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Comparative Study of Iron and Steel Industry Transition in the Countries of Central-East Europe and Former Soviet Union

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Abstract
Comparative analysis of iron & steel industry's transition in the countries of Central-East Europe as well as in Kazakhstan, Russia and Ukraine during the quarter of century after collapse of Soviet Union has been performed. Influence of political and socio-economic aspects on pathways and results of reform analysed focusing on restructuring, modernisation, production and consumption patterns, international trade etc. Energy efficiency and environmental performance indicators achieved in the countries concerned have been studied in the context of economic and environmental sustainability. Policies for greenhouse gases emissions abatement in the iron & steel sector have been analysed towards addressing commitments to Paris Agreement and further transition to a low-carbon and sustainable economy in the countries covered by this study.

Keywords: Transition, sustainability, iron and steel industry

1. Introduction

Twenty five years ago collapse of communist regimes in East Europe and disintegration of Soviet Union set off transition of planned economies to liberal market. Steel sector, former basis of military power, previously consolidating mutually dependent countries to self-sustainable block, had to adapt to new conditions. Results of transition depend upon socio-economic patterns in particular country and region. Previous studies (Hanzl & Havlik, 2004; Trappmann, 2015; Troschke & Wittmann, 2014, Shatokha, 2017) vary in the depth of the historic period as well as in the list of countries covered. In this paper we aim to analyse sector's evolution with emphasis on economic and environmental sustainability aspects.

2. Methodology and Scope

Versatile steel production routes might be summarised in two large groups: integrated and non-integrated. Integrated route (or primary) covers full production cycle from iron ore materials to finished steel. Non-integrated (or secondary) route produces steel from the scrap. Typical flowcharts are schematically shown in Fig.1. Following aspects are noteworthy:

1) For the integrated route, an added value of a product grows along the production chain from raw material to final product, whereas specific weight of investment cost, energy and emission's intensity decreases in this direction.
2) Not only finished product but also intermediate items such as pellets, pig iron and

steel semis (e.g. ingot, slab, billet) are sellable on the market.

3) Raw materials and semi-products not necessarily have to be processed or manufactured at a given enterprise: pellets are commonly shipped from outside, steel semis might be produced at an enterprise or supplied from elsewhere etc.
4) Above features provide steelmakers with elasticity and enable optimisation of capital and operational expenses towards both - strategic vision and market conditions.
5) Core facility of an integrated enterprise - a blast furnace, producing molten pig iron[1] - is the most energy and carbon intensive link of the flowchart – not because it is obsolete but owing to physicochemical nature of reduction and smelting processes.
6) Non-integrated mills cannot fully substitute integrated ones owing to superior quality of product manufactured from primary materials and lack of scrap on a global scale.

All these aspects shall be taken into account when considering optimisation of industry's infrastructure. Moreover, to ensure environmental and economic sustainability and to stay competitive when energy and raw materials' costs are volatile, while the environmental requirements tighten, steelmakers have to reduce energy intensity and environmental impact (BCG, 2009).

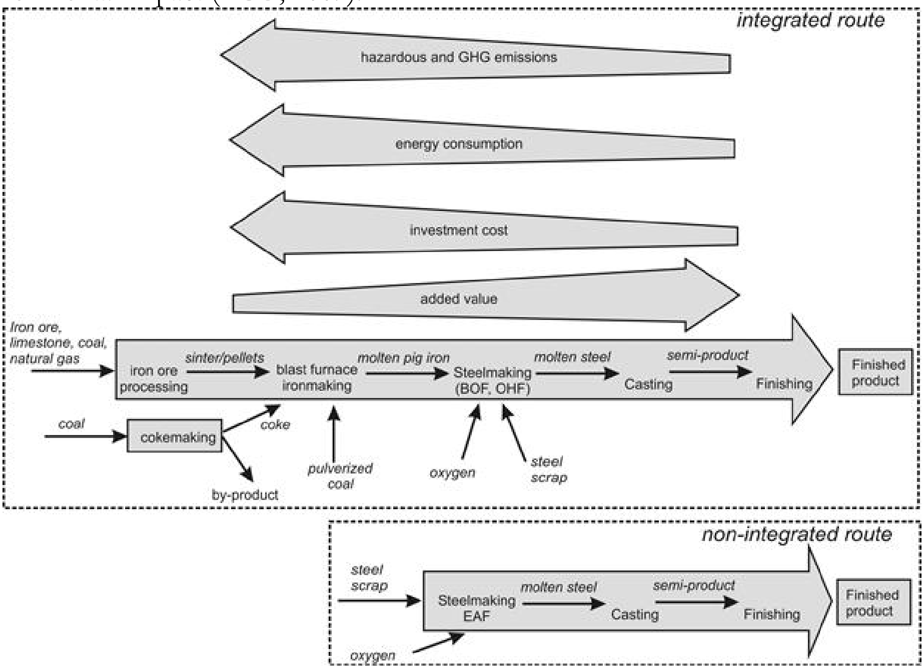

Fig.1. Steel production routes (BOF – basic oxygen furnace, OHF - open hearth furnace, EAF – electric arc furnace)

In this paper we analyse the experience gained in restructuring of the steel industry focusing on those Central-East European Countries (CEEC) and countries of former Soviet Union (FSU) where this industry, at least partially, retains integrated route. This

[1]An alternative option to process iron ore by making direct reduced iron (DRI) further smelted in electric arc furnace among the countries covered is used only in Russia where its stands for <10% of the market. For the brevity reasons it is not shown in Fig.1.

focus is explained by the fact that this route is globally responsible for 77.8% of production and 91.7% of CO_2 emissions of steel sector (Shatokha, 2016) and therefore is the most important for reaching sustainability targets. For the CEEC this study covers Czechia, Hungary, Poland, Romania and Slovakia, and for the FSU - Russia, Kazakhstan and Ukraine. Two of the countries in the regions concerned abandoned integrated route during transition - Bulgaria (in 2007) and Georgia (in 1993)[2] - and are not covered by this study.

3. Results and discussion

In the past, steel industry integrated countries of the Council of Mutual Economic Assistance (CMEA), notably, by exchange of cheap raw materials and semi-products from FSU versus finished products from CEEC. After breaking of cooperative links, rapid decline of military industry, shutting of infrastructural and housing projects etc the demand for steel shrunk drastically, causing spectacular drop of production - as seen from Fig.2 where steel output is shown starting from 1988 (virtually last high production year) through 2016. Further evolution of steel production depends upon the local and regional context and analysed in sections below.

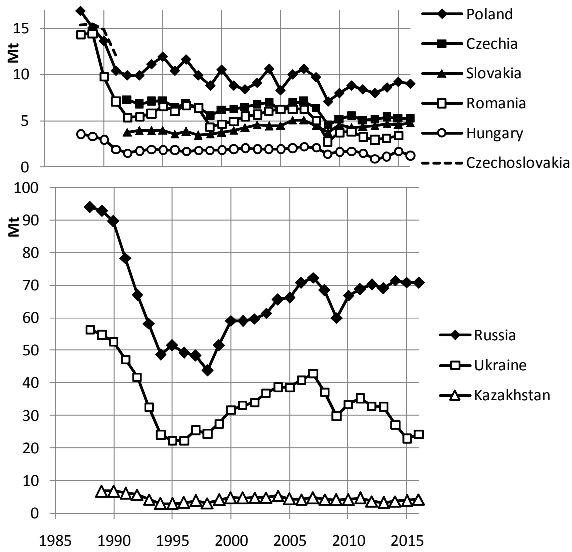

Fig.2 Evolution of steel production. Source hereinafter - author's elaboration on WSA (2017)

3.1 Patterns of transition

3.1.1 Former Soviet Union

In Russia and Ukraine voucher privatisation, uncertainty of ownership, barter trade, and capital leakage offshore impoverished steel industry by the end of 1st decade of transition (Durand, 2003; Hanzl & Havlik, 2004). Often privatization was deemed corrupt

[2] In 1999 Georgia also ceased to produce own steel. Bulgaria retains secondary steel production but the output shrunk by more than 80% from 1988 level.

with prominent example of Ukraine's largest steelworks Kryvorizhstal. In 2004 it was privatised through opaque scheme for just USD 0.8 billion. Under pressure of public society after Orange Revolution it was renationalised and sold in 2005 to ArcelorMittal at an open auction for USD 4.8 billion, being the most transparent privatization event in the sector.

Although, general post-soviet context in Kazakhstan was similar to Russia and Ukraine, one event was game changing - in 1995 the only country's integrated steelmaker was purchased by Ispat International company (since 2007 - ArcelorMittal) which became first large direct foreign investment in steel sector on the area from Prague to Vladivostok. Gradually foreign capital penetrated also to Ukraine's steel industry, whereas in Russia this sector still has exclusively domestic owners. Ownership and market share of integrated steel companies in FSU and CEEC are shown in Table.

Generally, it took 10-15 years for settling the ownership - a period when the owners focused on short-term goals, whereas long term approach for restructuring and development was missing. Currently, development strategies of steel companies are rather focused on corporate targets, not necessarily coherent with the national socio-economic goals. Strategic documents developed by state agencies, aiming to bring holistic vision for the industry's future, lack instruments to incentivise modernisation and remain rather declarations.

In FSU steel industry mainly uses own resources, abundant in all three countries, whereas CEECs largely import raw materials. Therefore, steel industry in FSU has very substantial infrastructural component of minerals processing. Steel companies in FSU are predominantly large vertically-integrated holdings covering production chain from mining through finished steel. Referring to Fig.1 it means that, inherently, specific weight of capital- and energy-intensive industries is higher in FSU, compared to CEEC. This feature implies higher domestic environmental impact; however, it assisted performance under conditions when often volatile raw materials' prices compete with cost of steel product, hampering profit.

Table: Ownership and market share of integrated steel companies in FSU and CEEC

Enterprise	Owner or major shareholder	Country of owner	Market share
Ukraine			
ArcelorMittal Kryvyi Rih	ArcelorMittal	India	21.8
Alchevsk Iron & Steel Works*	ISD**	Ukraine/Russia	12.2
Dniprovsky Iron & Steel			8.6
Azovstal Iron & Steel Works	Metinvest	Domestic	13.1
Ilyich Iron & Steel Works			14.7
Zaporizhstal Iron & Steel Works			11.2
Yenakiieve Iron & Steel Works*			8.5
EVRAZ DMZ Petrovskogo	EVRAZ	Russia	2.9
Non integrated	-	-	7.0
Russia			
Novolipetsk Steel	NLMK Group	Domestic	22.4
Magnitogorsk Iron & Steel Works	OJSC MMK Group		18.9
Nizhniy Tagil Iron and Steel Works	EVRAZ		6.1
West-Siberian Metal Plant			8.0
Chelyabinsk Metallurgical Plant	Mechel		6.0

Severstal	Severstal		22.4
Non integrated			16.3
Kazakhstan			
ArcelorMittal Temirtau	ArcelorMittal	India	91.9
Non integrated	-		8.1
Romania			
ArcelorMittal Galati	ArcelorMittal	India	60.0
Non integrated			33.0
Czechia			
ArcelorMittal Ostrava	ArcelorMittal	India	37.5
Třinec Iron and Steel Works	Moravia Steel	Domestic	55.5
Non integrated			7.0
Poland			
ArcelorMittal Dabrowa Gornicza	ArcelorMittal	India	46.7
ArcelorMittal Krakow			11.1
Non integrated			42.2
Slovakia			
Kosice US Steel	US Steel	USA	93.5
Non integrated			6.5
Hungary			
ISD DUNAFERR	ISD**	Ukraine/Russia	90
Non integrated			10

*since 2014 these enterprises are on the territory out of Ukraine's governmental control
** ISD Corporation is headquartered in Kyiv, Ukraine; however, 50% + 2 shares of its steelmaking assets were sold in 2010 to a group of investors linked to Russian EVRAZ

Despite complexities of transition, from 1997 remarkable growth of steel production, mostly enabled by global demand for steel, is observed in FSU with peak in pre-crisis 2007 for Russia and Ukraine. Financial crisis downed production by 17% in Russia and 30% in Ukraine in 2009 compared to 2007. During next 2-3 years the production partially recovered, but then stagnates in Russia and declines in Ukraine owing to ongoing military conflict.

Before 2008 Russian steel holdings actively acquired foreign assets, often with the help of loans. During last few years, withdrawal from some of earlier acquired assets, notably in CEEC, became more prominent trend. After aggression to Ukraine in 2014, financial sanctions imposed by the USA, the EU, Japan, Canada, and Australia impede crediting of new acquisitions and of new projects by Russian companies (INFOMINE, 2014).

Nowadays international steel trade is constrained by declined demand and huge overcapacity: global capacity utilisation in 2015 reached its lowest during last decade level of 68.7% (WSA, 2017). Domestic consumption in Russia stagnates owing to financial situation caused by falling oil prices.

Euro-Asian Economic Union (EAEU), bringing back together Armenia, Belarus, Kazakhstan and Kyrgyzstan, is seen by Russia's government as geopolitical instrument for recombining self-sufficient supranational economy: e.g. the Eurasian Economic Commission report (EEC 2015) recommends to cut the share of steel import from 'third' countries (now ca 40%) to the EAEU to increase capacity utilisation.

Ukraine escaped involvement to the EAEU thus depriving this union's ambition. Since January 2016 it participates in the EU-Ukraine Deep and Comprehensive Free Trade

Area. DCFTA aims to boost trade in goods and services between the EU and Ukraine by gradually cutting tariffs and bringing Ukraine's rules in line with the EU's (European Commission, 2017). Currently, the EU is Ukraine's largest trading partner, accounting for more than 43.8% of its trade in 2016 with iron and steel products accounting for over 23.5% of exports (Klympush-Tsintsadze, 2017).
The military conflict lasting since 2014 brought as much as 20% of production capacity out of government control (see Table 1). In 2015 Ukraine's steel output was down by 30% compared to 2013, although recovered in 2016 by 5.4% year on year. All iron ore mining & processing industry is located on the territory under governmental control, but many coal mines, notably producing hard coking coals, and nearly a half of total coke production capacity are on the occupied territories.

3.1.2 CEEC

In early 1990s high production levels and low prices in CEEC were deemed risky by the EU15 steel industry, who lobbied conditioning of EU accession on downsizing of steel industry which became major driver for transition, formalised in 1993 as additional protocols to the Europe Agreement with Poland and Czechia (Trappmann, 2015). In Romania, restructuring strategy also stipulated capacity reduction. Validated by the European Commission in context of the Accession Treaty it was completed by 2010 (European Commission, 2010). Apart of capacity reduction, any social, technological and environmental issues had to be solved in compliance to the EU rules of state aid and environmental and occupational health & safety legislation (Hanzl & Havlik, 2004; Trappmann, 2015).
Although in the CEEC governmental privatisation policies placed emphasis on foreign partners, capable to bring funding and new technologies (Deutsche Bank Research, 2004), large EU groups did not entered CEEC steel industry, most of which was acquired by ArcelorMittal during 2001-2007. Largest Slovak steelworks in 2000 was acquired by US Steel[3]. Only Czechia has an integrated enterprise with domestic owner. During this transition many steelworks were downsized, some ceased to produce primary steel or even closed.
Comprehensive analysis by Trappmann (2015) shows that the role of the EU in guiding the restructuring of steel sector in CEEC was controversial, although finally it resulted in modernisation of steel mills, which would otherwise not compete on the European and global market.

3.2 International trade and domestic consumption

Development patterns of international trade in FSU and CEEC after separation are very different. Worth noting that, fostered by foreign direct investments, transition of machinery manufacturing sector in CEEC was more successful than of steel industry, whereas in FSU transition of manufacturing was even worse than of steel industry (Hanzl & Havlik, 2004). E.g., in Ukraine during 1990-2000 share of steel sector in

[3] According to MoU of January 2017, US Steel sells Kosice mill to He Steel Group (China). Slovak government pledged to buy 34% share to prevent closure of enterprise. It relates to Trump's administration plan to impose a 41% tax on US companies doing business abroad and to offer tax relief if they return business to US (The Slovak Spectator, 2017).

industrial gross value added grew from 11% to 27.4%, while share of machinery manufacturing sector was down from 30.5% to 13.4% (Efimenko et al, 2010). Therefore, as shown in Fig.3, indirect steel export (i.e. export of steel-made goods) even in absolute figures for CEECs is higher than for FSU. With respect to the size of economies the success of CEECs is obvious: Poland even became 8th world's biggest indirect steel exporter. Larger specific weight in the economy of steel-consuming industries in CEEC assisted creation of the economy where machinery manufacturing delivers more added value with less environmental impact.

The apparent steel use[4] per capita in CEECs grew almost steadily, exceeding in 2007 level of 1993 by 210-340%. In Russia and Kazakhstan this indicator just recovered before crisis, whereas in Ukraine[5] it shrunk by 60% (Fig.4).

Without sound restructuring strategy, Russian and Ukrainian industry owners generally tried to stay as large as possible. With declined domestic demand they emphasised international trade and became world-leading steel exporters with export far exceeding import. Instead, almost all CEEC (Slovakia is the only exception) became net steel importers.

Noteworthy, structure of export is very different for the two groups (Fig.5). Over 50% of Russian and 45% of Ukrainian exports are ingots and semi-product, whereas for CEEC this share is less than 15%. Moreover, for Russia and Ukraine the share of semi-products in export tends to increase, while for most of CEEC it shrinks or fluctuates at very low level. Kazakstan with its 17% of ingots and semis in export is closer to CEEC than to its FSU counterparts. Obviously, in FSU export is exclusively based on local production of crude steel, whereas CEEC export largely involves product of imported semi-products' processing.

Referring to Fig.1, it is possible to summarise that the restructuring drove CEEC to an economic model where value-added finishing dominates over energy-intensive and polluting production of semis. Coupled with robust domestic steel consumption it delivers economically viable, technologically flexible and more environmentally clean model.

Currently, in Ukraine and Russia domestic consumption of produced steel declines reaching 56% for Russia and just 15% for Ukraine in 2015. It increases vulnerability of sector in these countries to situation on the global market. In Kazakhstan domestic consumption is more robust and stable at the level of about 80%. In CEEC domestic consumption of steel products exceeds production of crude steel with only exception for Slovakia which consumes domestically only 47% of steel produced (WSA, 2017).

During years of transition both Russia and Ukraine accumulated large delayed demand for replacing depreciated steel-made structures in industry, transport, municipal sector etc estimated at 330 Mt for Ukraine (Amosha et al, 2013) and at 170 Mt for Russia (Ivanova, 2013). Hence both countries have very high potential to enhance domestic consumption: e.g. value of delayed demand in Ukraine exceeds ten years' steel output with full capacity utilisation.

[4] The mathematical sum of production plus imports minus exports.

[5] In 1992 apparent steel use per capita in Ukraine was among the world's highest behind only Singapore, Taiwan, Japan and South Korea.

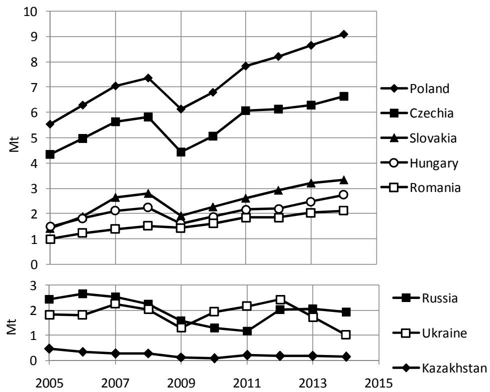

Fig.3. Indirect export

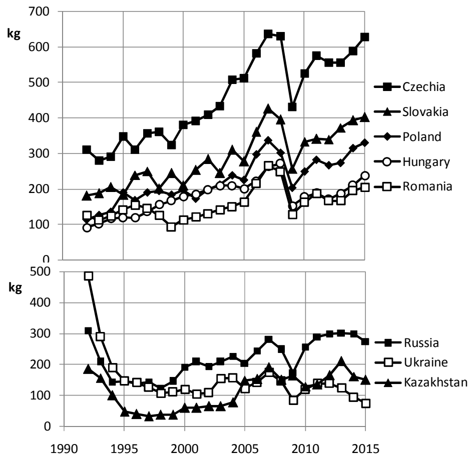

Fig.4 Apparent steel use per capita

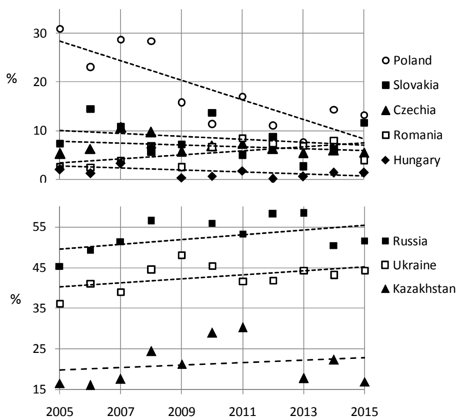

Fig.5 Share of ingots and semi-products in export

3.3 Modernisation

Detailed analysis of modernisation goes beyond the scope of this paper. Here we observe penetration of only two best available technologies (BAT) both symbolising global modernisation trends - substitution of open hearth furnaces (OHF)[6] by basic oxygen furnaces (BOF) and of ingot casting by continuous casting[7]. As shown in Fig.6, all CEEC managed to decrease share of OHF rapidly and finally got rid of this technology. Partially it was achieved by new projects; however, essential role played also shutting of obsolete capacities in the process of restructuring and downsizing of the industry. Kazakhstan succeeded even better, eliminating OHF by 1998 - earlier than Czechia, Poland and Romania (Slovakia had no OHF from the start). In Russia pace of modernisation was comparable to CEEC, however it started from worse position and hence achieved the result 15 years later. Ukraine from similar starting position made much worse progress: significant drop of OHF share is observed only during crisis of 2008-2009 when more than a half of OHFs were shut down thus eliminating excessive production capacity (Shatokha, 2015).

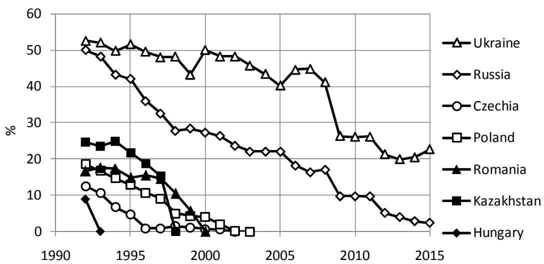

Fig.6 Share of OHF method in steel production

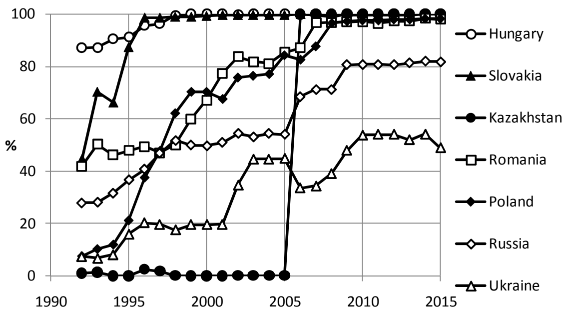

Fig. 7 Share of the continuous casting in steel production

For penetration of continuous casting (Fig. 7), generally, more rapid change is also observed in CEEC; however, Kazakhstan jumped from 0 to 100% in just one year. In Ukraine and Russia brief and modest progress during first decade of transition was achieved largely by shutting most obsolete facilities. Then stagnation for 6-8 years is observed followed by moderate growth exchanged with long term stagnation in both countries. Finally, Russia achieved better result than Ukraine but almost within the initial margin.

Generally, judging from the results shown in Fig.6-7, CEEC and Kazakhstan better succeeded in modernisation of industry towards the world's best standards, Russia's progress is more modest and Ukraine achieved results the worst.

During 1st decade after purchasing steelwork in Temirtau ArcelorMittal invested US$ 1.5 billion to modernisation, and then continued to invest ca US$ 110 per tonne of steel as yearly average (KazWorld, 2017). During 2005-2012 Russia's steelmakers invested nearly

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[6] OHF is now obsolete steelmaking technology. Energy consumption of OHF is ca 35% higher than of BOF. Worldwide only 0.5% of steel is produced in OHFs (WSA, 2017).

[7] Casting is a process when molten steel solidifies to semi-product. Continuous casting since 1950s gradually substitutes casting to stationary molds. It saves ca 50% of energy directly with more saving achieved by increased yield. Worldwide 96.1% of steel is continuously cast (WSA, 2017).

US$ 8 billion per year average (ca US$ 80-90 per tonne of steel). Ukraine in the same period invested less to modernisation: investments peaked in 2007 at a level of US$ 47 per tonne of steel with the average level of about US$ 25 per tonne of steel (Shatokha, 2015). Obviously this level of investment was far from sufficient, hence the energy intensity of Ukraine's iron & steel industry remains among the worlds' highest: the potential to reduce energy consumption via the BAT deployment for Ukraine exceeds 7 GJ per tonne of steel, whereas for Russia it is 4 GJ and for OECD Europe countries - below 2 GJ (OECD/IEA, 2014).

3.4 Climate policies and competitiveness of steel industry

The iron and steel sector contributes about 7% to global anthropogenic and 30% of industrial greenhouse gases (GHG) emissions (OECD/IEA, 2014). Therefore participation of this sector in reaching the environmental targets is very important.

3.4.1 EU steelmakers

Under Paris Agreement CEECs have to contribute a collective EU target of reducing GHG emissions by at least 40% from 1990 level (UNFCCC, 2015). Hence in this section we analyse not only CEEC but wider EU context.

In the EU iron and steel sector accounts for 21% of total industrial CO_2 emissions (Croezen & Korteland, 2010) and, hence, is important for reaching the climate change mitigation goals. This sector is covered by EU Emissions Trade Scheme (EU ETS), designed to incentivise modernisation by setting a cap on freely allocated emissions. However, steel industry is categorised as vulnerable to carbon leakage (i.e. to relocation to countries with less stringent climate policy) and receives 100% of free allocations. Hence, so far sector's performance was not essentially affected by the EU climate policy and this situation will remain in place until the end of 3rd EU ETS phase in 2020.

Legislative proposal of the European Commission (European Commission, 2015) for post-2020 EU ETS reform envisages revision of the free allocations approach for industry. Owing to several structural changes, carbon prices may rise significantly towards 2030, while the availability of free allowances for vulnerable to carbon leakage sectors (including iron and steel) will be more limited. Estimation made by Ecofys (2016) shows that these changes may translate to carbon cost of €6 per tonne of steel in 2021 and to €23 - in 2030. In October 2016 CEOs of all EU steel companies signed an Open Letter to heads of state and government leaders arguing that the proposed EU ETS reform beyond 2020 creates costs for EU steelmakers that are not borne by global competitors putting jobs and investment in EU steel sector under risk (Eurofer, 2016).

Indeed, most of EU steelmakers, including those in CEEC operate very close to the theoretical carbon emissions intensity limit of current technologies and further reduction of GHG emissions using BAT might cost too much compared to other competitors. Some innovative and breakthrough solutions, developed under aegis of the Research Fund for Coal and Steel and of the European Commission, are widely considered among the key approaches for reducing GHG emissions beyond possibilities of current technologies. However, despite the expectations, none of them has been proven industrially so far.

In particular, the Top Gas Recycling Blast Furnace project capable of reducing CO_2

emissions per tonne of final product by 15% (van der Stel, 2013) was expected to reach demonstration level in 2015. If happens, this would be the first large-scale industrial project with Carbon Capture and Storage co-funded under the EU NER300 programme. However, it was suspended in 2013 owing to withdrawal of ArcelorMittal (NER300, 2012). Another key technology HiSarna, innovative smelter capable of reducing CO_2 emissions by 20% (Croezen & Korteland, 2010), developed by consortium of prominent EU industrial and R&D companies under leadership of Tata Steel IJmuiden, planned to reach demonstration level in 2018 with commercialisation planned after 2020 (Meijer et al, 2015). However, we found no promising signals to confirm this schedule in the literature available.

As shown in our previous paper (Shatokha, 2016) a delay in deployment of these or other key low-carbon technologies will result in GHG emissions higher than envisaged by carbon budget consistent with the trajectory leading to limiting of global warming within 2°C during this century.

3.4.2 Steelmakers in FSU

Ukraine ratified Paris agreement in September 2016 and committed to reduce GHG emissions at least by 40% in 2030 compared to 1990 (UNFCCC, 2015). In 2014 Ukraine`s GHG emissions were down by 63% below 1990 levels, hence the target is not ambitious. Moreover, Ukraine will revise this target after the restoration of its territorial integrity with account for renovation of the damaged infrastructure. In 2013 iron and steel sector accounted for 30.6% of country's industrial CO_2 emissions (Shatokha, 2015).

Ukraine applies tax on CO_2 emissions of 0.37 UAH (ca US$ 0.015) per tonne set for 2017 (Taxation code of Ukraine, 2017). Obviously this amount is not sufficient to incentivise modernisation. With current production and emissions level it translates to ca US$ 0.7 million of taxes collected from the sector per year which is negligible also for supporting any state funded environmental programmes.

Ukraine is going to actively participate in current and future international carbon market mechanisms. So far Ukraine was the prominent EU partner for international carbon schemes: as much as 77% of Emission Reduction Units (ERU) exchanged for EU ETS allowances since 2014 originate from Ukraine (European Commission, 2016). Ironically, in future, its huge potential for cutting the CO_2 emissions may help modernise Ukraine's industry using international carbon trade schemes, if other factors to attract investors will be in place. Moreover, with obsolete capacities Ukraine's steelmakers might be less reluctant to deploying most innovative technologies compared to their CEEC counterparts whose capacities have not reached the final depreciation limit.

Russia and Kazakhstan have not ratified Paris Agreement so far (as of April 2017).

Russia pledged to reduce GHG emissions in the range from 25% to 30% below 1990 levels by 2030 (UNFCCC, 2015). It has neither cap-and-trade system nor taxation for CO_2 emissions even under consideration.

Russian State statistics doesn't distinguish ferrous and non-ferrous metallurgy, providing a total figure for metallurgy sector of 41.6% from total industrial GHG emissions in 2016 (Rossstat, 2016). Judging from previously reported proportion between emissions of these two sub-sectors (Golub, 2007), the share of iron and steel sector in total industrial GHG emissions can be estimated ca 19%. All major steel companies are included to the list of systemic organisations entitled for the state aid; hence, it is unlikely that they will be seriously affected by climate policy (EEC, 2014). Moreover with opaque approach to accounting emissions of the forestry sector, the real emissions from industrial sector may even increase, while Russia will fulfil formally its climate commitment, using currently undefined absorbing capacity of forests (Climate Action Tracker, 2017).

Russia also actively develops innovative technologies with high potential to curb CO_2 emissions such as e.g. Romelt, analogous to HiSarna and capable to produce pig iron from low grade iron ore and coal. Having relatively modern own production facilities, Russia seeks to commercialise Romelt abroad: commissioning of first industrial plant erected in Myanmar was delayed several times and is expected in 2017-2018 (Myanmar Industry Portal, 2017).

Kazakhstan pledged to reduce GHG emissions by 15% below 1990 levels by 2030 (UNFCCC, 2015). Its steel sector accounts for 8.9% of industrial CO_2 emissions (Ministry of Energy, 2014). Kazakhstan was the first country in Asia to implement an economy-wide ETS in 2013 covering steel sector among the others. However, since February 2016 ETS is suspended until 2018 following complaints from industry that the emission reduction demands under the system are too strict and the legal basis is too weak. The market has been over-allocated in the first three years after its launch, with prices ranging from $0.20 to $4 per tonne of CO_2 (Carbon Policy Observer, 2016).

Generally, it is possible to summarise that to date iron and steel sector in the countries covered in this study was not affected essentially by climate policies and currently industrial lobby seeks to protect sector's privileges also beyond 2020. This policy prevents industry from leakage, although hampers incentive to deliver low-carbon technologies to the market fast enough to bring emissions on the trajectory consistent with climate targets.

Conclusions

1. Specific weight of capital- and energy-intensive raw minerals' processing industries is higher in FSU, compared to CEEC. This inherent feature implies higher domestic environmental impact although assists performance under conditions of volatile raw materials' prices.
2. In the restructured steel industry of the CEEC a value-added finishing dominates over energy-intensive and polluting manufacturing of semi-product. Coupled with robust domestic steel consumption it delivers economically viable, technologically flexible and more environmentally clean economic model.
3. Decline of steel consumption in Russia and, especially, in Ukraine increases vulnerability of the sector in these countries to global demand for steel. In Kazakhstan domestic consumption is more robust and stable. In CEEC domestic steel consumption exceeds production of crude steel with only exception for Slovakia.
4. Specialisation of CEEC in finished items and of FSU in semi-product deepened: the share of value-added product grows in CEEC and declines in FSU.
5. CEEC and Kazakhstan better succeeded in modernisation of industry towards the world's best standards, Russia's progress is more modest and Ukraine's achievements are

the worst.
Political crisis of 2014 and Russia's aggression in Ukraine split driving vectors of transition: Russia tries to develop self-sufficient market recombining supranational economic relationships within the EAEU, whereas Ukraine explores challenges and opportunities of participating in the DCFTA.
6. To date iron and steel sector in the countries covered in this study was not affected essentially by climate policies. Currently industrial lobby seeks to protect sector's privileges beyond 2020. It hampers incentive to deliver low-carbon technologies to the market fast enough to bring emissions on the trajectory consistent with climate targets.

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