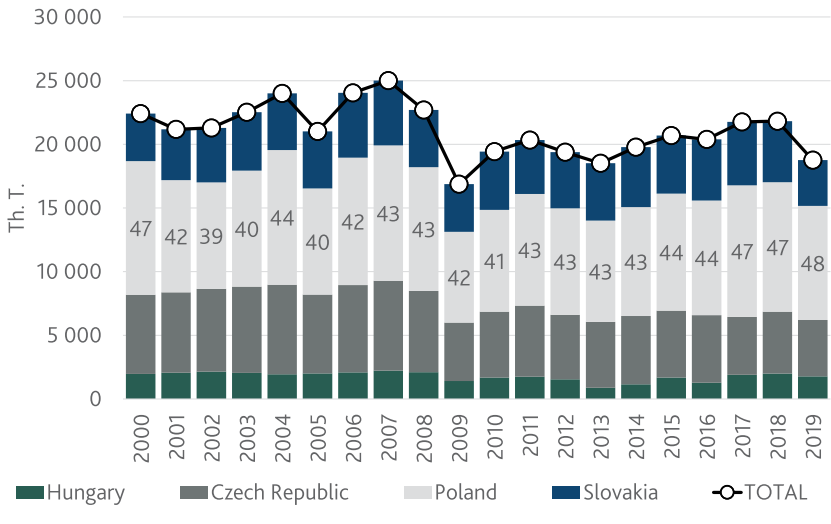
1. Industry Barriers to Decarbonization

The 1989 change of political regime in Hungary significantly altered the country's industrial landscape. Heavy industry, that was artificially kept alive, collapsed in just a few years. Due to this collapse, emissions of carbon dioxide and of atmospheric pollutants decreased significantly, but this was not connected to better energy efficiency or better technologies, which means that most of the industrial installations that are still functioning in the country need technological upgrading. As the restructuring of the economy led to important CO_2-emission reductions, Hungary did not have to reach very important emission-reduction targets under EU climate policies until now. Neither the Member State targets nor the relatively low price of carbon under the EU's Emission Trading System were motivating enough for Hungary's heavy industries to invest in drastic changes in energy use and/or in technology. This was surely one of the main barriers to decarbonization until today.

Steel production

Visegrad 4 countries (V4) represented approx. 12.5 percent of the EU steel production in 2019. Considering the country break-down Poland comes out leading with 6 percentage points (pp) of the EU production, Czech Republic contributed 3 pp., Slovakia another 2.4 pp. and Hungary added a paltry 1.2 pp.

Figure 1: Production trend is on a decrease pattern, while Poland's share in the V4 production is gradually increasing



Source: Equilibrium Institute based on Eurostat and the Hungarian Statistical Office. Note: Numbers in the Polish data represent the share of Polish production in the V4 production.

When looking at the long-term trends, steel production volumes follow a decelerating trend. Poland is a notable exception as its production has been increasing since 2010. Hungary's steel capacities[2] are modest when compared to the regional peers. Hungarian crude steel production is about 1700 ktonnes, compared to 3600 in Slovakia, 4400 in Czechia and 9000 in Poland.

In Hungary, there are two installations participating in the ETS whose market share totals at about 94 percent:

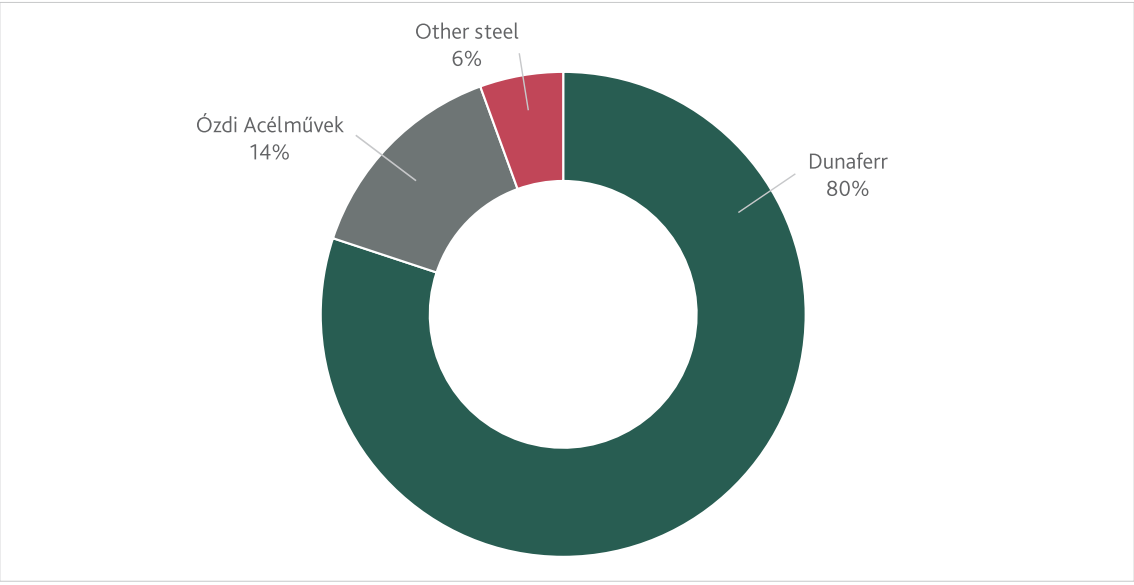
- ISD Dunaferr Ltd. in Dunaújváros, one of the largest industrial producers in Hungary, owned at 99 percent by the Cyprus-based Steelhold Ltd. The final controlling entity of the company is the Russian Vnyesekonombank (VEB), currently sanctioned by both the EU and the US.

- Ózdi Acélművek Kft. (Ózd Steelworks, Ltd.) based in Ózd. Majority stakes are held by Max Aicher GmbH & Co (80 percent) from Germany while the remainder 20 percent is held by the Hungarian state.

Regarding the technological frontier, there are two main technologies in use in Hungary. ISD Dunaferr Ltd uses Basic Oxygen Furnace while Ózdi Acélművek Ltd installed the more modern Electric Arc Furnace approach in production.

The emission-intensity of the two processes could not be more different: The Basic Oxygen Furnace emits 1,5–2,0 tons of CO_2 per ton of crude steel, the Electric Arc Furnace prints at a 0,4–0,5 tons of CO_2 per ton of crude steel.

Figure 2: Dunaferr accounts for 80% of all steel making revenues in Hungary



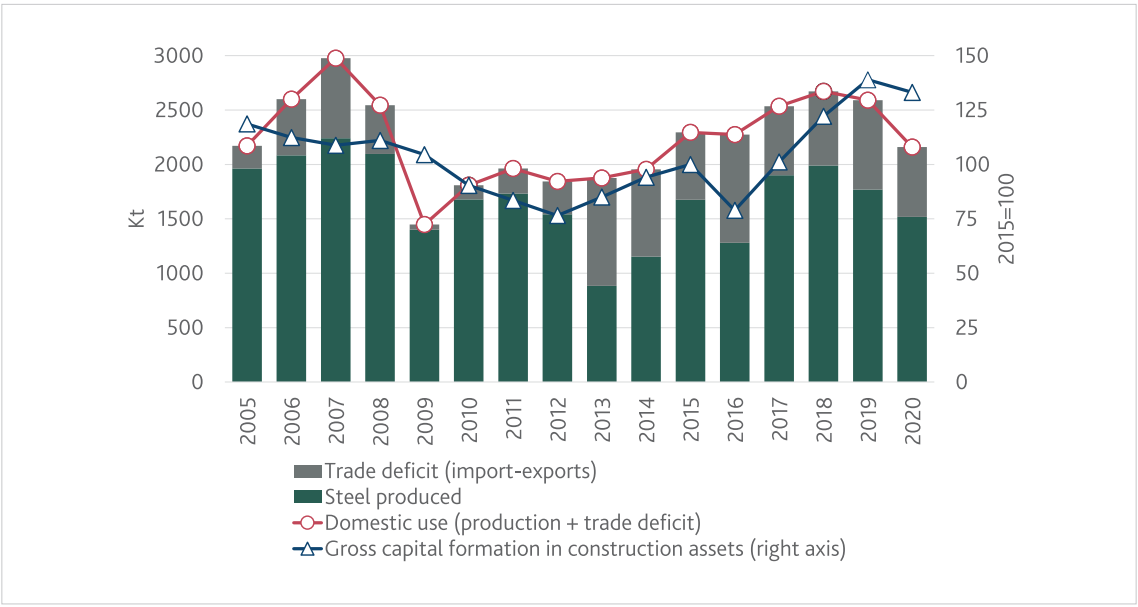
Source: Equilibrium Institute based on financial reports (2020).

[2] In the data analysis, we concentrate on steel. In some cases, the available datasets capture iron and steel industry together. In those cases, we provide aggregated data and indicate the source and definition.

ISD Dunaferr had 3356 employees in January 2022 and the Ózd Steelworks employed 638 persons.[3] Based on media coverage, Dunaferr might indirectly create 15 thousand jobs including the suppliers used.

Despite the robust building sector, domestic steel production could not meet the demand and has dwindled since 2005. Currently, steel import covers 58 per cent of the domestic use.[4]

Figure 3: Currently steel import covers 58 percent of the domestic use



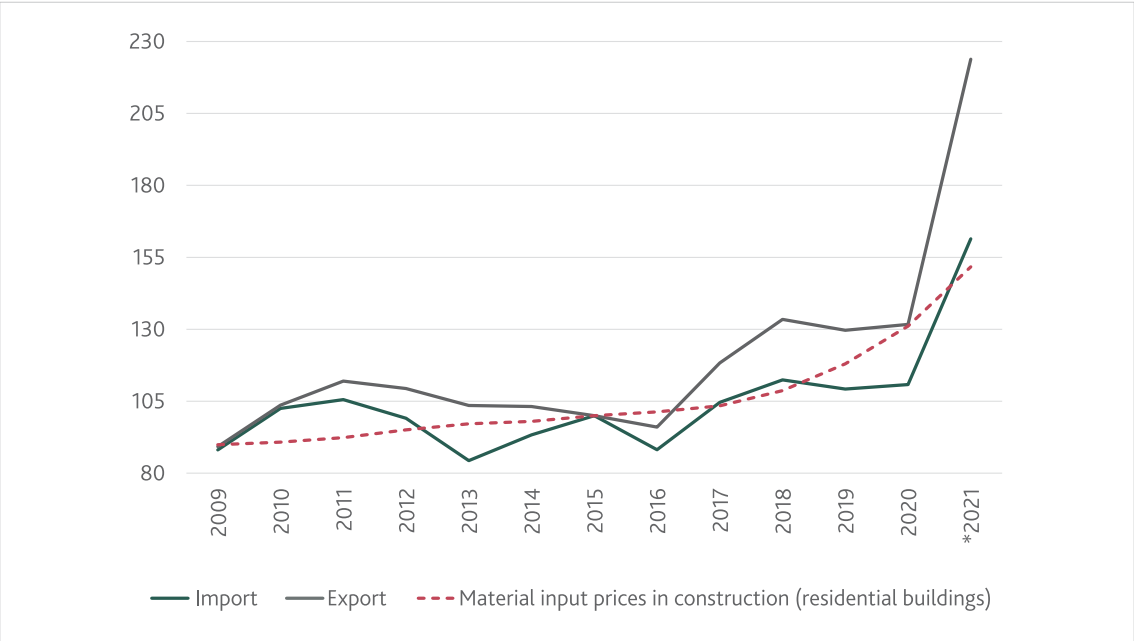
Source: Equilibrium Institute based on the Hungarian NFR report for the Convention on Long-Range Transboundary Air Pollution (CLRTAP), and Eurostat.

According to the National Inventory Report of 2021, GHG emissions from the iron and steel producing sector decreased by 10 percent since 2018 thanks to a reduction of pig iron production. Emission intensities, however, did not budge throughout the period.

Hungary benefited from an improvement in terms of trade. Against the backdrop of surge in base metal supplies, import prices flatlined between 2009 and 2020. Slovakia emerged as the key trading partner at 19 percent of import shares while imports from Germany and Italy were significant with a 15 percent cut respectively.[5]

[3] Data from National Tax Authority.
[4] Based on the assumption imported steel is fully used domestically, thus is not reexported.
[5] Direct exposure to Russian and Ukrainian markets is rather negligible (<1.5 percent of total imports).

Figure 4: Import prices flatlined between 2009 and 2020



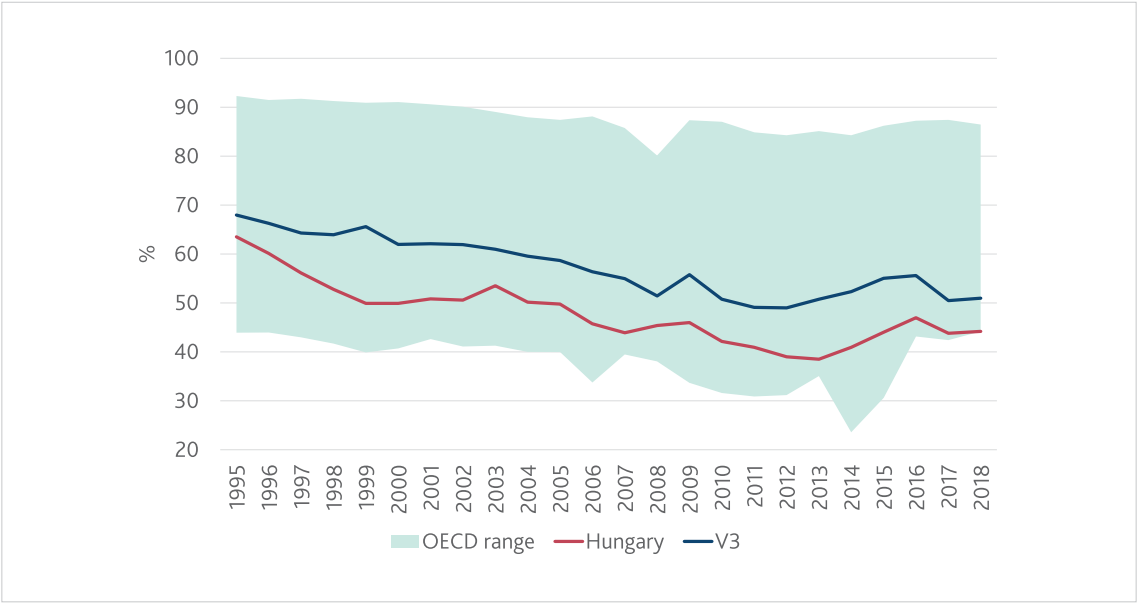
Source: Equilibrium Institute based on Eurostat. Note: *EIB estimates for 2021 for the material input prices time series.

The Hungarian steel industry's competitiveness eroded. Hungary is poor in iron ore, which is one of the several possible explanations for the declining domestic content in production.

Another explanation stems from globalisation as the latter has given birth to supply chains engineered on a global magnitude, with diversified inputs. Steel is no exception to that imports rose in this sector, too. Moreover, the domestic services' value-added share of exports declined to 10 percent (2018) from 16 (1995), while foreign services gained share (23.5 from 13.7). Thus, production became slightly more service intensive in the steel industry but shifted towards a globalised "servicesation" rather than local services (eg. engineer services, strategic advising). Stakeholders indicated that the steel industry grapples with structural problems. Local production falls short of delivering the quality and type of products needed. This also means that the emissions stemming from import of steel can be considerable due to transportation as well as the Scope 1 emissions of production. If the product structure could be modified to produce more for the Hungarian market – more steel products suitable for the Hungarian automotive industry, for example –, connected emissions would significantly decrease.

Another structural difficulty is that the steel market became a short delivery market in the past two decades and every actor wants to receive the products ordered as quickly as possible. This has changed the favoured form of transport from rail and shipping to road transport, which has a much bigger carbon footprint.

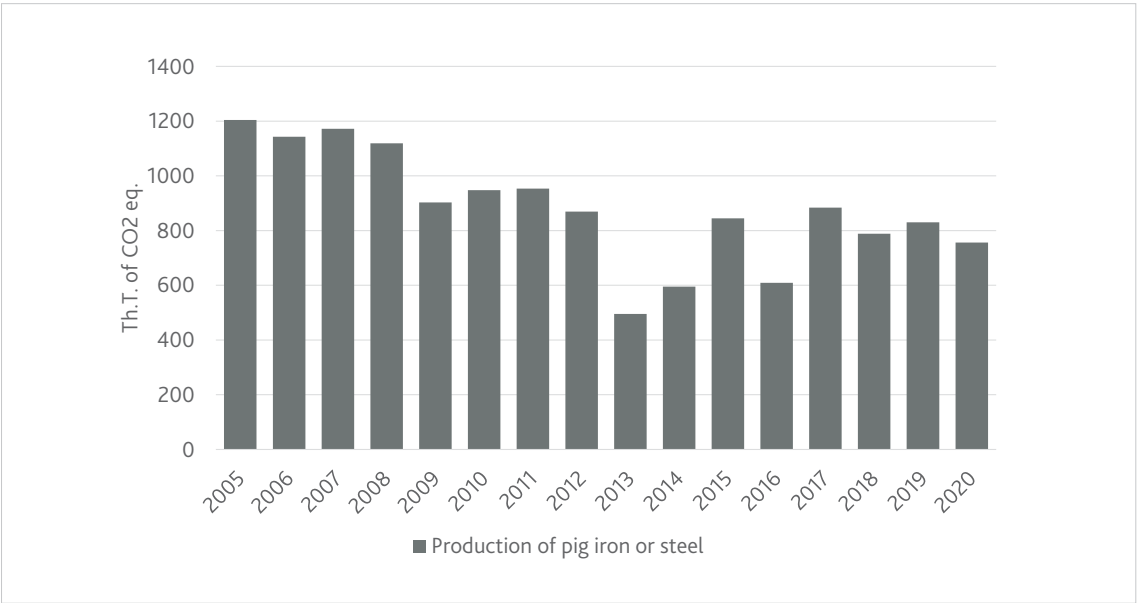
Figure 5: Domestic value added of steel and iron export declined significantly, which can be linked to the servicesation of the industry



Source: Equilibrium Institute based on OECD-TiVa 2021 indicators.

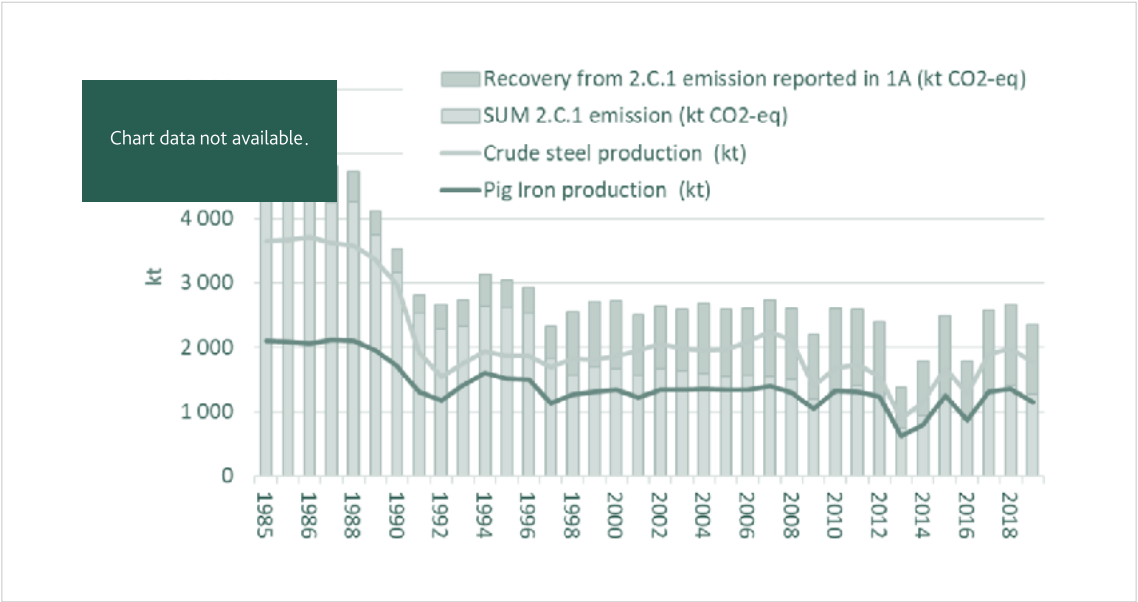
With a total of 1140 thousand of tonnes CO_2, the sector's contribution to the project focus group's total is still moderate (23 percent from the total emission of the steel, chemical, and cement industries).

Figure 6: Steel emissions are on a declining trend in line with Dunaferr's decreasing production figures



Source: Equilibrium Institute based on the EU Transaction Log

Figure 7: The deindustrialization of the 90s had important impact on the steel industry



Source: Nation Inventory Report for Hungary 1985–2019. Note: The two types of emissions are connected to methodological issues of the registry, it is not relevant from the point of view of this analysis.

Against the backdrop of plummeting production volumes, emissions almost halved since the '80s. The decline in emissions continued between 1990 and 2010s but the trend reversed around 2013–2014. Moreover, iron and steel production reached almost the level before the 2008 economic crisis by 2015. In conjunction with the volume gains, emissions rose as well, underscoring that no decoupling of emissions from production was achieved.

Climate protection goals and reality in the Hungarian steel industry

Financial woes of **ISD Dunaferr** might be both help and hindrance to the decarbonization agenda. For one, the impending solvency issues coupled with the mounting legal and operational risks can drive the company to the ground in the short run. According to stakeholders close to the industry, insolvency can't be averted. Shutting down the production then could mean a full decarbonization. However, the looming controversies also present a key obstacle: the biggest Hungarian steel producing plant lacks transparency and a viable business model that renders any planning for sectoral decarbonization futile.

The production at Dunaferr has already nosedived as the facility runs just at 25 percent of capacities, while operating under 60 percent makes the company accumulate losses which renders the operations uneconomical. In 2019 alone the company printed at a loss of EUR 146 million. As the equipment reaches end-life, only a large-scale investment could restore the capacities.

Worrying is that ISD Dunaferr has been penalized several times for not complying with environmental regulations, solely between 2014 and 2018 it has been ordered to pay around EUR 5.5 million of environmental fines, and the sum got much higher in the past years. ISD Dunaferr also failed to fulfill its obligations under the ETS in 2020, it was not able to surrender enough allowances to cover its emissions, consequently, it has to pay a penalty of EUR 139 million and buy 1.3 million CO_2-allowances.[6] As this has not happened until spring 2022, the company does not receive emission

According to stakeholders close to the industry, insolvency can't be averted. Shutting down the production then could mean a full decarbonization.

[6] https://hvg.hu/360/202119__dunaferr__tisztujitas__szendioxidkvota__kivul_tagasabb

The mandatory energy report for 2020 stresses the importance of energy efficiency and climate protection but fails to mention any emission-reduction targets.

allowances at all, meaning the penalty will just grow bigger and bigger every year.

The fact that ISD Dunaferr has no decarbonization plan or strategy in the offing is not surprising given the financial backdrop. Hungarian government so far has resisted intervention, but we can't rule out a government action in a bid to secure jobs.

Contrast to Dunaferr, **Ózdi Acélművek Ltd** is financially sound and its machinery is in a much better state. Currently, the installation operates leveraging the best available technology (BAT) and has a much more favorable emission intensity profile. Its profit (after tax) in 2020 was EUR 8 million or 40 percent lower than a year-ago in 2019. About half of the company's turnover comes from its exports.

The company has not made information available about its sustainability strategy or climate pledges. In publicly available documents however, the company enclosed its carbon footprint data for 2018.

The mandatory energy report for 2020 stresses the importance of energy efficiency and climate protection but fails to mention any emission-reduction targets. The report prepared by an independent energy expert state that the company is cooperative when it comes to the need for realizing energy efficiency investments, and the focus is on developments that help reduce electricity demand linked to production, as electricity represents 79 percent in the use of energy carriers, and it is responsible for about 87 percent of CO_2-emissions of the plant.[7]

As the company also uses natural gas for reheating the steel billets (a semi-finished

[7] https://www.vg.hu/cegvilag/2021/08/gigavesztesege-keletkezett-a-dunaferrnek

product) coming out of the Electric Arc Furnace and keep them workable, the company is interested in technologies that could help switch away from natural gas like the ones using hydrogen. Biogas could also be an option for switching away from natural gas.

Barriers to decarbonization of the steel sector in Hungary: financial or technological?

The entrenched slump of the biggest steel facility likely means that steel production related emissions will further narrow in Hungary. However, there are some concerns when it comes to the incumbent production.

Nevertheless, Ózdi Acélművek Ltd already leverages electrification. The EAF is cheaper and more sustainable, the only barrier to its use is the availability of scrap steel. Experts argue that there will never be enough scrap steel to make EAF more current than BOF at the global level. This likely means that the existing facility will be unlikely to ramp up production levels leaving Hungary reliant on imports.

Steel is recyclable at 100 percent. Working on circular economy is of utmost importance for reducing the carbon footprint of the steel industry, and Hungary has much to improve in the recycling of construction waste. Significant amount of scrap steel ends in landfills instead of staying in the loop of circular economy. Recycling routes must be developed and planned for.

Within the EAF framework further efficiency gains in the steel production processes can prove difficult to attain. Then the heavy lifting is left to the energy sector, which can go a long way in reducing its own emissions. We see potential for the steel producing companies tapping into renewables, for example photovoltaics like some actors of the Hungarian cement industry do.

Working on circular economy is of utmost importance for reducing the carbon footprint of the steel industry, and Hungary has much to improve.

The Hungarian steel sector is in a troubled state and both technological and financial barriers to the decarbonization are daunting.

In the case of Ózdi Acélművek Ltd working at BAT-level, energy efficiency can still be improved in the secondary furnace fuelled with natural gas (where steel billets are reheated to be workable): waste heat recovery is a way forward to reduce CO_2-emissions.

According to experts working in the sector, decarbonisation technologies are already available. The caveats are the massive investment costs and higher operating costs, although the cost efficiency of these investments is increasing since the war in Ukraine and the rise in fossil fuel prices.

An example of these revolutionary technologies is the HYBRIT project which aims at realizing fossil-free steel production by using fossil-free electricity and hydrogen. According to estimates from actors of the steel sector, transforming the Dunaferr plant into a carbon-free steel producing plant like the one in the HYBRIT project could cost around EUR 1 billion.

The Hungarian steel sector is in a troubled state and both technological and financial barriers to the decarbonization are daunting. The sector can get stuck in the rut and lack meaningful movement on those issues if the primary producer, Dunaferr's status stays unresolved. Lack of transparency can hold back on decarbonization investment. Deep-pocket investment to overhaul the old steel-making capacities is then unlikely, barring significant state support and guarantees. Without the government guiding the way, the sector's biggest actor is likely to disappear in a few years. State intervention is very unlikely to happen as the state did not express interest in doing so, as it has even auctioned some of its remaining shares in the beginning of September 2022.[8]

[8] https://g7.hu/vallalat/20220902/megint-elszabadult-a-pokol-a-dunaferr-arveresen/

Cement production

When it comes to cement production[9] Visegrad Four (V4) countries have about 16 percent cut of aggregate EU production. The country contributions follow the size of the national markets. Poland tops the chart at a hefty 10,8 percent share of EU production. The rest of the pack has a more moderate contribution with Czech Republic printing at 2,6 percent, Slovakia at 2,3 percent and Hungary at 0,6 percent.

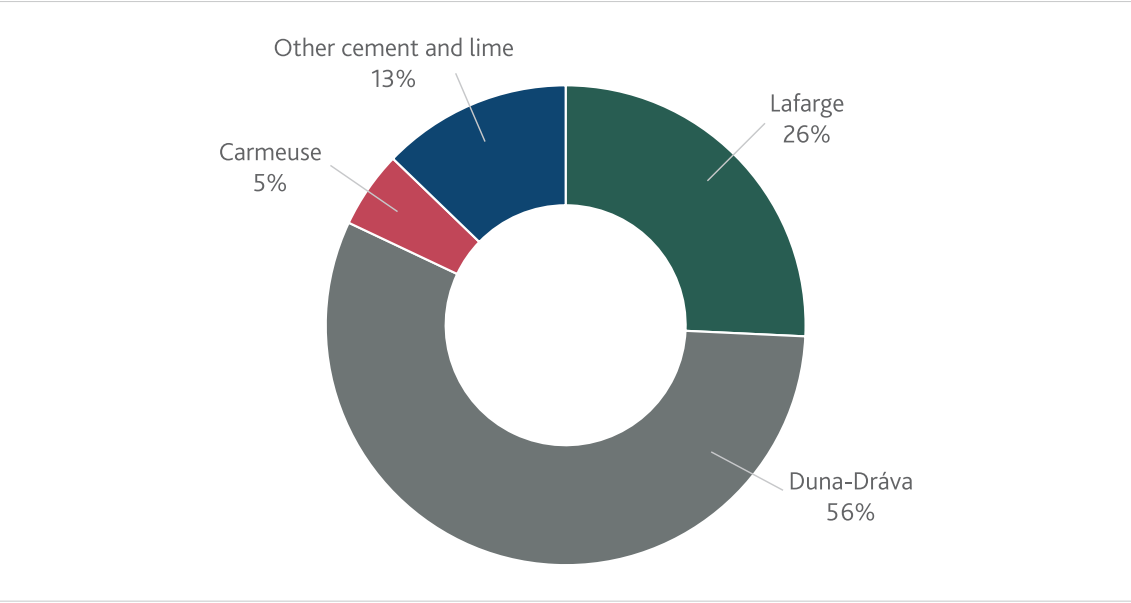
When considering ETS emissions there are three installations participating:

- Two facilities (Vác and Beremend sites) under the supervision of DunaDráva Cement Ltd. The company co-owned by SCHWENK Zement KG, a family business and by Heidelberg Cement Group.

- LAFARGE Cement Magyarország Ltd, owned by Holcim Group has one plant in Királyegyháza.

The two companies' market share is at 82 percent.

Figure 8: Duna-Dráva Cement's production accounts for more than half of the sector's



Source: Equilibrium Institute based on Company financial reports.

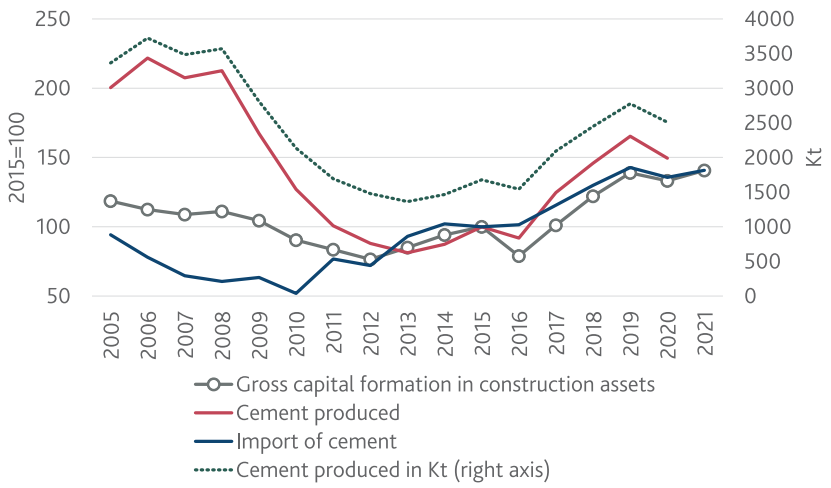
Duna-Dráva had 672 employees in January 2022 and LAFARGE had 143 employees.[10]

[9] Although in our analysis, we focus on cement, some of the data sources tend to group cement and lime in dustries as one. In these cases, we give aggregated data, but one must consider that cement industry is a far bigger greenhouse gas emitter in Hungary (and in the V4) than the lime industry, thus, we consider that it is justified to concentrate on solely cement whenever data permits.

[10] National Tax Authority.

Construction boom bolstered the cement production after 2017. Despite the 15-year peak in cement, domestic production still has not reached its pre-2008 levels. The share of imported cement in total domestic use more than doubled since 2008 (from 16.4 percent to 38.4 percent).[11]

Figure 9: The evolution of cement production is linked to demand of national investments in construction assets

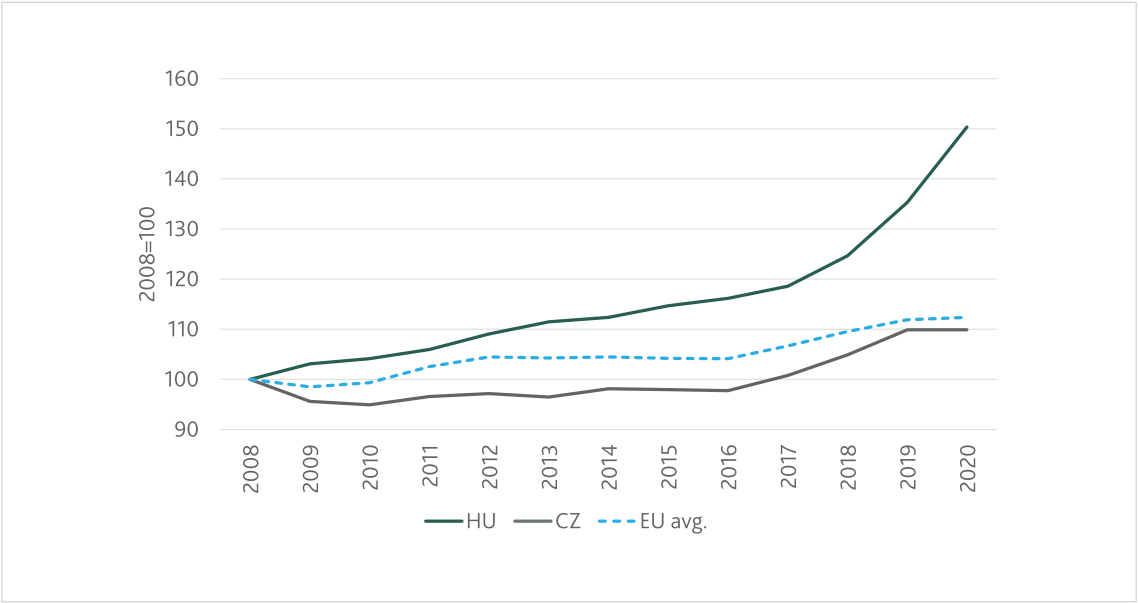


Source: Equilibrium Institute based on the Hungarian NFR report for the Convention on Long-Range Transboundary Air Pollution (CLRTAP), and Eurostat.

Weaker forint coupled with reinvigorated demand let construction material prices skyrocket. Absent of adequate data on domestic cement prices we can only consider construction material costs as proxy. Data indicates that material costs ballooned in Hungary since 2008. Based on the steady increases, Hungary came out ahead of EU peers every year since 2008. In conjunction with the construction boom, greenhouse gas emissions from cement clinker production also rose:

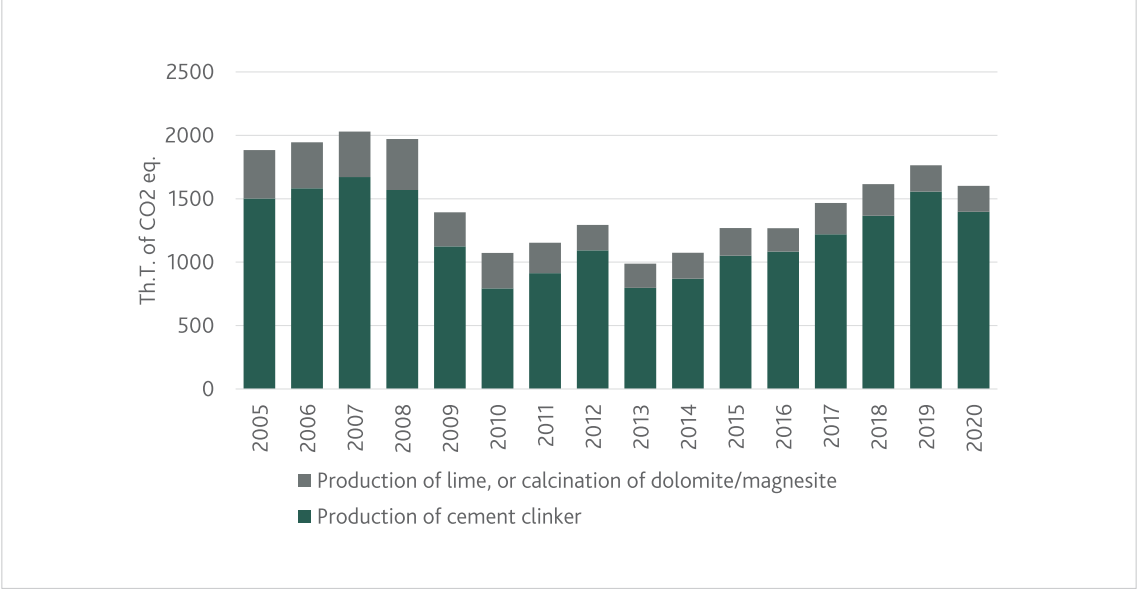
[11] Based on the assumption that imported cement is fully used domestically, thus is not reexported.

Figure 10: Weaker forint coupled with reinvigorated demand let construction material prices skyrocket



Source: Equilibrium Institute based on Eurostat (2020).

Figure 11: Emission trends followed the growing demand from 2013

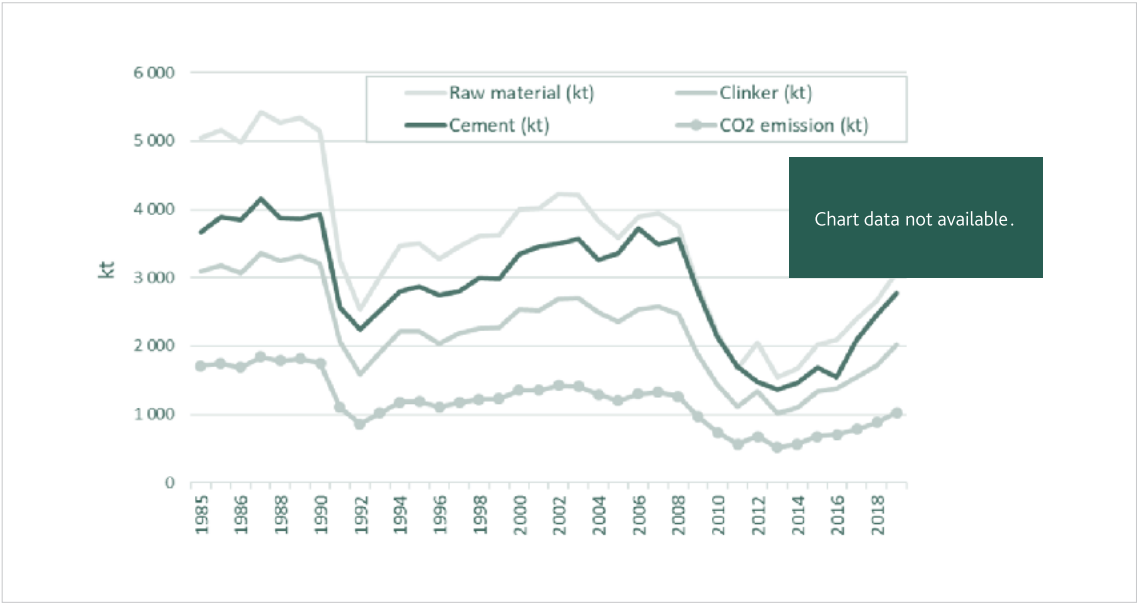


Source: Equilibrium Institute based on the EU Transaction Log.

National inventory data confirms that emission intensity did not improve over the past 15 years. CO_2 emissions of cement production closely tracks the production data. We only observed tepid signs of decoupling from 2016 on.

Industry experts state that the decoupling might continue as the sector moves to reduce clinker content of cement produced, which reduces emissions.

Figure 12: National inventory data confirms that emission intensity did not improve over the past 15 years



Source: Nation Inventory for Hungary 1985–2019.

Climate protection goals in the Hungarian cement industry

Duna-Dráva Cement Ltd aims to reduce its emissions by 15 percent by 2030 from 2019 levels, building on a reduction of 22 percent achieved since 1990. The 2030 target means emission-reductions of 33 percent compared to 1990 levels according to the company's decarbonization pathway. If we consider that the company should reach emission levels close to net zero by 2050, the pace of decarbonization is still too slow.

In its road to carbon neutrality roadmap, Duna-Dráva Ltd wishes to reduce its emissions by four main elements:

- the increased use of alternative fuels (like waste) and raw materials,
- replacing clinker by other materials in the production of cement (materials that have a smaller carbon footprint),
- extensive investments in efficiency and CO_2-emission reduction at the level of installations,
- increasing the share of the production of low-carbon concrete.

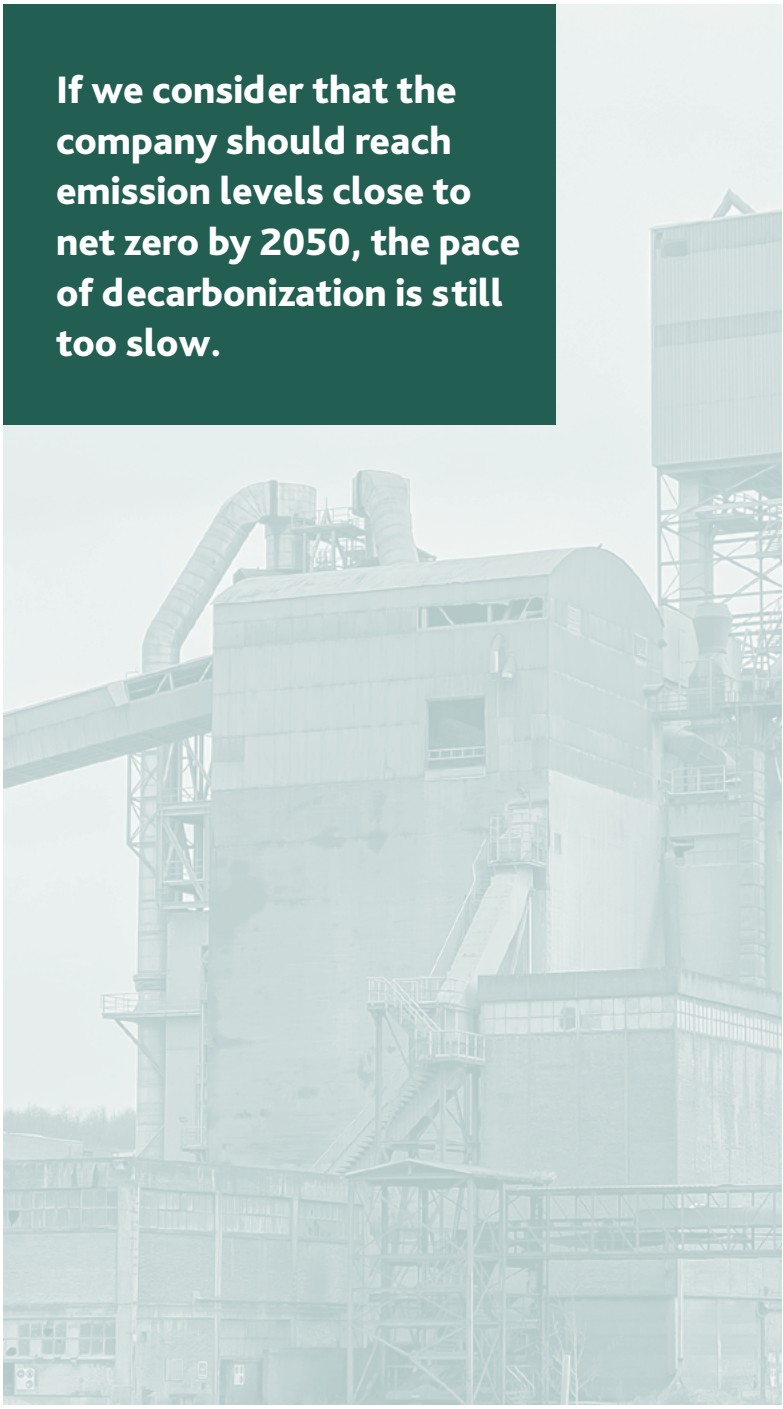
In its roadmap, the company has also plans for the period between 2030 and 2050. What is extremely important from these plans is that total decarbonization can become a reality only if we consider the whole life cycle of concrete production, with circular economy and carbon capture and usage/storage technologies (CCS/CCU).

LAFARGE Cement Magyarország Ltd, as a member of the Holcim Group, also adheres to a decarbonization roadmap at the group level, with concrete objectives for 2030 in the plan called "The 2030 Plan". Holcim Group wishes to reduce its emissions by 40 percent by 2030 compared to 1990 levels.

The main technologies used for reaching carbon neutrality are the following:

- replacing clinker in final products and develop new low CO2 binders,
- using more waste-derived fuels,
- further investing in energy efficiency by reducing thermal consumption,
- exploring the possibilities offered by CCS/CCU.

If we consider that the company should reach emission levels close to net zero by 2050, the pace of decarbonization is still too slow.



We can state that is general, industries in the CEE region are followers when it comes to technology development. The cement industry is not an exception.

Barriers to decarbonization in Hungary: financial or technological?

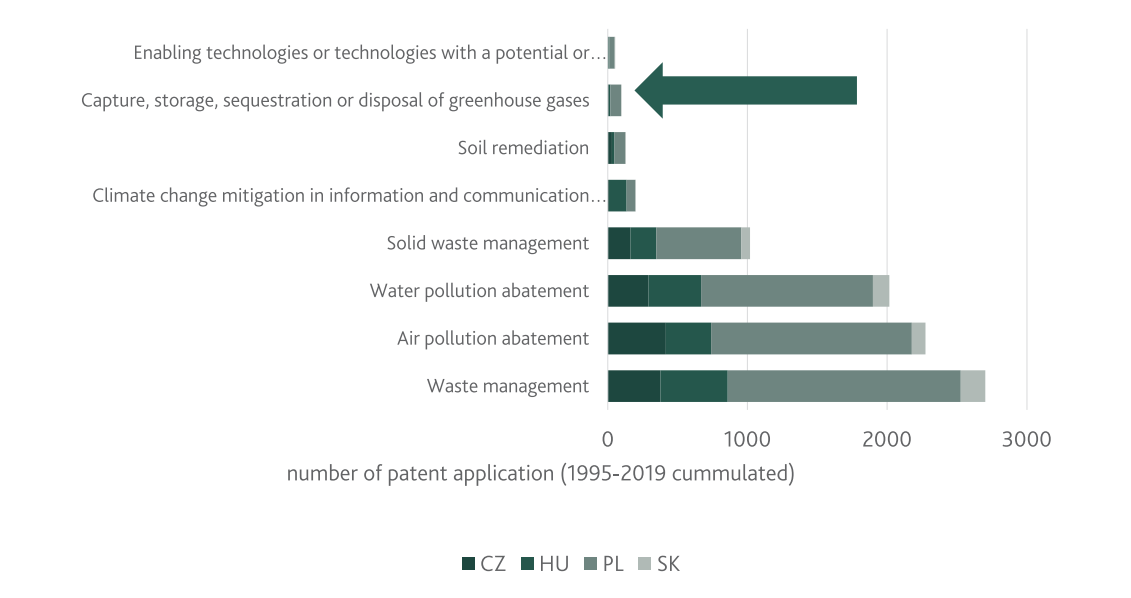
According to Duna-Dráva Cement Ltd, the company meets 40 percent of the cement demand of the country (2018). In some years (especially after 2008), the company was producing at a level lower than half of its capacities, the consequences of the crisis took time to disappear: from 2018 onwards, it seems that the situation of the sector stabilized at a reassuring level.

The construction sector is very dependent on state projects in Hungary. State-funded projects are the engine of the sector, and the state is heavily relying on EU-funds for its projects. Consequently, a predictable policy and financial environment is key in the development of the construction sector and the cement industry: this is needed for the sector to be able to attract additional capital for investments in emission-reduction technologies and R&D activities.

A significant obstacle is the lack of specialized work force which is exacerbated by looming retirement of sectoral experts in Hungary. The cement industry would need qualified experts savvy in production processes and decarbonisation technologies.

We can state that is general, industries in the CEE region are followers when it comes to technology development. The cement industry is not an exception. Companies typically wait for a bigger technological breakthrough which can occur in the central units of international business groups as research and development activities are totally concentrated where the center of the parent company is located. This is due to the great uncertainties related to return on investment of R&D.

Figure 13: Industries in the CEE region are followers when it comes to decarbonization technology development



Source: Equilibrium Institute based on OECD Patstat.

Would a higher price on carbon allowances help the switch to greener technologies? Based on stakeholder interviews the biggest problem is that there is no significant decarbonization technology that is mature enough to be used on scale. If these technologies were existing ones, the price signal would work, but until these technologies are developed, the rise in the price of emission allowances would just increase the price of the finished products. The war in Ukraine led to skyrocketing fossil fuel prices changing the game for CO_2-intensive industries like the cement industry. We will see if these changes lead to more technology development in the middle-term, but we must keep in mind what was earlier said about the situation of R&D in Hungary: rising costs (may they be due to the price of emission allowances or the price of energy) will not lead to enhanced investments in R&D in the country. As the return on investment is very uncertain, this field is left to the parent company. What could help, according to experts, is some form of state aid to have public funding and/or the development of green financial schemes to attract private funding in the sector, to help the use of new technologies developed by the parent companies.

Running up to 2030 we expect the cement industry to make steps towards reducing energy use and dependence on fossil energy use by investing in energy efficiency and renewable energies. To that we can add that both Duna-Dráva plant and Lafarge-Holcim have ongoing photovoltaics projects working towards that aim. What is more, clinker content reductions can be expected which then could reduce process emissions.

Transition plans are unlikely to fulfil net zero objectives. As stated earlier, companies set GHG-emission reduction objectives of around 30–40 percent for 2030, compared to 1990 levels. That means that the actors plan to do 30–40 percent of the job in forty years and then leave the bigger part, 60–70 percent of emission-reduction efforts to the last twenty years,

waiting for a technological breakthrough that will help the sector reach carbon neutrality by 2050.

Chemical production

In Hungary, the chemicals sector is one of the industries with the biggest energy demand, this, added to process emissions of some of the industrial processes makes the sector one of the biggest CO_2-emittters of the country.

Going forward we analyse the three biggest emitters from the sector, ones that are under the EU's Emission Trading Scheme (ETS), have high energy and/or process emissions and represent around 2/3ds of the net revenue of the sector (66 percent according to a 2018 analysis[12]). In Hungary, these major chemical sector CO_2-emitters are concentrated under two ETS-activities: production of bulk chemicals (MOL Petrolkémia Ltd. and BorsodChem Ltd.) and production of ammonia (Nitrogénművek Ltd.).

MOL Petrolkémia Ltd. is part of the major regional actor MOL Group[13], BorsodChem Ltd. is owned by the Chinese Wanhua Group[14] while Nitrogénművek Ltd. is privately owned and based in Hungary.

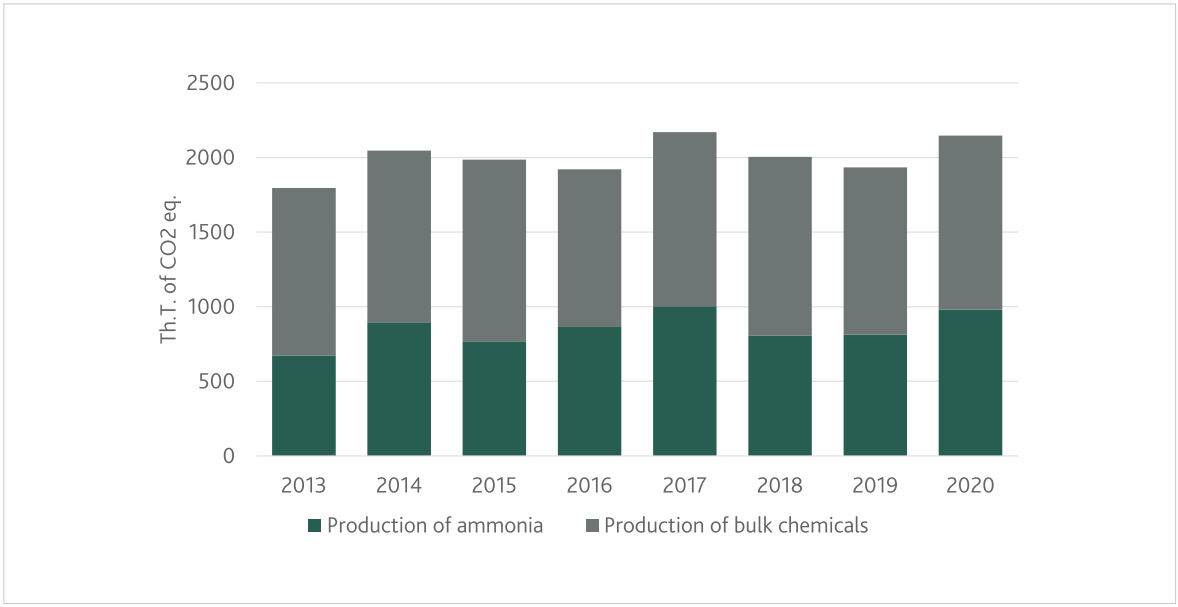
Table 1: In the ETS system, two companies stand out in terms of emissions

Entity	Emissions 2019 (tCO_2)	ETS Activity	Company	Main product
TVK	988,254	42	MOL Petrolké-mia Zrt.	Production of bulk chemicals
Nitrogénművek Zrt.	811,610	41	Nitrogénművek Zrt.	Production of ammonia
BorsodChem Zrt.	127,262	42	BorsodChem Zrt.	Production of bulk chemicals

Source: EU Transaction Log.

[12] https://docplayer.hu/110756771-Magyar-vegyipar-kornyezetvedelem-klimavedelem-fenntarthatosag.html
[13] https://molgroup.info/hu/a-mol-csoportrol/attekintes
[14] https://www.portfolio.hu/uzlet/20190110/egy-kinai-vilagceg-europai-buszkesege-lett-az-ismert-magyar-marka-309919

Figure 14: Ammonia and bulk chemicals emission processes are stable over time. The industry produces 2000 tons of CO_2/year



Source: Equilibrium Institute from the EUTL.

The three companies that must play a decisive role in the decarbonisation of the chemical sector are the following:

1. BorsodChem Ltd. (3000 employees)

The company produces chlorine in Hungary by means of electrolysis, with a high demand of electricity and heat. The feedstock used is sodium chloride solution. BorsodChem has a chlorine production capacity of 384.000 tons per year.[15] It produced 271.000 tons in 2018 and 298.000 tons in 2019.[16]

At the production site of BorsodChem Ltd, there is also a power plant, BC-Erőmű Kft., which is owned partially by BorsodChem Ltd. As the two are linked physically by the production process itself, the allocations and verified emissions can be misleading. BC-Erőmű is also under the ETS but under the category "combustion of fuels". For analysis we consider the emissions registered under BorsodChem Ltd, in the category "production of bulk chemicals".

2. MOL Petrolkémia Ltd. (1150 employees)

This company is the biggest petrochemical producer in Hungary. High energy need and intensive process emissions characterize the production. The ethylene production capacity of

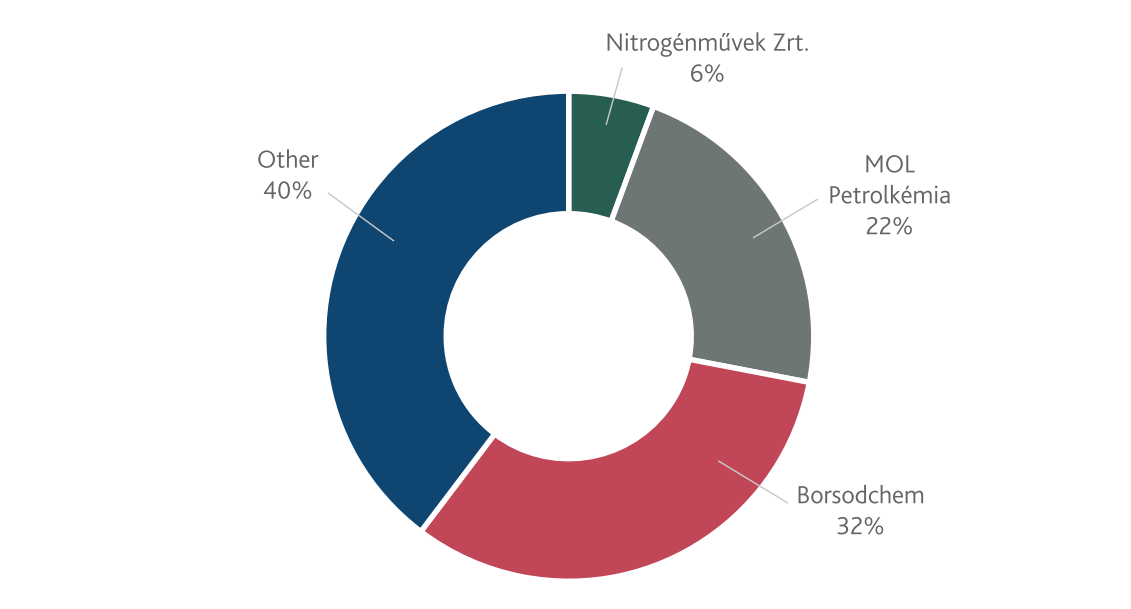
[15] https://adoc.pub/klorgyartas-a-borsodchemben-kovacs-gabor-technologiai-mernk-.html
[16] http://emiktf.hu/Ugyfelinf/dontesek/doc/BO-32-3385-10-2020.pdf

the company is 680.000 tons per year,[17] while the propylene production capacity is estimated to be around 340.000 tons per year.

3. Nitrogénművek Ltd. (500 employees)

The company gives 80 percent of ammonia production capacities in Hungary. CO_2-emissions of ammonia are linked to both important energy and process emissions: the feedstock used is natural gas and CO_2 is one of the by-products of the production process, whereas a significant amount of heat and electricity is needed in the process. The production capacity of the company is 511.000 tons of ammonia per year.[18]

Figure 15: BorsodChem's emission efficiency is high: their turnover is higher than MOL Petrolkémia, while their emissions are much lower

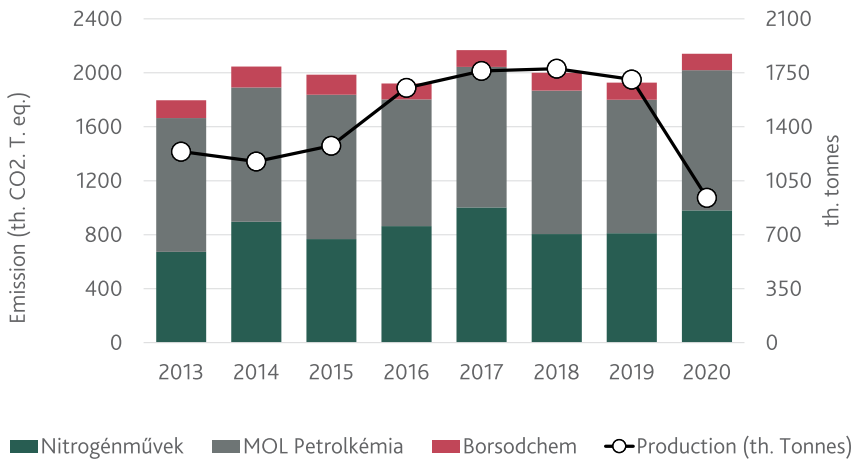


Source: Equilibrium Institute from Eurostat and company financial reports. Note: in percentage of the total chemical industry (NACE rev. 2, C20).

The CO_2-emissions of the three companies analysed flatlined in the past 7 years while productivity barely nudged in the period of 2014 to 2017. The COVID shock in 2020 curbed outputs and ate into the revenues of the chemical producers. However, emissions showed an upward trajectory.

[17] https://mol.hu/images/pdf/A_MOL_rol/tvk-rol/tarsasagunkr%C3%B3l_roviden/mediaszoba/eves_jelentes/TVK_evesJelentes_2012_hun_k.pdf
[18] https://www.nitrogen.hu/hu/74-nitrogenmuvek/uzemek/174-ammonia-uezem

Figure 16: MOL Petrolkémia (former TVK) is the largest CO_2 emitter in the chemical industry

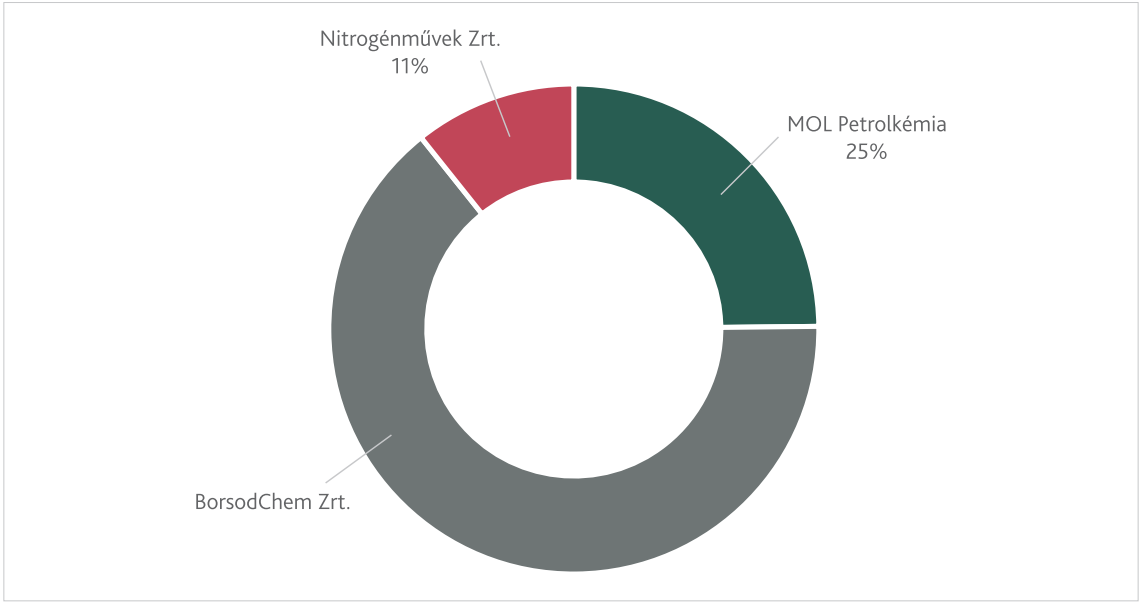


Source: Equilibrium Institute from the EUTL and Eurostat. Note: Production figure based on Eurostat PRODCOM database (NACE rev.2 2015 and 2016 products total).

The number of employees also show the importance of these three companies in the chemical sector. In 2021, 938 companies were registered in the statistical category of production of chemicals and chemical products,[19] and the subsector was employing around 15.000 people.[20] Out of these, more than 4500 employees work at the 3 companies in the focus of our analysis:

[19] https://www.ksh.hu/stadat_files/gsz/hu/gsz0003.html
[20] https://mavesz.hu/ipari-adatok-elemzesek/

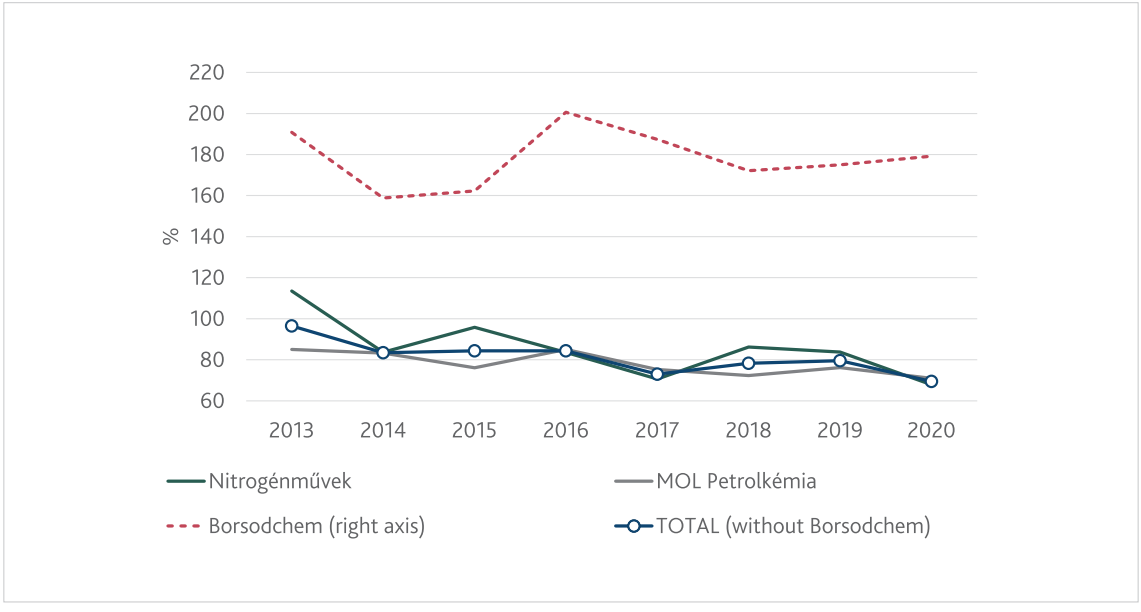
Figure 17: Chemical industry is concentrated: more than 4500 employees are working at the 3 industry featured in the ETS, which is 1/3 of the total chemical employment



Source: Equilibrium Institute based on NAV (National Tax Authority).

The Hungarian chemical sector chiefly benefits from the generous free allowances that account for ¾-th of their total emissions and giving them a wild card. Although allowances have been declining over time, the free transfer is still very important from the financial and competitiveness perspectives.

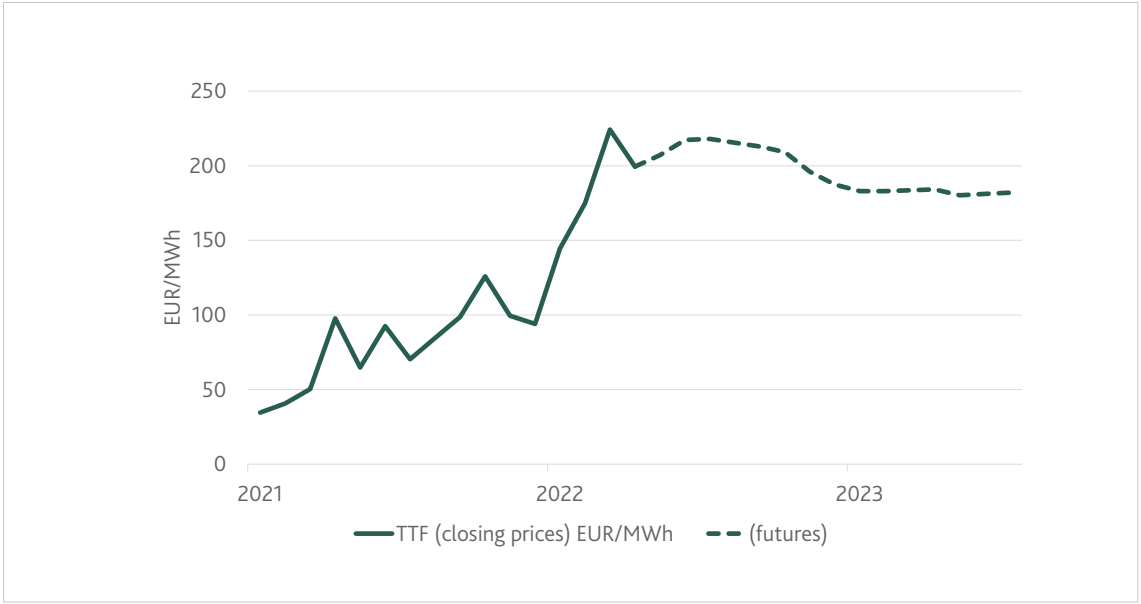
18: The Hungarian chemical sector benefits from the generous free allowances that accounts for ¾-th of their total emissions



Source: Equilibrium Institute based on EUTL data.

Over the recent years prices of CO_2-quotas were still not high enough to motivate emission-reductions at the pace needed to reach the 2050 net zero target. The recent invasion of Ukraine by Russia and the sudden increase in energy prices led to a situation where emitting CO_2 became very expensive. On 9 March, Nitrogénművek Ltd. announced the provisional closure of its ammonia producing installations as the price of natural gas – used as a feedstock and an energy source – went so high. To avoid ammonia shortages on the market, it reopened its plant after one month. According to the company's key performance indicators for the second quarter of 2022, its production of fertilizers dropped significantly (e. g. ammonia production dropped to one third of the production in the first quarter of 2022), both input prices for their production and market prices for their sale rose. This means that the company did not have to shut down again,[21] until the end of the summer, when natural gas prices went so high that it had to stop production again. According to the company, it is thanks to their former EUR 450 million modernization investment that they will have a good financial year despite being forced to shut down already twice in 2022.[22]

Figure 19: The evolution of gas prices is badly hurting the chemical industry's profitability



Source: Stooq.com as of 14.09.2022 (closing prices).

Climate protection goals

Even though the war in Ukraine is switching the focus from climate protection to energy security, big actors of the chemical sector have sustainability strategies and climate protection objectives: it is not clear yet how the energy crisis will affect these goals in the middle-term and longer term.

[21] https://www.nitrogen.hu/images/Key%20Performance%20Indicators%2021Q2-22Q2.pdf
[22] https://hvg.hu/kkv/20220906_Bige_Laszlo_Hetek_ota_all_a_Nitrogenmuvek

MOL

Although its carbon footprint is, of course, very large, MOL Group is dedicated to climate protection by mitigating CO_2-emissions and also by developing an economy that is more reliant on low-carbon technologies. GHG reduction activities are focused on energy efficiency and energy savings, but optimization of process control and the elimination of energy losses are also key areas of mitigation.

MOL Group wishes to reach a 30 percent reduction in GHG-emissions at group level by 2030.

MOL Group is also focusing on renewable energies, as in 2018 it started the building of three PV-plants in Hungarian sites, and it is also investing in geothermal energy.

MOL Hungary refreshed its long-term strategy in 2021, paving the way for decarbonization. It wishes to become a lead actor in the region in the field of R&D&I and implementation of CCSU-technologies.

To reach carbon neutrality by 2050, it will spend every second dollar on sustainability projects until 2030, which, in five years' time means approximately EUR 1 billion of investment in projects helping the development of circular economy.

According to its sustainability strategy, MOL plans to increase its capital expenditure in investments fulfilling the EU Taxonomy criteria, above 50 percent by 2030 and ideally to 100 percent by 2050.[23]

BorsodChem

The company introduced a detailed GHG-inventory based on the international "Greenhouse Gas Protocol" to be able to quantify its direct and indirect emissions as well and reach its goal of carbon neutrality by 2050.

By starting its new aniline plant in 2022, BorsodChem plans to avoid the emission of more than 14.000 tons of CO_{2eq} per year.

The company's objective is to reduce GHG emissions per unit of production by 40 percent until 2030 compared to 2013 levels.[24]

Nitrogénművek does not have specific climate protection goals.

[23] https://mol.hu/hu/molrol/mediaszoba/7650-a-mol-frissitette-hosszu-tavu-strategiajat-belep-a-korkoros-gaz-dasagba

[24] https://borsodchem.com/download/29/borsodchem-zrt-fenntarthatosagi-jelentes-2019-2020

Barriers to decarbonization: financial or technological?

When talking about companies that use fossil fuels – among others – as feedstock, the main barrier to decarbonization is the production process itself, the technologies used are difficult (if not impossible) to replace by other technologies.

For example, green ammonia (made from hydrogen gained from water, and nitrogen gained from the air) is being developed and tested, but the investment costs are high and the production of green hydrogen for green ammonia still raises important questions of sustainability.

For MOL Petrolkémia, the financial result of MOL Group gives a comfortable financial background for investments in emission reductions.

For all three companies analysed (just as for all companies since the beginning of the energy crisis), the return on investment of energy efficiency and renewable energy projects is much better than in the previous years. With rising energy prices, financial obstacles appear in a different light: it is worth investing in projects that have a quick effect towards reducing energy consumption.

To fight technological barriers, more investment is needed in research and development, but investing in this field in times when some companies are fighting for survival is not evident.

Obviously, decarbonization should not mean shutting down producing capacities but modernising production. The sooner we start, the better chance we will have to avoid shocks like the one currently hitting all industries using natural gas as feedstock or as energy carrier.

Decarbonization will be difficult, but the more we postpone action the more difficult and harsher the switch to a carbon-free economy will be.

With rising energy prices, financial obstacles appear in a different light: it is worth investing in projects that have a quick effect towards reducing energy consumption.

2. Policy landscape and barriers to decarbonization

Climate Law

The Hungarian Climate Law entered into force before its European counterpart which set the objective of reaching climate neutrality by 2050, with an intermediate objective of 40 percent reduction in GHG-emissions by 2030 compared to 1990 emissions. Indeed, the legislation can be praised for its forward-looking element of the Hungarian policy scenery. However, criticism is warranted as the Act is very short and details about how to reach the 40 percent emission cut are missing. We see that the climate neutrality objective has not been further developed.

National Energy and Climate Plan

According to its National Energy and Climate Plan (NECP), Hungary intends to ensure that the final energy consumption does not exceed the value of 2005 in 2030 (785 PJ). If this would still happen, such increase should come from carbon neutral energy resources. The improvement of energy efficiency in the economy is a key project of the Energy Strategy as well. Further, the so-called energy efficiency innovation programme aims to reduce – amongst others – the energy consumption per unit of industrial production.

With the introduction of an obligation scheme ensuring the cost-effective fulfilment of energy efficiency targets, the country intends to drive investment to areas with the highest energy consumption and energy efficiency potential on a market basis.

The NECP sets out to derive a sustainable and climate-friendly energy management scheme while maintaining the industry's share in the national economy. Furthermore, it encompasses investments into the transition of energy intensive and GHG intensive industries as well as into industries with low energy intensity.

The NECP is built on scenario forecasts running to 2030, but in some economic sectors it considers longer term energy demand projections up to 2050. Construction sector is envisaged to have increasing energy demand while others – like lime production – will probably have a declining demand.

The NECP points out that there will not be a significant difference in industrial energy consumption between the scenario with existing measures and the scenario with additional measures. The only difference is then the shrinking share of natural gas consumption under the scenario with additional policy measures. The similarity of the projected emissions under the two scenarios means that although increasing energy efficiency and decreasing process emissions in the industrial sector are both key to decarbonization, the NECP does not consider that this will happen in the middle term.

Hydrogen is recognized as a key solution for decarbonisation of the country, as beyond its reconversion into electricity, it can be blended with natural gas, and contribute to satisfying the energy demand of the industry. Hungary, under the NECP, will support the decarbonisation of industrial production schemes with the help of pilot projects on green hydrogen.

Long-Term Strategy

In the Hungarian Long-Term Strategy (LTS) also dubbed as National Clean Development Strategy 2020–2050, three scenarios are analysed: a "business as usual" one, a late action on climate one and an early action on climate one. Just as the NECP, the LTS heavily relies on hydrogen switch in decarbonizing the industrial sector. Both in early and late action scenarios, carbon capture and storage (CCS) technologies are seen to become scalable and economically viable after 2030 and help emission reductions. Energy demand of the industrial sector increases in both scenarios until 2030 and then decreases.

The LTS is counting on four measures to tackle emissions from the industry: energy efficiency improvements, electrification of the production phases, CCS deployment and hydrogen deployment.

Energy Strategy

According to Hungary's Energy Strategy the industrial subsectors' GHG-intensity and energy use per unit of production cannot exceed the EU-average of the specific sector.

The Energy Strategy reinforces what was presented in the above-mentioned documents: to decarbonize the industry, Hungary wishes to start pilot projects on green hydrogen.

To help communication between the different actors, and sound strategy development, an Energy Innovation Council was set up in 2018, with the participation of energy and industrial companies, universities, research establishments, professional organisations, and the relevant national bodies.

Hydrogen Strategy

Hungary's National Hydrogen Strategy sets several objectives for 2030. First, reaching significant results in the decarbonisation of the industrial sector with hydrogen. In the 2020s, mainly low carbon hydrogen would be used to decarbonise the industrial processes and product use, but later, green hydrogen would take the place of grey hydrogen. The concrete objective set in the strategy is to reach 20 thousand tons of low-carbon hydrogen production per year, plus 4 thousand tons of "green and other carbon-free hydrogen" per year in the period going till 2030. According to the strategy, this would help Hungary avoid 95 thousand tons of CO_2-emmissions.

The strategy presents blue hydrogen (hydrogen made from natural gas and helped with CCS technologies) as the most cost-efficient option for Hungary as time until 2030 is relatively short. Parallelly to this the conditions for decentralised, carbon-free hydrogen production with electrolysis must also be established. To help the deployment of CCS a stimulating regulatory environment and support system will also be established.

Hungary is also planning to develop hydrogen clusters, where the functioning of a whole so-called hydrogen-ecosystem can be presented. Two clusters are planned near petrochemical industrial plants (one around Miskolc and one around Százhalombatta)

Thus, the objectives directly linked to the scope of our project are:

- the promotion of activities aimed at hydrogen production for the chemical industry and fertilizer manufacturing processes,
- supporting – already before 2030 – the R&D of CCS-solutions and the testing of the new technologies within the framework of pilot programmes in the chemical industry,
- developing hydrogen usage conditions necessary to meet the industrial heat demand of the cement industry and supporting production processes reducing carbon intensity in steel production as well, mostly after 2030.

A general barrier to concrete industrial decarbonisation roadmaps is the lack of details, timing and exact funding options for decarbonisation. In Hungary, there are plenty of strategies, but often, the work on the strategies stops when the strategy is ready, and it is not transformed into an action plan.

Several skilled experts left public administration in the past years to work for the private sector, meaning that the Hungarian public sector cannot retain enough talent and specialized workforce for better climate intelligence, policymaking, and implementation.

There is also a lack of efficient and effective government communication towards the population on the need for decarbonization, on the need for energy efficiency, on the linkages between energy consumption, energy security and climate protection. The cooperation with the civil sector and other stakeholders is weak, consultations on strategies and new legislation are short, superficial, or often non-existent.

3. FINANCIAL BARRIERS

Transitioning is currently poorly financed in Hungary, and we see a clear market failure justifying state aid. Hungarian financial market is dominated by debt issuance. The ongoing monetary tightening amid negative supply shock will cool green investments. This can create a need for stronger government support for transition and decarbonization. Economic downturns do not necessarily cause market failure but are more likely to do so if the nature of the shock is from the supply side. This is the case nowadays: high energy prices revealed the vulnerability of the heavy industry, which is likely to move the sector towards greening the mix of its energy inputs (ie. making it more resilient to external shocks), while green manufacturing process solutions will be less attractive to finance. This is where the state comes as a facilitator of transition.

Second, overlooking economic cycles, a serious underlying knowledge gap comes from the fact that return on investment (ROI) numbers are dependent on external (regulatory) costs, mainly ETS prices. In other words: one may find a hard time to predict future quota developments, and this impacts the rentability of the projects. Before the massive disruption on the European energy market, ETS prices were on a steady increase. The war in Ukraine directed ETS futures quotes south, and it is unclear whether ETS prices will converge to the previous trend or head to a new, significantly lower price path. If the latter set to occur, ROI of green transition will be significantly lower, making it necessary for the state to get more involved. Purely market-based initiatives are unlikely to emerge in large numbers for several reasons (see the last part on private capital). Figures in this sub-chapter are all benchmarked against national GDP and industry investments (gross fixed capital formations) for 2021 and 2020 respectively. National GDP in Hungary amounted to EUR 154.1 billion, while investments in the target group reached EUR 0.781 billion in 2020 (no data is available yet for 2021).[25]

This paper aims to present financial barriers starting with public finances and then concerns with green private capital. For both subchapters we present a state of play, then at the end of the document we provide possible solutions. A detailed roadmap will follow this publication. It is important to stress out that although we separated public and private finance in this analysis, the boundary between the private and public sector green finance is often very thin, because the state is usually the promoter and enabler of green transition in all fields. Our work features the processing of the relevant documents as well as the inclusion of expert opinions.

[25] NACE codes included in the investment figure: 20, 235, 241.

3.1. Public finance

Barrier 1: Although the decarbonization of industry processes could be financed from centrally managed EU funds, the Hungarian government did not include this priority in its plans.

Barrier 2: Enhancing energy security and improving transport come as number 1 and 2 national green priorities, process emission efficiency and decarbonization of the industry are not in the scope of governmental actions for the next seven years.

Barrier 3: Centrally allocated funds (Horizon Europe) offer some possibilities for R&D projects on decarbonization, but Hungarian companies do not participate.

3.1.1. State aid rules of the EU

In the EU, funds from the Multiannual Financial Framework (MFF) or from the Innovation and Modernisation Funds are all available for heavy industry as well, but very important limitations persist for industrial decarbonization. European Investment and Structural funds are the deepest pockets of finance for decarbonization. However, the most popular item for state support, the "regional support" title is not available for companies in the Steel sector for EU regulation reasons.[26] Steel companies may be able to apply for R&D funds, however it is highly unlikely that they are willing to do so (the implementation of existing technologies is not supported as it is not novel enough, while a certificate of R&D content from the relevant state authority is requested and difficult to obtain).[27]

Another current issue of regional support aid rules is the fact **that large companies are only eligible for support if the scope of outcome of the project mostly benefits SMEs.** Companies in scope for industrial decarbonization are exclusively large companies and their operations are not linked to SMEs. A third issue is that currently, member state financed decarbonization projects need to undergo Commission approval mechanism[28], however this is likely to change from next year. Based on professional background information, **the European Commission (EC) is planning to amend the relevant legislation so that investment aid for environmental protection including decarbonisation be compatible with internal market regulation, especially concerning state aid rules. Despite the amendment improving the legal framework of decarbonization financing, there is a chance of overregulation too:**

[26] GBER regulation of the Commission (EU) No 651/2014. https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32014R0651&from=HU

[27] R&D activities by definition mean that there is a technology-development novelty included, ie. the adaptation of existing technologies does not fulfil this criterea.

[28] Commission communication on Guidelines on State aid for climate, environmental protection and energy 2022 (2022/C 80/01), section 4.1.

- support cannot be attributed to (new) investments in equipment, machinery and industrial production facilities using fossil fuels, including those using natural gas (however the greening of existent equipment is supported),

- the project shall enable the beneficiary to increase the level of environmental protection resulting from its activities by going beyond the applicable Union standards,

- investments in carbon capture and storage (CCS) and use (CCU) shall be integrated into a complete CCS and/or CCU chain.[29]

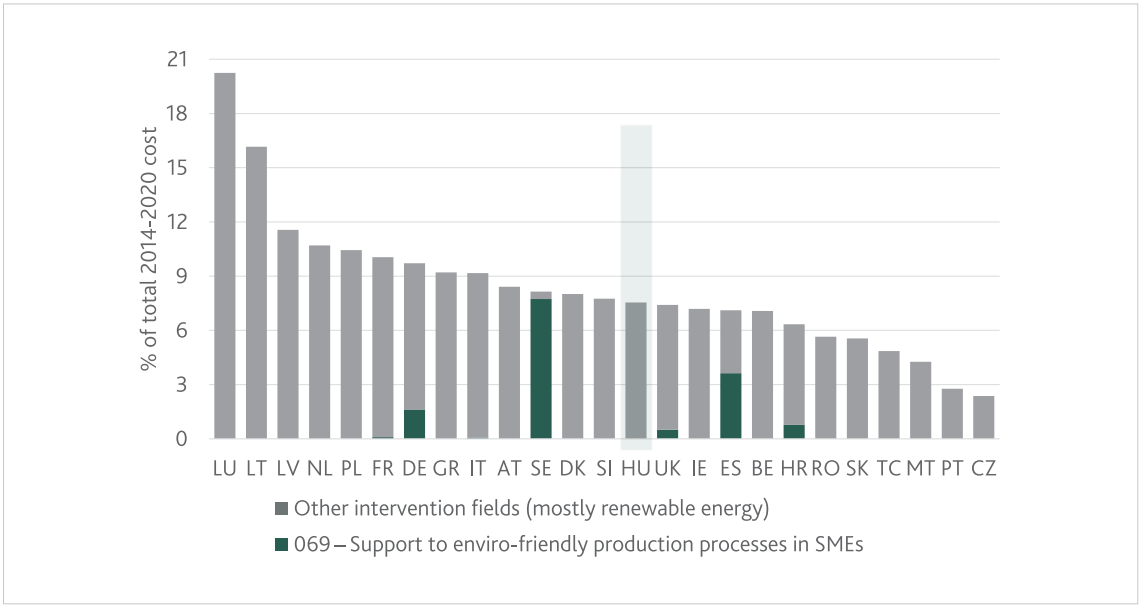
Despite the new 2023 European Commission state aid rules being more favourable for decarbonization, they will probably need to be reconsidered. Our general assessment of the new legislation by the EC is that it needs to be adjusted to better align with the information gap for decarbonization projects. Indeed, assessing net present value (NPV) or ROI for decarbonization investments can only be done with great uncertainty. A threshold would help to ease these constraints (e.g. a slightly positive expected NPV should be eligible for support). Also, the counterfactual cost assessment seems to be difficult to comply with. Finally, eligible cost for CCS technologies should also include additional costs related to the whole CCS or CCU chain. This is in fact needed because CCS installations work in an ecosystem, where transport, storage and demand also have significant financing gaps. On the other hand, the new legislation is much more advantageous for large companies, because aid intensities are higher than for energy efficiency measures (40 percent in contrast to 30 percent) and do not depend on the geographical location of the project. The new legislation does not exclude steel production either.

3.1.2. EU – Multiannual Financial Framework – Operational programmes

Because of financial regulation by the EU, SMEs were favoured against large companies between 2014 and 2020 to carry out decarbonisation projects through process or energy efficiency measures. However, Hungary like most countries in the EU, did not use this possibility, we see that allocations to this matter were low in the respective national operational programmes (OPs). Nevertheless, Hungary was not far behind the European average allocation for the broader "low-carbon economy" allocations. Most of the available funding for low-carbon economy was allocated for renewable energy and energy efficiency in buildings (insulation) projects.

[29] Additional criteria are the following: The net present value ('NPV') of the investment project over its lifetime shall be negative (including avoided ETS costs); the eligible costs shall be exclusively the additional investment costs stemming from the application of CCS or CCU technologies to a CO_2-emitting installation (industrial installation or power plant), compared to a counterfactual where such technologies are not applied; the aid intensity shall not exceed 40 percent of the eligible costs, while aid intensity for CCS/CCU technologies might be 30 percent of costs; the aid amount shall not exceed the difference between the eligible costs and the operating profit of the investment; the aid intensity may reach 100 percent of the eligible costs where aid is granted in a competitive bidding process, which fulfils additional criteria.

Figure 20: Hungary, like most member states did not allocate funds to process decarbonization in the period of 2014–2020



Source: European Commission (2021). Note: eligible costs to low-carbon economy thematical objective in the 2014–2020, in % of total allocations for the country.

The Economic Development and Innovation Operational Programme (EDIOP) – which was the principal tool to finance company investments between 2014 and 2020 – mainly financed energy efficiency projects, but featured a programme called "Green national champions" too, with an allocation of HUF 9.8 billion (EUR 28 mil, about 0.1 of total EU OP finance). The aim of this programme was to find SMEs that have an investment need to develop green innovations. The list of eligible activities did not feature any topic related to the reduction of process emissions. Not surprisingly, the 40 projects financed by the government did not feature any related low-carbon economy or Carbon Capture and Storage (CCS) related projects.

The forthcoming financing period will mainly follow the previous period's national financing logic, but this time will feature environment-friendly processes as supported activities. The new Economic Development and Innovation Operational Programme (EDIOP Plus) plans to spend EUR 166 million to enviro-friendly production processes in SMEs. This amount is 0.1 percent of the GDP and 1/5th of the target group's one year of investment. Most of the calls are not published yet as at the time of writing this analysis the OPs are not finalized and approved by the European Commission.[30] However, the fact that the new draft EDIOP does not feature any output indicator related to environmental goals indirectly projects that support for CCS and other decarbonization technologies may only be an auxiliary to the support of general fixed asset investments of SMEs.[31] The few calls already available feature

[30] Opposite positions from the Hungarian government and the European Commission on the so-called Rule of Law mechanism hinder the transfer of funds to Hungary. Until an agreement is reached, new calls are unlikely to be launched in Hungary.

[31] The (planned) OP for Environment and energy efficiency does not feature production process reduction for the industry in its agenda and rather focuses on the energy and transport sector.

the Green national champions programme once more, with a budget three times higher than the previous one (HUF 30 billion). However, as its predecessor, the new Green champions programme will likely not support process emission reduction, but large companies are in the scope of the programme (with a lower support intensity than SMEs).

3.1.3. EU – Recovery and Resilience Facility – Recovery and Resilience Plan

The Hungarian Recovery and Resilience Facility (RRF) – that is not approved by the Commission at the time of writing this analysis – does not feature any element dedicated to make industrial production processes greener. The plan roughly follows the logic of the operational programmes financed by the European Structural and Innovation Funds (ESIF) (see above), where the green targets are to be reached through the greening of energy and transport.[32]

3.1.4. EU – Innovation and Modernisation Funds, Horizon Europe

Unlike for the ESIF, centrally allocated state support programmes (Horizon 2020, Innovation Fund etc.) are not subject to state aid regulation. This means even steel activities are eligible for grants and there is no business size class restriction either. However, these funds do not represent a viable option for the focus group companies for various reasons.

1. Overlapping of EU funds: for a country that is as highly financed from ESIF as Hungary (about 3–4 percent of GDP each year), competing for finance nationally is less burdensome than running against international counterparts. Hungarian companies, especially project management ones, have much more experience in the Hungarian application for grants system than for the centrally (Brussels) managed ones.

2. High share of foreign-owned companies: many companies in the focus group (included in the ETS) are mostly subsidiaries of foreign companies and for this reason the bulk of the R&D activity of the group is not in Hungary.

   MOL (chemical industry) and Nitrogénművek could be important exceptions to that, however applying for public grants is not in focus for any of them. According to the European Commission's SEDIA database[33], no Hungarian industrial entity was involved in either Modernisation or Innovation Fund projects. Modernisation Fund projects selected by Hungary included mostly energy efficiency projects, the development of Energy Communities, but also energy storage instalments.[34]

   The Swiss cement company LAFARGE-Holcim who owns an important cement-producing plant in Hungary currently works on calcined clay and alternative clinker demonstration projects. It is unclear to what extent the Hungarian branch can be involved in the process.

[32] At the time of writing, Hungarian RRF plan is still not adopted by the European Commission.
[33] https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/projects-results
[34] MOL has however an Innovation Fund project in Croatia, through its subsidiary INA. INA implements a bio-refinery project to use biogenic CO_2. The project cost is EUR 300 mil. (0.2 percent of Hungarian GDP) and is partly financed from EU grant and has been declared strategic project of the republic of Croatia.

3. Small knowledge networks: Hungarian companies tend to be local, there are very few heavy industry entities that have their own R&D activity and are active internationally too.

3.1.5. Using revenues from the EU ETS

Similarly to the use of other green finance sources, EU ETS revenues are allocated to energy efficiency and transport. According to Hungarian legislation[35], 100 percent of revenues from the auctioning of aviation allowances, and 50 percent of revenues from the auctioning of regular (EUA) allowances are used to help reaching climate goals.

In the period 2015–2020 auctioning revenues were used via the Green Economy Financing Scheme, mainly for increasing the energy efficiency of buildings, the electrification of transport and for international climate financing. ETS revenues were not allocated for industrial decarbonization.

Based on the 2022 state budget proposal[36], 80 million euros will be generated from auctioning EUA-s (allowances) – although the realised income can be significantly different due to the price volatility of the allowances (this is less than 1 percent of the GDP).

3.1.6. State budget – national resources

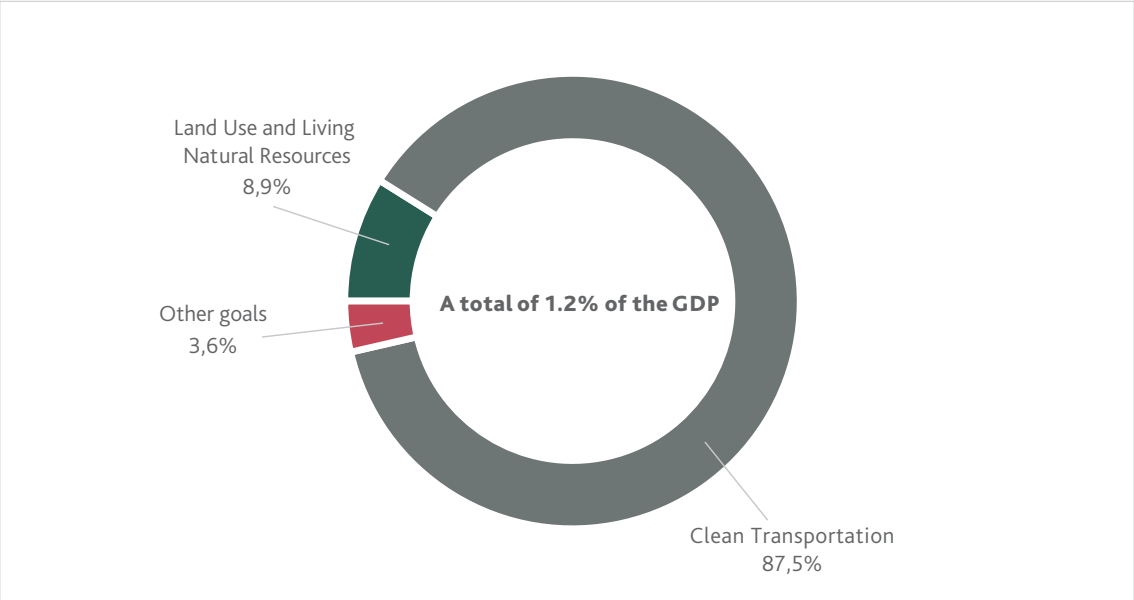
In this section we will be reviewing the budgetary allocations at national level. Regional and local authorities' budgets are not relevant, mainly because of their modest size and the design of the national industrial development policy, which is heavily centralised. Thus, we will only cover central sources.

The Hungarian government took the first move toward encouraging green finance in June 2020, when it issued green government bonds, which raised cash for government initiatives relevant to Hungary's Clean Development Strategy's climatic and environmental goals. Since then, a slew of new policies has been enacted to aid with the funding of green initiatives. The Green Bond Programme of 2020 amounted to HUF 718 billion in 2021, roughly 1.3 percent of the total gross central debt of the government (about two and half years of investment from the target group), while HUF 574 billion of projects have been selected by the state. The maturity of these issuances is 15 years for euro denominated bonds (75 percent of all green bonds). Eligible Green Expenditures included investment expenditures, intervention expenditures, tax expenditures and selected operating expenditures. To avoid double financing, companies already obtaining dedicated funding (e.g. a dedicated tax, proceeds from sale of EU ETS allowances or EU funding) have been excluded. **Allocation has been almost exclusively dominated by transportation projects.**

[35] 2012. évi CCXVII. törvény

[36] https://www.parlament.hu/irom41/16118/16118.pdf

Figure 21: Green bonds almost exclusively finance transportation projects



Source: Hungarian Debt Managing Authority report (2021).

Unfortunately, the Hungarian Green Bonds Programme's reception is ambiguous. Background expert information stated that most of the projects included in the Programme were already sanctioned to be financed prior to the start of the Green Bonds, which hurts the green credibility of the programme. Also, the total sum of the Programme is far from being in line with the investment needs to reach the national green targets.

3.1.7. Tax system

Tax credits on energy efficiency investments are in place since 2017, but process emission reductions are not supported under this scheme. The tax credit is financed in the Green Bond Programme. The base of these tax credits was broadened to include energy efficiency renovations too. The main purpose of this measure is to boost the overall energy efficiency of the companies (including energy consumption, efficiency of buildings, transportation, and production).[37] The tax allowance may be claimed up to 70 percent of the calculated corporate income tax, for a length of 6 years. The tax credits on investments in energy efficiency not claimed by the taxpayer in the corporate tax can also be claimed in the special tax of energy suppliers up to 50 percent of the calculated tax.

[37] Energy efficiency investments are defined by the law (Law nr. LXXVII of 2015): mostly all energy-saving investments are eligible subject they reduce the total final energy consumption of the company. All companies wishing to use this incentive must have a certificate of compliance from a certified auditing company.

In total, about 500 companies were eligible for the tax credit. Manufacturing industry as a whole received 38 percent of all tax relief in 2020, which is significantly higher than the industry's share in total tax base (24,8 percent). Considering the hard-to-abate industries, non-mineral chemical manufacturing (including cement) and steel production received 9.4 percent of all tax allowances (0.3 percent of the GDP), however the projects financed through the instrument are not published.

3.2. PRIVATE CAPITAL

Barrier 4: As part of the UN NetZero initiative, the greening of bank portfolios is challenging, because banks may choose to divest green assets rather than actually cleaning them.

Barrier 5: The current situation on the energy markets requires tangible awareness-raising for decarbonization. There are ready to use methods which can help to persuade companies that decarbonization actually has a financial value for them.

Barrier 6: The MNB's (the central bank's) green capital requirement programme is set to phase out soon and there is uncertainty over its continuation in the light of the general monetary tightening.

Barrier 7: Risk pooling options are missing from the green finance ecosystem.

Barrier 8: Decarbonization related technology projects (such as CCS or CSU) are out of scope for both the industry and the State, because these technologies offer less return than green hydrogen projects.

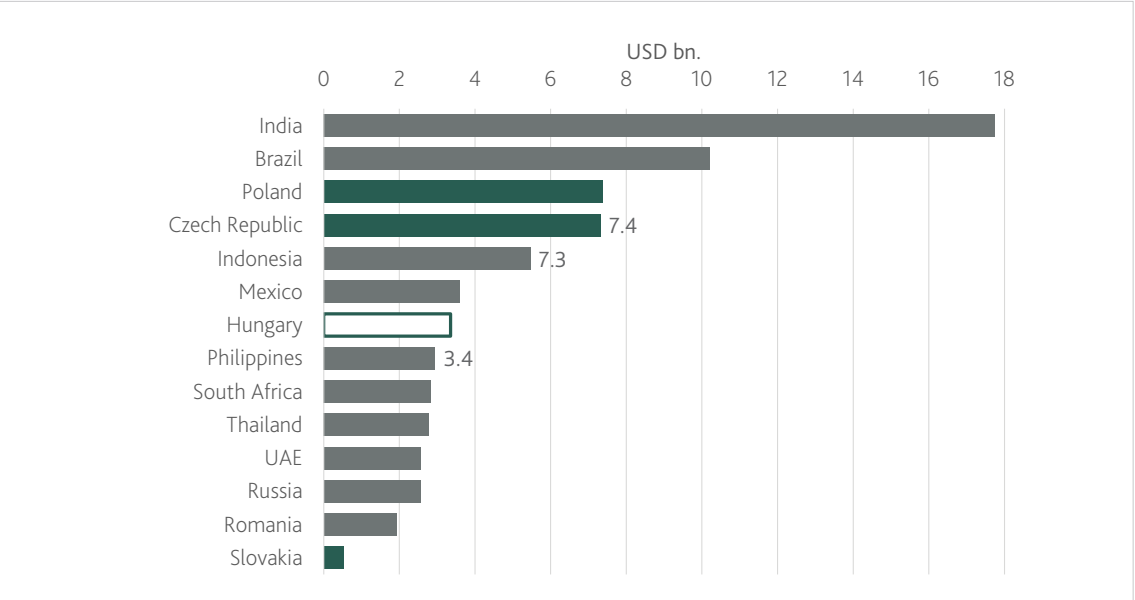
In this subsection, we will cover the principal aspects of green private financing. First, we touch upon the role of the Hungarian National Bank (Magyar Nemzeti Bank – MNB), because apart from being a monetary authority, the MNB is also the financial regulator and is active in green finances. Then, we will present the current situation of the green bond market. The third and last part will talk about company strategic concerns that hinder investments in decarbonization technologies.

3.2.1. Private finances at a glance

The green capital market is increasing in Hungary however, its size is still relatively small. Based on data provided by the MNB, stock of green instruments reached HUF 1200 billion (about EUR 3 billion), about 2 percent of the GDP. Most of the assets however are sovereign issuance (more than two-thirds of the total), while private market activity is a magnitude smaller. Total wealth managed in ESG funds currently (2021) accounts for HUF 158 billion, which is 0.3 of the GDP. But there is no denying of the dynamism in the segment: ESG funds posted a whopping fivefold increase when compared to the previous year (2020).

Green assets' share from the total assets managed by investment funds is currently 1.8 percent.[38] There is still a lot of ground to make up in this segment since from the 704 investment funds active in 2021 in Hungary, only 21 incorporate ESG aspects.[39] It is hard to map a particular ESG spending goal as their focus areas are diverse. Putting the Hungarian situation in international context, we can conclude that although Czech Republic performs better in the issuance of green bonds, Hungarian position among emerging market economies is good.

Figure 22: Hungarian Green bond issuance has been relatively strong between 2012–2021



Source: Amundi (2022). Note: Cummulative between 2012–2021.

Green and sustainable investment venture capital funds have also appeared recently in Hungary. Sustainability goal is most evident in that funds invest in companies whose core business contributes to climate and environmental objectives due to their nature, such as water, waste management and renewable energy organizations. Based on MNB information, there are four venture capital funds related to ESG goals, none of them are industry-oriented.

In Hungary, the primary financing mean of green projects is equity financing, mostly because the risk associated with green investments is high, and by consequence collateral-based financing is not an option. Bank loan financing is used for mortgage only, while bond issuances are the most common form of green finance. We examined bank financial reports in Hungary. They provided limited information on their green portfolio. ERSTE Bank set out a goal to reach 25 percent green portfolio, most of these efforts are asset focused. ERSTE started to build decarbonisation models for energy, commercial real estate and mortgages segments, but no industrial sectors were included. To move decarbonization forward and help build resilience K&H Bank is reconsidering its lending policy toward carbon-intensive industries and industries that are the most affected by climate change, thus, it is widening its offer of

[38] MNB (2022): Zöld Pénzügyi Jelentés 2022 (Green Finance Report 2022)
[39] MNB (2022): Zöld Pénzügyi Jelentés 2022 (Green Finance Report 2022)

sustainable investment funds. Socially responsible investments (SRIs) represented HUF 60 billion in 2021. The bank financed solar capacity development at the level of HUF 86 billion.[40] It is unclear whether these sums are to be considered separately or if there is some overlap between them. OTP is a Hungarian bank that is also active in green finance, mostly through its Climate Change Equity Fund, but its focus is international. **The regulatory authority will need to be wary of how banks execute the greening of their portfolios: there is a significant risk they will choose to drop "brown" assets rather than choose to engage with the counterparties to move towards a greener set-up.**

Blended finance is not directly available in Hungary, but since there is no dedicated scheme for industry decarbonization in any of the national development programmes, blended finance could be a relevant concept to foster decarbonization. Blended schemes are by nature similar to standard EU co-financed supports, in that EU schemes also incorporate a significant amount of private co-financing complementing state aid (which is the main idea behind blended finances too).[41] We expect this form of finance to arise, but it is more likely to start with hydrogen focused projects, as these investments are preferred against direct decarbonisation technologies.

Multilateral bodies also contribute to green investments in Hungary through their contribution to bank portfolios. The EBRD signed, but has not yet disbursed:

- EUR 75 million in a green senior preferred bond issued by OTP Bank, as part of its total issuance of EUR 400 million (2022).
- EUR 13.2 million in covered bonds issued by UniCredit Mortgage Bank ("UCBM") to invest an amount corresponding to at least 100 per cent of the EBRD's invested amount to finance green investments in renewable energy projects and/or residential building sector (2020).
- EUR 60 million (17 percent of the issuance amount) in a Senior Preferred bond (the "Bond") issued by ERSTE Bank Hungary Zrt, with at least 120 percent of the EBRD's investment to be allocated to finance green projects (2022).
- EUR 12.6 million equivalent, or 16.8 percent of the issuance amount in a Senior Preferred bond (the "Bond") issued by Raiffeisen Bank Zrt. The project also aims to support strong Green-impact targets with at least 120 percent of the EBRD's investment to be allocated to financing green projects (2022).

EIB recently signed a project agreement with the Hungarian Eximbank, in the sum of EUR 100 million, to support the Green Financing Framework of Hungarian Eximbank and to provide funding for eligible projects of small and medium-sized enterprises (SMEs), mid-caps and other corporates.

[40] https://www.kh.hu/documents/20184/490492/K%26H+Csoport+fenntarthat%C3%B3s%C3%A1gi+-jelent%C3%A9s+2021.pdf/60598a8d-3bd5-c611-4a5c-8e6a8f1dc0fa?t=1650548503079

[41] Blended finances have been mostly used in developing economies to complement official development assistances (ODAs) in order to finance green investments usually in the energy sector. For more details refer to Choi-Seiger (2020): Catalyzing Capital for the Transition toward Decarbonization: Blended Finance and Its Way Forward.

As of today, to our knowledge no financial tool has been used to reduce carbon emissions in industrial production. ESG projects are concentrated in four areas in Hungary: financial sector, energy & utilities, real estate, transportation and mobility. Thus, industry is just indirectly affected by ESG through financial risk regulation by the MNB. "This for example includes the requirement for financial institutions on examining whether a financing project is environmentally sustainable and conducting a climate change and environmental risk assessment of customers before taking a risk. Assessing how climate and environmental risks affect a borrower's probability of default (PD) and average loss given default (LGD) is a particular challenge when assessing credit risk."[42]

The EU-wide Corporate Sustainability Reporting Directive (CSRD) regulation offers an opportunity to put Hungary at the forefront of green reporting. These guidelines set out by the EC will help make the market more transparent via more credible green financial statements of listed companies. An earlier (sooner than 2025) and wider (all companies having an ETS account, public companies) adoption of the regulation. **MNB could collect and showcase the published non-financial reports of legal entities,** creating awareness among medium and large market players on reporting.

[42] https://assets.kpmg/content/dam/kpmg/hu/pdf/FRR-okt-eng1.pdf

3.2.2. Activities of the central bank as regulatory authority with a green mandate

The Hungarian National Bank (MNB) is one of the early mover green central banks, and is the only one among V4 central banks to have a green mandate (since 2021). The MNB's Green Programme is organized around three pillars: (i) the financial sector, (ii) the development of the MNB's social and international ties, and (iii) the further greening of the MNB's own day-to-day operations. **The Green Financial Services consists of a number of efforts ranging from assessing the existing state of green financing to rewarding financial market participants to operate in a more environmentally friendly manner** and engage in green financial services (mainly loans and bonds). In addition to financial and non-financial company related activities, the MNB also has a household programme (Green Home), which we will not elaborate on here.[43]

The MNB introduced a capital requirement discount programme in 2021. Starting with the 2021 ICAAP (Internal Capital Adequacy Assessment Process) revisions, the MNB intends to improve the risk profile of the banking sector and reduce the banking system's exposure to transition risks through positive incentives. Participating banks may get waivers (discounts) on their capital requirements. The amount of the discount is 5 percent of the total gross exposure of the relevant portfolio existing at the relevant time of the ICAAP review or – in case of full compliance with the EU Taxonomy – 7 percent. The programme started as a 2-year fixed period project, and is set to expire in 2023. A prolongation of the programme is anticipated as it had a positive reception among participants. The range of eligible projects is wide, however some practical guidance on the EU taxonomy or CBI taxonomy could make the programme even more popular.

The MNB was instrumental to foster green financing, as it helped its own Growth Bond Programme[44] participating companies to issue HUF 189 billion of green bonds. In addition to promoting green lending and its green bond programme, **the MNB introduced a capital requirement discount programme for the purchase of corporate green bonds by commercial banks,** among other things, as a further greening of the bond market. About 14 percent of the total Growth Bond Programme has been issued under green label. 2 percent of the bonds issued under the MNB's Programme were subscribed by manufacturing companies, amongst those, the plastic manufacturer Deltaplast Zrt. is the only company falling near our focus group (chemical, cement, and steel industry). The green framework document issued by Deltaplast states that funds will be used to contribute to circular economy goals via a zero-waste production process.

The future of the recently experienced dynamism in the Hungarian green capital market is somewhat in doubt because – as part of its tightening process on the monetary variables – the MNB stopped the Growth Bond Programme in 2021, but the capital requirements discount programme will remain in place until 2023.

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[43] MNB's strategy: https://www.mnb.hu/letoltes/zold-eszkoztar-strategia-publikacio-2021-hun-0706-2.pdf

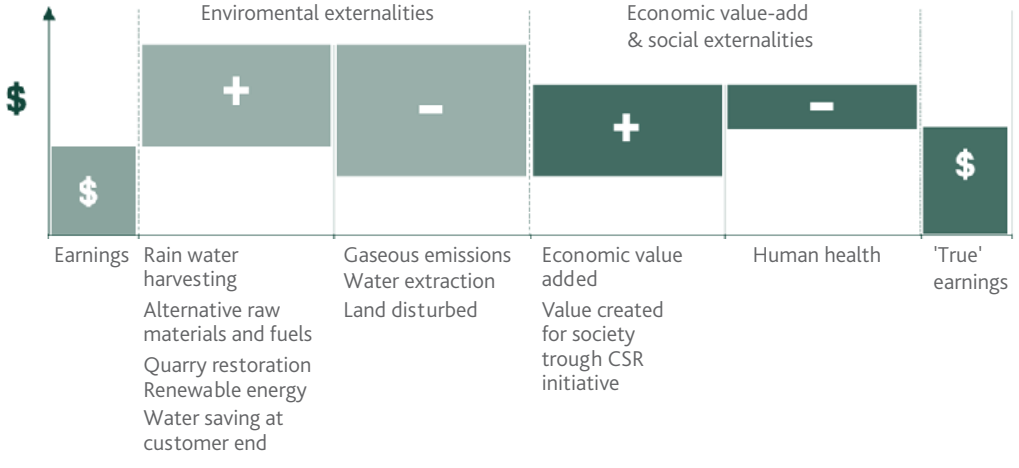
[44] The Growth Bond Programme (NCP) was established in 2019 to help the domestic diversification of companies' external resources. The programme in addition also plays a key role in launching green bonds.

Qualitative assessments by experts in the topic recommended the MNB to continue its work in the field, because the authority can significantly speed up the transition to green finance. As part of an EBRD financed project, Deloitte Hungary reviewed the sustainable capital market in Hungary.[45] Financial stakeholders interviewed in the project stated that if the MNB greens its own assets, other banks are likely to follow.[46]

3.2.3. Strategic focuses and awareness

Awareness is a general challenge, especially in the light of current energy market events. Heavy industry players are generally focused on OPEX, moving them away from this set-up would either require a stricter state regulation (as a negative incentive), higher expected ETS costs (also as a negative incentive) or positive financial returns (positive incentive) from green investments. A different approach is indirect benefits through value creation. Methods such as the True Value approach from KPMG offers a way to assess externalities. For instance, the return on capital expenditure can be higher if one accounts for externalities. If these externalities can be numerated, there is higher probability that risk pooling options will become available. The 'true' earnings bridge, which combines the company's financial profits with its monetized positive and negative externalities can be substantially higher than monetary profits (or value-added). For example, a cement company's positive externalities include (and are not limited to): water harvest (through check dams, river linking), using waste from other industries in its manufacturing process. Negative externalities include: emission of greenhouse gases, other emissions such as fine particles, groundwater extractions. An Indian cement company's True Value assessment revealed that true earnings of the company are somewhat higher when taking into account the externalities too (see Figure 23).

Figure 23: When assessing a company's financial performance, accounting for externalities can show the true value of the company



Source: Ambuja Cements Limited and KPMG (2014).

[45] Deloitte (2022)

[46] The MNB in its new green strategy committed itself to reach that goal, with a HUF 200 bn green mortgage programme.

Green hydrogen projects are the most current focus areas of the state and private companies too, while process CO_2-emission reduction technologies lack the incentive to prosper. Although Hungary has relatively good attributes to store and use carbon-dioxide, market incentives to decarbonize production processes do not exist yet. First, carbon-dioxide based final products that could use for instance CCS technologies in the process would see output prices rise two to three times the current ones, because the technology is costly. There is no stable demand for greener products in the market either. On the other side, there are opinions about a breakeven price for natural gas high enough so that hydrogen technologies become a viable substitute, but again, the technological viability is a concern. Based on estimates, ETS allowances may run out by 2027, which means CCS and other technologies may soon become financially viable because they can be used to reduce ETS costs for companies. To sum, current technological and financial environment is not favourable for market investments, however this might change in the long term. Another issue faced by possible investors is that existing decarbonisation solutions compete with other decarbonisation alternatives, mostly targeting energy production and use. A serious concern is the long-term viability of the technologies. CCS is limited because storage capacities are finite in Hungary and there is no guarantee that an alternative technology building on simultaneous capture and use might become more viable than CCS. Yet, because CCS is currently in use in US and Europe, the required R&D investment risk is lower compared to other decarbonization alternatives.

The Hungarian Oil and Gas Company (MOL) is the most important player in hydrogen and CCS projects too, because most of the Hungarian natural gas and hydrogen production is operated by MOL, while it is also the biggest owner of possible CO_2-storage locations in Hungary. MOL has significant international experience in carbon storage technologies, however – based on background expert information – their willingness to put more efforts into the technology is in doubt. First, because of technological feasibility concerns, second because of the recent sectoral tax sanctioned on MOL by the Hungarian government for the current and the next business year. MOL will probably put its available financial sources in the delinking from Russian oil blends. Nevertheless, MOL is currently active in the transition to green hydrogen production. **MOL – who is a very important chemical industry player as well – plans to build a hydrogen transformation capacity worth EUR 22 million in Hungary and Slovakia to substitute 3 percent of the total standard (grey) hydrogen production of MOL.** This might seem to be a small contribution, but the plant will be amongst the largest ones in Europe and will spare 25 thousand tonnes of CO_2 each year (equivalent of EUR 2 million of ETS quotas, that is only 0.05 of MOL group's EBITDA). MOL has been rated in 2021 by Moody-s Investor Service as the only ESG company in Hungary. The rating score fits in the pattern of oil companies in the region (moderate to highly negative).[47]

[47] Available at: https://www.moodys.com/research/Cross-Sector-Global-MIS-ESG-credit-impact-scores-and-issuer--PBC_1286636

4. CONCLUSIONS AND TAKEAWAYS

Financial barriers can be defined as obstacles to the implementation of decarbonization technologies. We identified 8 barriers, 3 of these are related to public finance, the remaining 5 are related to private capital and the strategic approach companies are taking. In this final chapter, we will once more list these barriers and provide a short, possible list of solutions. We will elaborate on these in an upcoming document.

Barrier 1: Although the decarbonization of industry processes could be financed from centrally managed EU funds, the Hungarian government did not include this priority in its plan.

> **Possible solution:** Operational Programmes (OPs) are yet to be accepted by the EU. Although the reason behind the late approval is mostly of political nature, the time gained by the delay could be used to green the existing drafts. To our knowledge, the drafts proposed by the Hungarian government underperform in terms of green content.

Barrier 2: Enhancing energy security and improving transports come as number 1 and 2 national green priorities, industrial process emission efficiency and decarbonization are not in the scope of governmental actions for the next seven years.

> **Possible solution:** There is a need for the stakeholders to form lobby coalitions. Background expert talks revealed that without public finance, decarbonization initiatives are unlikely to happen. However, the Hungarian state is focused on specific green topics (eg. Hydrogen, insulation) rather than green techs in general. Industry players together with the operators of the gas pipelines and storage facilities should form a coalition to lobby for the introduction of CCS or CSU technologies in the government's plans.

Barrier 3: Centrally allocated funds (Horizon Europe) offer some possibilities for decarbonization R&D projects, but Hungarian companies do not participate.

> **Possible solution:** Since Horizon participating coalitions usually require high and wide knowledge in the field, member states with more established industrial R&D knowledge are more likely to apply. These capacities are usually not existing in the V4 for historical and scale reasons (ie. the economies are not large enough). Another approach to assess the lack of Hungarian (V4) participation is that Hungarian companies are for most of the time subsidiaries of foreign companies, they do not have strategic rights to be involved. A third approach behind the reasons to understand the low domestic participation is the phenomenon of fund overlapping: national and EU structural policy funds are usually easier to access than central EU funds (Horizon Europe, Innovation Fund, Modernization Fund). A solution could be the pooling of national projects and the formation of coalitions in the region.

Barrier 4: As part of the UN NetZero initiative, the greening of bank portfolios is challenging, because banks may choose to divest green assets rather than actually clean them.

Possible solution: Engagement deems to be a more viable way to green bank portfolios. In this concept, regulating authorities cooperate with financial institutions, so that the latter chooses the portfolio elements they would normally drop in order the work for a joint greening roadmap. This inevitably requires the active involvement of the financed companies.

Barrier 5: The current situation on the energy markets requires tangible awareness-raising for decarbonization. There are ready-to-use methods which can help to persuade companies that decarbonization actually has a financial value for them.

Possible solution: Soft methods (eg. information facilities, workshops, demonstration projects) and hard methods (reporting obligations) can all be considered. With the gradual shift in finance towards ESG, industry companies wishing to obtain funds may well consider to present a different approach of their financial value. A method to do that is the True Value briefly presented in this text. The True Value method encompasses (environmental) externalities in the book value of the company.

Barrier 6: The MNB's (the central bank's) green capital requirement programme is set to phase out soon and there is uncertainty over its continuation in the light of the general monetary tightening.

Possible solution: A verbal commitment from the MNB (as a regulating authority) would ensure that banks stay committed to their previous efforts. Although a waiver on capital requirements for green investments would mean a small loss on the monetary transmission, the long-term benefits are larger than the short-term losses. Yet, MNB's intentions are mostly focused on mortgage and clean energy while there is no special attention dedicated to industry process decarbonization.

Barrier 7: Risk pooling options are missing from the green finance ecosystem (blended finance, hybrid forms of state support).

Possible solution: Because risk pooling inevitably entails participation of the state in private green projects, the relevant public bodies must consider these options. For instance, in the EU budgetary period of 2014–2020, R&D projects received blended funding through the MFB (Hungarian Bank for Development). An extension/reinitialization of the previous programme to include green finances too could result in a greater private investment appetite.

Barrier 8: Decarbonization-related technology projects (such as CCS or CCU) are out of scope for both the industry and the State, because these technologies offer less return than green hydrogen projects.

Possible solution: Technological possibilities in green or blue hydrogen seem to be more viable than carbon capture and storage (CCS) or carbon capture and utilization (CCU) because of the large CAPEX of the two latter; hence, further cross-sectoral

alignment on a Europe-wide CO_2 transport and storage infrastructure would be required.[48]

In general, green private finance is still in its infancy but has a growth potential (see table below). Because financial returns are highly doubtful for heavy industry projects, the involvement of the state is necessary. This should happen both in the form of awareness raising and provision of information, dedicated financial instruments (blended finance and development projects) and indirect instruments (tax deduction).

Below, we enumerated a few key numbers of the Hungarian green finance ecosystem.

Table 2: Hungarian green financing market at a glance

	EUR mil.	% of GDP	% of a year of investments by focus group
Green national champions call, round 2	166	0.108	21.2
ETS quota selling revenue	80	0.052	10.2
Green bonds (incl. sovereign)	2003	1.299	256.3
Tax incentives for green investments	456	0.296	58.4
Private green capital market	1116	0.724	142.8

Source: Equilibrium Institute based on various data sources.

[48] GreenSteel for Europe (2021): Collection of possible decarbonisation barriers.

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