



Executive
Perspectives

War in Ukraine: Industrial Sector Impact

BCG Global Advantage & Industrial Goods Practice Areas

Prepared: 14 April 2022

Introduction to this document

The war in Ukraine is above all a political and humanitarian crisis...

Russia's invasion of Ukraine has led to a serious **humanitarian crisis**. BCG condemns this attack and the violence that is killing, wounding, and displacing so many people.

The top priority in moments like these must be the **safety and security of people**. Corporates, governments, and non-for-profit organizations should focus on supporting the people in Ukraine, Russia, Europe, and globally affected (physically and mentally).

...but is already impacting the global economy through the industrial sector

It is the duty of political, societal, and business leaders to navigate through this crisis. **The intent of this document is to inform discussions and decisions on the global economic impact as well as the industrial sector impact of the war in Ukraine.**

The situation surrounding Ukraine is dynamic and rapidly evolving - this document reflects information and analysis as of **14 April 2022**. It is not intended as a prediction of future events and is shared only as a resource for BCG and client conversations.

BCG Executive Perspectives

IN THIS DOCUMENT

IMPACT ON INDUSTRIAL SECTOR

Russia's invasion of Ukraine is exacerbating a crisis among industries that were already struggling to cope with supply chain bottlenecks, soaring costs, and critical material shortages stemming from the pandemic. The ripple effects could include reduced automobile production, delays in big infrastructure projects, major shifts in global trade, and a food crisis in Africa.

Sectors that rely heavily on materials and natural gas from Russia and Ukraine are among the hardest hit. Global agriculture, for example, was under stress prior to the war because of high fertilizer prices. The war is driving up fertilizer costs even further, causing the biggest leap in food prices since 1990. The impact is especially dire in Africa, which imports much of its wheat from the two countries. Disruption in supplies of pig iron, semifinished steel, and natural gas will hobble production of finished steel. This, in turn, could affect major construction projects worldwide and automakers in the EU.

In other sectors, such as chemicals and transportation, war-related supply shocks could be more manageable as companies gradually shift to Asian and North American sources of energy and materials. As a result, an increased number of goods are likely to travel via ocean freight. And higher hydrocarbon costs could make green energy solutions more attractive across industries.

War in Ukraine: Industrial Impact

AGENDA

Perspective on industrial sector impact

- Cross-industry trends
- Selected sector impacts
- Implications for leaders

Summary | Industrial Trends & Implications of the War in Ukraine

Cross-industry trends

This is a crisis on top of existing crises (e.g., Covid, supply chains), exacerbating price increases (e.g., oil & gas, fertilizers) and existing supply chain shortages (e.g., semi-conductors)

Critical industrial sectors exposed to rising costs and supply shortages (e.g., food crisis), but **manageable risks** and business upside for some segments (e.g., ocean freight, Greentech, clean energies)

Sector implications

SECTOR IMPACT

Critical
Manageable

Agriculture | Food crisis driven by price and supply shock, compounded by high fertilizer prices and risking severe socioeconomic consequences, especially in Africa & Middle East

Raw Materials | Scarcity of raw materials causes specific sector impacts (e.g., Steel) and second-order effects reach end users

Construction | Higher input costs & supply chain bottlenecks drive delays, and hinder infrastructure-led recovery

Chemicals | Manageable global impact of high input costs, but vulnerability and second-order impact for downstream chemical players and customer industries if potential cuts in Natural Gas supplies were to materialize

Automotive | Limited direct global sales impact; rising material, energy, labor costs stress supply base

Transportation | Change in trade patterns to cause modal shift to ocean freight and sustaining high rates

Greentech & Sustainability | Opportunity to accelerate adoption driven by energy independence, relatively more attractive economics, but constrained by supply in the short term

Implications for leaders

Business | Understand exposure and respond with contingency plans, proactively manage 360° risks, invest in resilience and review long-term strategy including geopolitical risk

Policymakers | Shape evolving situation, plan for socioeconomic resilience and review long-term industrial strategy & sector-specific policies

War in Ukraine: Industrial Impact

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Perspective on industrial sector impact

> Cross-industry trends

> Selected sector impacts

> Implications for leaders

War in Ukraine is a crisis on top of existing crises

EXAMPLES, NOT COMPREHENSIVE

Industrial sectors already under pressure...

... and War in Ukraine added further stress

Supply chain bottlenecks



Automotive sector already affected by '21 chip shortages

11.3M units of **production lost** in 2021 from **chip shortage**¹

Added threat to semiconductors as Ukraine produces a key input

~70% of **global Neon gas**, a critical **semiconductor component**²

Rising prices



Agriculture sector had been facing surging fertilizer prices from demand, supply chain disruptions, energy prices, etc.

+210% in **Ammonia fertilizer prices** (Sept 2020 – Sept 2021)³

Fertilizer prices continue to rise, as Russia, Ukraine & Belarus are significant exporters, already exacerbating the global food crisis

+45% in **prices** since War started; prices now **3-4x higher than in 2020**⁴

Geopolitical uncertainty



Businesses grappling with trade conflicts & geopolitical tensions

~33% of Supply Chain Leaders moved business out of China (or plan to by '23) given need to **build resilience & avoid tariff costs**⁵

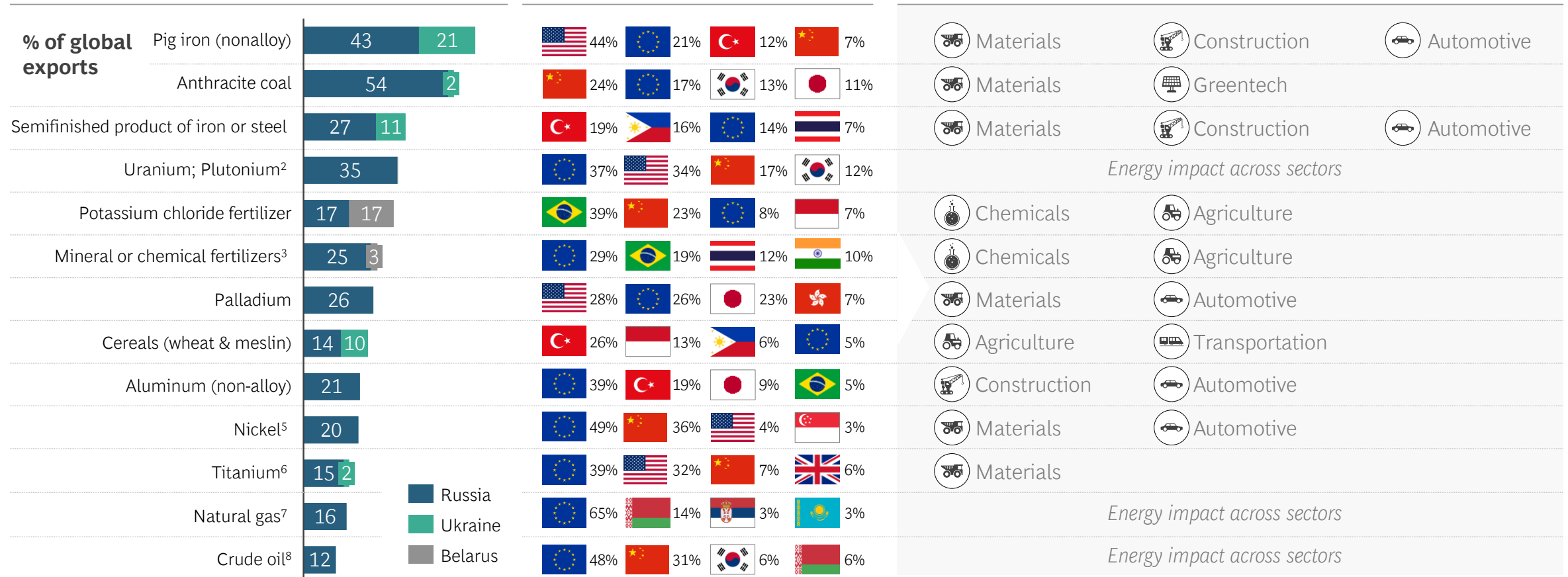
Added pressure for companies exposed to **sanctions, with assets exposed, and further global decoupling**

Negative industrial impact for sectors whose inputs are exposed to rising costs and supply shortages

Raw materials with high exposure¹




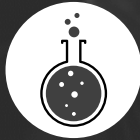


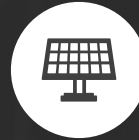























Top export markets

Industries primarily impacted



Note: Trade data from 2019; Based on HS6 level except for Nickel at HS4 level (7501,7502) Filtered for products w/export value >\$1B; Where no value for BY or UA; <1% of global exports 1. Analysis based on HS6 codes: 270111, 720110, 284420, 720711,711021, 310520, 750210, 760110, 310420, 271121, 100199; 2. And its compounds 3. Mineral or chemical fertilizers containing nitrogen, phosphorous, potassium; Russia indicated they might halt exports; 4. Excludes impact of indirect sanctions i.e., on financing, transport, and sanctions on individuals 5. Hs4 level data (7501,7502) 6.Titanium on HS4 level (8108), OEC data 7. In gaseous state Source: USGS, FAO, UN Comtrade, EIA, OEC World, BCG Analysis, Web search 8. Source: STATISTA 2020, EU includes UK, EIA, US Energy Information Administration, web research

Different implications across industrial sectors

Impact	Critical			Manageable			
	 <p>Agriculture</p> <p>Global food supply and price shock; obstacles to adjust short-term production</p>	 <p>Materials</p> <p>Scarcity of raw materials causes specific sector and second-order industrial impacts</p>	 <p>Construction</p> <p>Materials disruption and higher input costs cause large-scale projects delays</p>	 <p>Chemicals</p> <p>Manageable global risks, but vulnerability to potential cuts in Natural Gas</p>	 <p>Automotive</p> <p>Limited direct global sales impact; rising material, energy, labor costs stress supply base</p>	 <p>Transportation</p> <p>Trade changes drive route shift and higher costs; opp. for ocean freight players</p>	 <p>Greentech & Sustainability</p> <p>Short-term shortages but not rare earth; opp. to minimize energy dependency</p>
Trends							
 Supply disruption				 <i>Risk if potential NG¹ supply cuts</i>			
 Substitution complexity							
 Price volatility							
 Opportunity in response							

1. Natural Gas. Source: BCG analysis and experience

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Perspective on industrial sector impact

› Cross-industry trends

› **Selected sector impacts**

› Implications for leaders



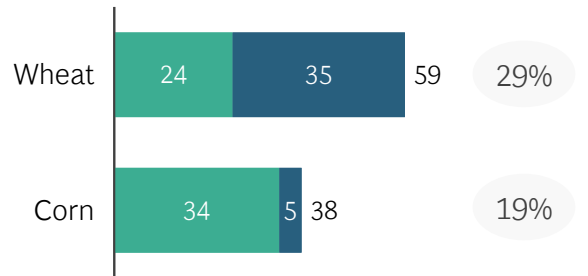
Agriculture | War-based shock compounds food security crises, exacerbated by droughts in Africa, Middle East, and Central Asia

Exposure of global cereal & fertilizer exports

Example: Cereals

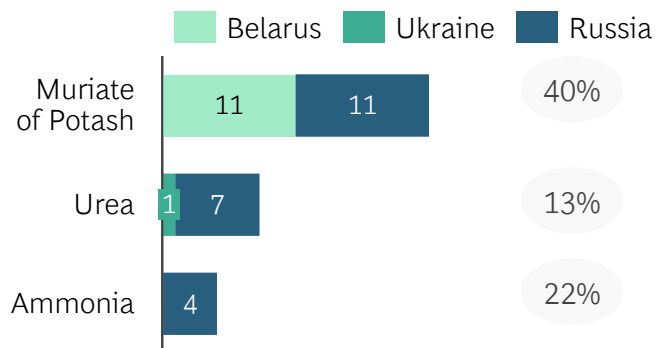
Volume of exports (M ton)

% of world exports



Example: Fertilizers

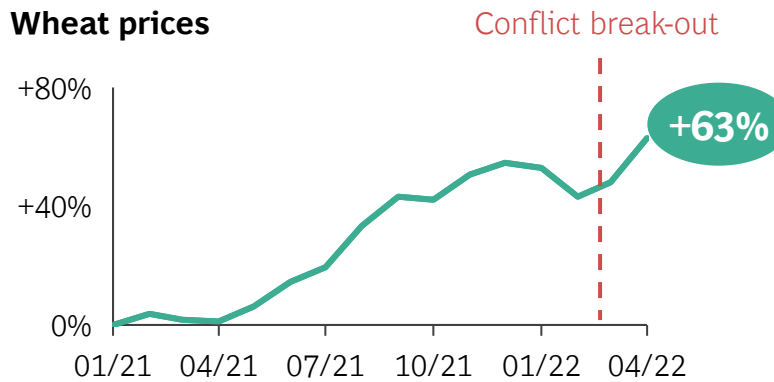
Volume of exports (M ton)



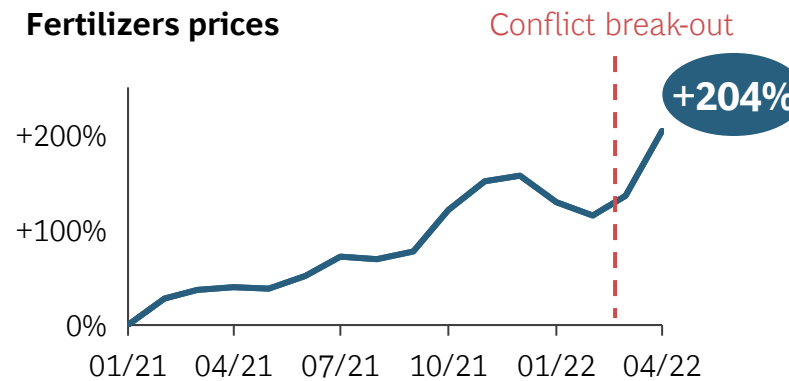
Exacerbation of pre-War price increases

Change in price since Dec. 2020

Wheat prices



Fertilizers prices

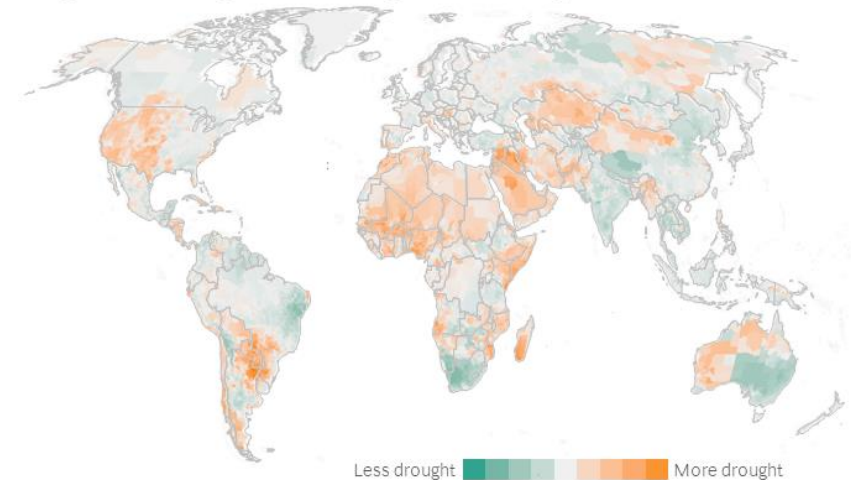


Africa, ME, and CA face historic droughts



Severe droughts in Africa & MENA compound import & local supply shock

Agricultural regions are facing historic drought levels



However, other markets with **record harvests** (e.g., India, Australia) may balance supply gap



Agriculture | Food and fertilizer challenges drive second-order implications

First-order impact

Food shock



+13% food prices increase, highest FAO Food Price Index since inception in 1990¹

Food quantities unavailable, and obstacles to local substitution (e.g., Africa & ME where 50% of cereal imports come from Ukraine/Russia²)



Reinforcing loop

Fertilizer crisis



+40% increase in **fertilizer prices**³

Farmers to **minimize fertilizer use** and pivot to fertilizer-light crops

Compounding effect of other shortages (e.g., fuel) to **limit farmer spending**

Second-order impact

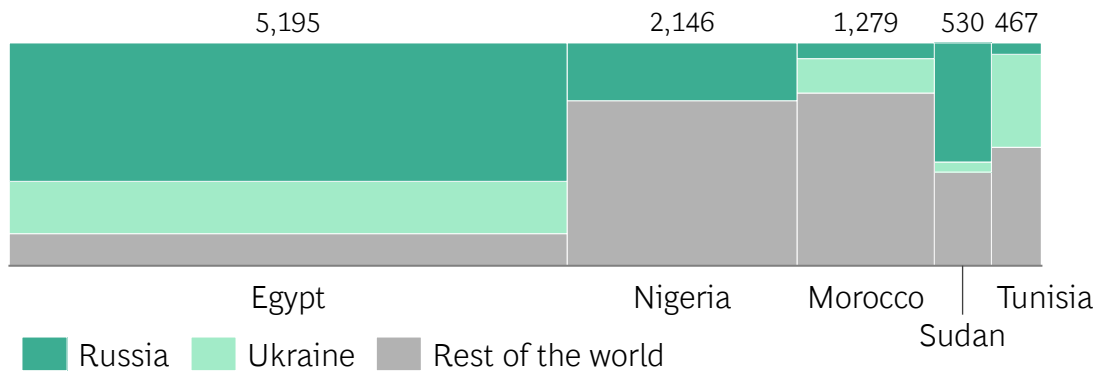
- **Change in trade patterns**
- **Shock to livestock** prices & production
- **Shock to household spending** (e.g., 43% of family income spent on food in Africa⁴)
- **Potential social tensions**, as 276 M+ people are facing acute hunger and 44 M are on the brink of famine⁵



Agriculture | Potential food security crisis in Africa with deep humanitarian implications

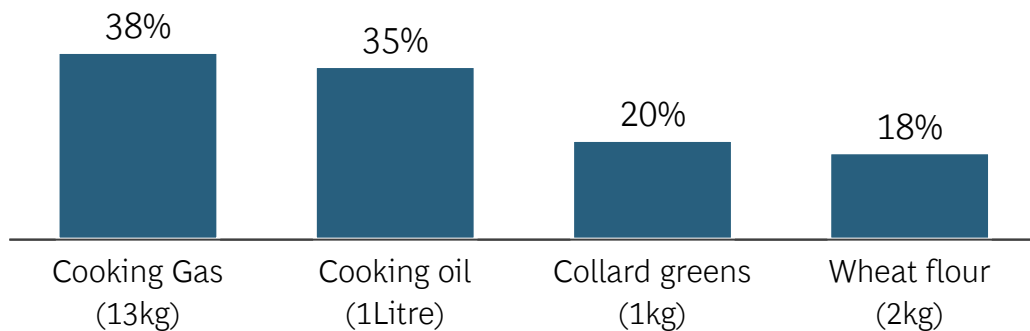
Africa exposure to Russia and Ukraine

Example: Wheat imports (Million Ton)



Countries already experiencing high price increases

Example: Food prices in Kenya (% increase, March 2022 vs 21)



Source: OEC; WTO; BCG Analysis and case experience

Potential humanitarian crisis in Africa



Strong impetus to **shift staple foods to locally grown cereals** (e.g., millet, sorghum)



Outsized economic and social development impact given high proportion of income going on food spend



Pressure on government investment in other priorities (e.g., education, health, debt reservicing)



Lower effectiveness of humanitarian aid given Ukraine is a major supplier for World Food Program (+50% wheat supplies)



Materials | Commodities shock with second-order industrial impact, but also influenced by balancing factors such as mining output substitution

Raw material shocks lead to 2nd-order impacts across industrial uses

Material	Exposure of global exports ¹	Use in components & end products
Pig Iron	64%	Steel, structural components
Anthracite Coal	56%	Power generation, residential/comercial heating
Semifinished iron and steel	38%	Steel, structural components, electromagnets
Uranium; Plutonium	35%	Electricity, radioisotopes used in medical and defence industries
Potassium chloride	34%	Fertilizers, medications
Palladium	26%	Process catalysts, Electrical Components
Aluminium	21%	Cables, electrical components
Nickel	20%	Steel products , EV batteries
Titanium	17%	Electronic circuits, heat exchangers, paint
Natural gas	16%	Key industrial heating & energy source, chemical feedstock

1. Russia, Ukraine, Belarus share of global exports per material (see pg. 9 for detailed references)
Note: Only significant commodities included. Source: Expert inputs; BCG Analysis & experience

Supply risks...



Conflict-driven **production disruptions** and **extended trade restrictions**



Physical inability to transport and **high freight rates**

...but also balancing factors



Substitution by global mining & materials players ramping up production (e.g., critical minerals & materials)



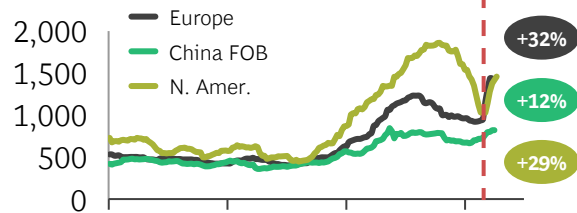
Potential demand reduction due to parallel factors reducing strain on markets (e.g., interest-rate driven decrease in capex investments)



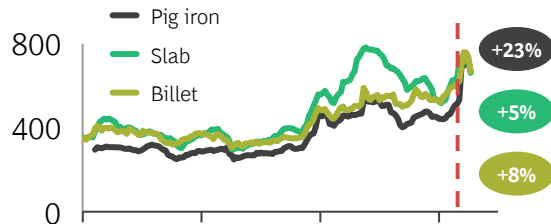
Steel deep-dive | Most impact on EU rerollers and USA EAF² mills; Natural gas potentially unviable in EU to bridge green steel transition

Higher prices & costs...

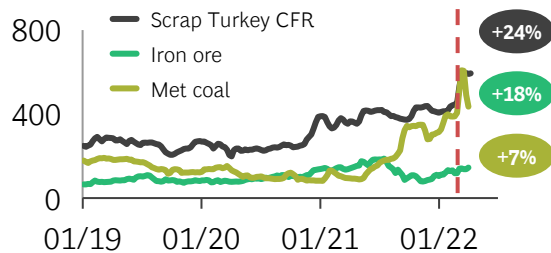
Steel HRC prices (€/t) Conflict break-out



Semis and pig iron prices (€/t)



Raw material prices (€/t)



...with varying impacts across steelmaking regions

First-order impact

European Union



Semis crunch impacting **reroller production** and leading to increase in HRC¹/plate prices

EAFs² were already suffering from high power and metallics costs, **crisis worsens cost position**

USA



Shortage of virgin metallics like pig iron/DRI³ for EAFs to produce high quality products

New avenues need to be explored to supply **increasing fleet of flat steel EAF capacity**

China



Potential **redirection of Russian semis and finished steel exports** to China

Low domestic steel prices mean room for arbitrage for **exports to EU despite duties**

Others



Low-cost Asian mills eye lucrative western markets to fill supply void of Russian exports

Domestic markets of countries neutral to Russia could **see influx of Russian imports**

Second-order impact

Producers

High NG⁴ prices make **DRI production with NG potentially unviable in EU**. DRI imports from **regions with low NG cost** an alternative solution.

EU players could **accelerate green H2 DRI production** by leveraging support under **REPowerEU**

Users

Looming shortage of steel for wind towers putting EU's renewable push at risk

Series of supply chain shocks (like current crisis, covid, Suez blockage etc.) could lead to **increased regional sourcing by end users**

1. Hot Rolled Coil 2. Electric Arc Furnace 3. Direct Reduced Iron 4. Natural Gas. Source: Kallanish, S&P; BCG Analysis and case experience



Construction | Most impact on public & large-scale infrastructure, potentially hindering economic recovery efforts

First-order impact

Material costs increase driving:

- Terms renegotiations in multi-year contracts
- Substantial delays in new bids
- Players withdrawing from new bids limiting price competition

Localized impact:

- Global impact exacerbated local shortages (e.g., ~100k Ukrainian workers returning from Poland)

Second-order impact

➤ **Limited effectiveness** of public infrastructure as **channel for economic recovery support**

➤ **Potential crowding-out effect** in infra investment if **interest rates increase** substantially

➤ Higher attractiveness of **green energy solutions**, especially for residential projects and building operation (e.g., solar panels vs fuel-based electricity)



Public infra. & commercial constructions



Residential construction



Residential renovation

Limited impact, minor delays due to already existing and exacerbated supply bottlenecks

Minor "wait-and-see" effect delaying renovation efforts during high input prices period



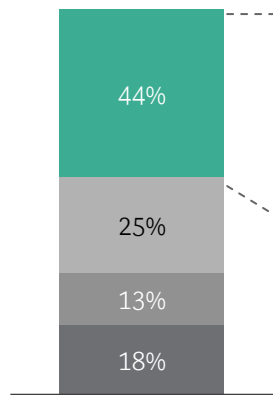
Chemicals | Potential impact for downstream chemical sector and customer industries if cuts in Natural Gas supplies were to materialize

DEEP-DIVE

German chemical industry exposed to Russia Natural Gas as energy & feedstock source

German Chemicals strongly rely on Natural Gas...

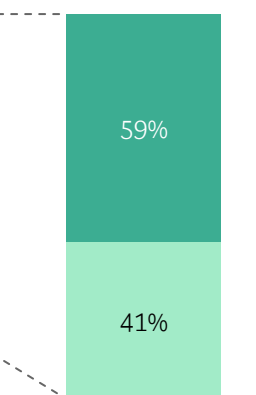
Energy consumption, Germany Chemical industry



■ Natural Gas¹
■ Heat
■ Electricity
 ■ Others²

...and is exposed to Russian supplies

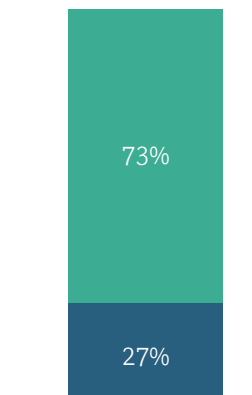
Relative share of gas used in Chemicals



■ Russian gas
■ Other gas

Relatively limited feedstock impact

Gas consumption in Chemicals



■ Energy
■ Feedstock

First and second order impacts

- **Energy shortage** risk for chemical sector if potential cuts in Russian Natural Gas were to materialize
- **Immediate shock** to German economy, as chemical industry is a key employer
- Given global leading position of German chemical players, potential **second-order shocks in key inputs for downstream chemical sector**
- Potential **ripple effects for key inputs for global economy** exacerbating supply shocks (e.g., fertilizer, plastic packages)

1. Incl. electricity generation from Natural Gas. Does not include feedstock consumption of Natural Gas. 2. Incl. renewables, nuclear power & others. Source: AGEBA; Destatis; VCI; BCG analysis



Automotive | Direct risks manageable, yet crisis underscores need for rigorous assessment of geopolitical risk & greater supply chain resilience

First-order impact



End market impact

Limited direct impact on global vehicle sales

(Russia accounted for only 1.7M of new vehicles sold in 2021)

More acute impact on **3 players that account for >70% of sales**

Inflationary / recessionary pressures increasing, but **automotive sales insulated due to semiconductor-driven pent-up demand**



Asset exposure

Automotive manufacturers (OEMs) and suppliers in Russia facing **potential write-offs, or Government seizure** of assets

Nonetheless, exposure relatively minor, **with ~\$5B** of asset exposure across major OEMs representing **~0.2 to 2%** of total assets¹



Supply shortage

22 foreign automotive suppliers with presence in Ukraine

(4th largest supplier of wire harnesses to Germany)

Resourcing of components will **minimize long-term impact**

Russia and Ukraine account for **significant source of core raw materials (e.g., Neon, Nickel, Palladium)**; war driving higher prices, do not however anticipate outright risk to production

Second-order impact

➤ Potential **redistribution of global markets**, with Chinese suppliers and OEMs replacing disrupted component and finished vehicle supply in Russia

➤ While OEMS will be able to pass on rising costs to consumers, **suppliers will need support** as their balance sheets are vulnerable to higher energy, material, & labor costs

➤ Higher fuel costs will drive **accelerated shift to EV** (impact offset by increase in Nickel costs)

➤ Reinforced **need to assess geopolitical risk** when developing supply chain strategy and prioritizing which markets to focus

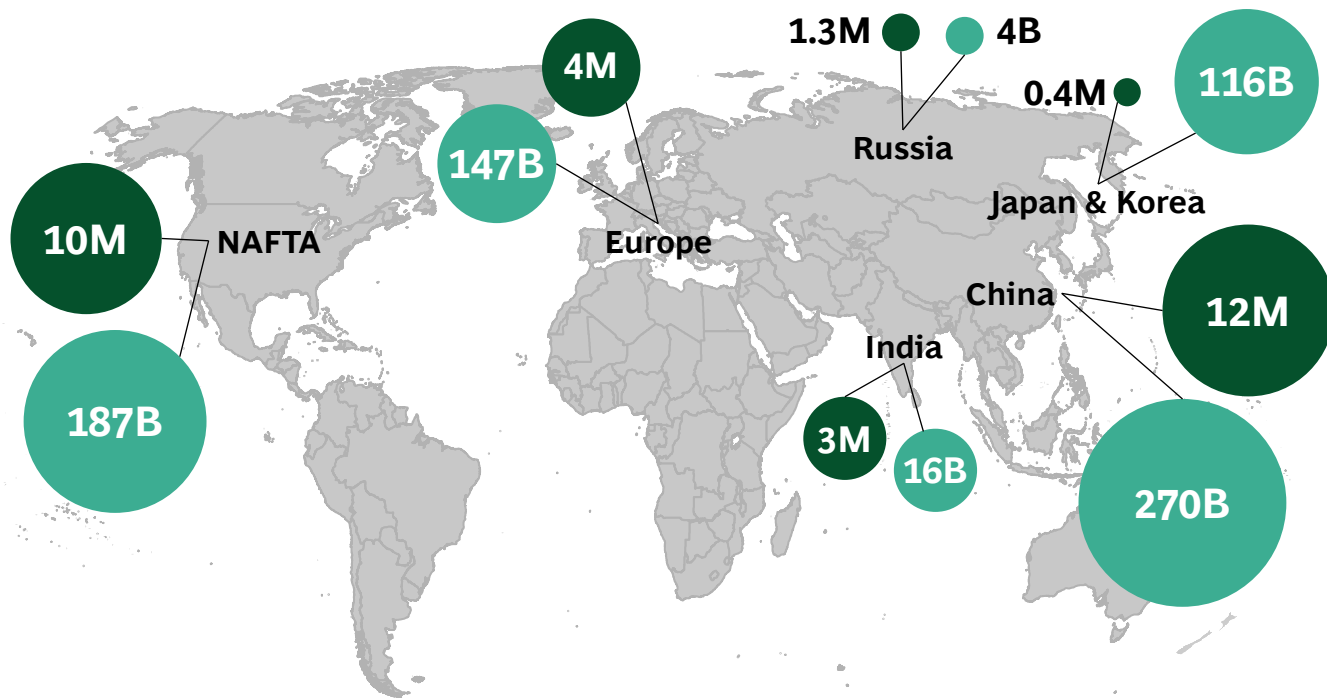
Focus on next page

1. For OEMs that have reported Russian asset exposure (4 OEMs) as of April 6. Source: NYTimes, Broker research, HIS Markit, World Bank, IFS, HSE Consensus forecast; BCG experience & analysis



Automotive | Crisis and global nature of industry elevates need for a revaluing of risk and the building of more resilient supply chains

High exposure to foreign companies in major trade blocs



- # units manufactured by foreign companies (2021)¹
- Value of auto components exported (2021)²

1. IHS Markit Light Vehicle Production (2021); 2. UN Com Trade

Implications for auto industry



Interconnectivity of global value chains **demands a much more robust assessment of risk**



Events of the last few years have brought more fully into light **the costs of single source risk and prioritizing lowest landed cost**



Looking ahead, imperative that companies incorporate a **broader range of criteria** for geographic markets and sourcing selection...



...focusing more fully on **geopolitical risks and supply chain resilience**



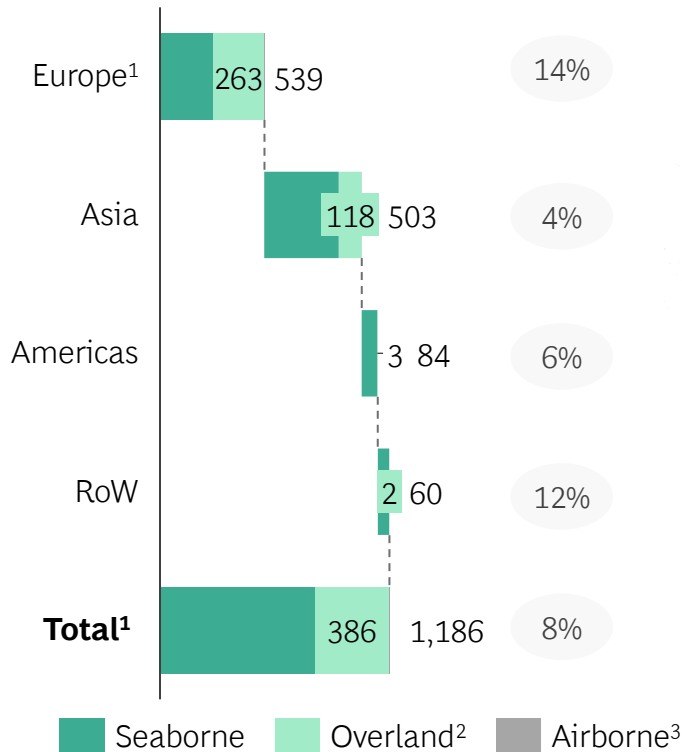
Transport | 8% of global trade volume at risk, with changes in trade flows leading to the transformation of transport routes

EXAMPLES, NON-EXHAUSTIVE

8% of global trade volume at risk

Russia, Ukraine & Belarus export volume to... (M ton, 2021)

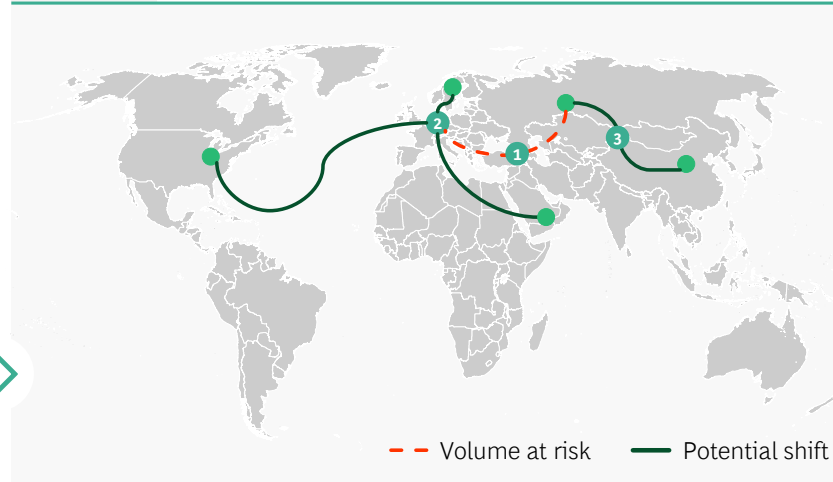
% of regional import volume



War-induced changes in trade flows lead to transport routes transformation



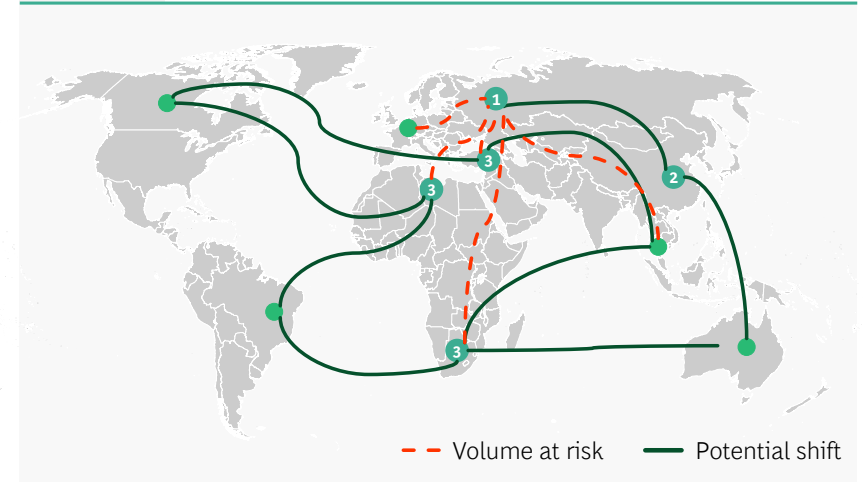
EXAMPLE Natural Gas



- 1 EU minimizes hydrocarbon imports (REPowerEU)**
- 2 EU substitutes imports with alternative sources**
- 3 Russia-China Natural Gas trade intensifies (via ocean freight)**



EXAMPLE Wheat



- 1 Disruption to Russia & Ukraine production & export routes**
- 2 Russia-China exports intensify, driving in-route lower prices and reshuffling of trade patterns (e.g., from India)**
- 3 Reduced Russia/Ukraine exports to Africa/ME could be backfilled by Americas and Australia**

1. Including Russia, Ukraine and Belarus, accounting for 87 M ton of trade among them 2. Includes rail, road & pipeline (esp. relevant in energy trade in RUS-EU) 3. Limited amount of airborne cargo, 162k ton to World. Source: BCG Analysis and experience. Note: excludes airborne due to negligible value



Transport | Ocean freight to absorb modal shift, while increase in uncertainty and trade costs drive broader implications

First-order impact

Ocean Freight



Tanker

Lost EU pipeline energy imports **to be backfilled by LNG and crude oil imports** from 3rd countries, driving freight rate increase



Container

East-to-West volume shift from disrupted Russian rail routes
Sustained high rates & more pressure on **container shortages**



Bulk

Commodities shock in short term, e.g., agriculture & iron ore
Russian exports to Asia **shifting from ocean** to rail & road
Global supply substitution **will impact demand rate outlook**



Rail & road

Asia-Europe volume reduced as Southern Route (Central Asia) cannot handle all Northern Route (Russia) volume
Low impact to inland routes, key to distribute seaborne trade



Air freight

East-to-West supply chain delays and risks lead to **increased emergency air freight demand**
Longer times due to closed airspace, leading to lower capacity

Second-order impact

- **Varying ability to substitute commodity shortages** depending on seaborne routes
- **Negative decarbonization impact in short term** due to shift to ocean freight vs pipeline
- Higher hydrocarbon costs and better electrification economics push **green transition** (e.g., electrification of heavy-duty transport, renewable fuels)
- Higher trade costs and uncertainty on shortages & times accelerate **manufacturing re-location**

Greentech & Sustainability | Opportunity to accelerate the adoption of 'green solutions' across industries







Push of sustainable solutions, although balanced

- ✓ **Political & business support** of green energy sources & technologies to secure independence
 - e.g., new 'Osterpaket' legislation in Germany with new RE subsidies and simplified permitting

- ✓ **Relatively more attractive economics** of 'green solutions' given higher hydrocarbon prices meeting increasing performance of green technologies, e.g., heat pumps, xEVs

- ⚖ Balancing factors such as supply shortages and higher costs (e.g., Nickel) **might delay the short-term transition to sustainable technologies**

Examples across industries

-  **Agriculture** | Change in consumption habits and push to locally sourced, sustainable food
-  **Materials** | Green H2 as feedstock and energy source in metal transformation processes (e.g., green steel)
-  **Construction** | Solar panels for residential projects, heat pump for heating (savings through 3x efficiency vs. gas/oil)
-  **Chemicals** | Opportunity to develop alternative fuels and green chemical products
-  **Automotive** | Acceleration of shift to xEVs (e.g., Q1/22 US xEV sales w/ record growth while overall market down 15%)
-  **Transportation** | Electrification of light/medium duty road transport, increased use of renewable fuels,



Additional focus on **recycling and improving collection & reverse distribution** to optimize supply of scarce materials (e.g., Nickel), but higher complexity and cost

War in Ukraine: Industrial Impact

AGENDA

Perspective on industrial sector impact

- › Cross-industry trends
- › Selected sector impacts
- › **Implications for leaders**

Industrial implications for business leaders and policymakers



BUSINESS LEADERS

Near term

Longer term

Understand exposure & respond

Proactively manage risks

Review long-term strategy



Strengthen **360° risk management** and invest in supply chain, production, technology & energy **resilience**

Understand **full risk exposure**, including first and second order impacts, and set up contingency plans for immediate response

Assess **long-term strategy** and include **geopolitical risk** as decision-making criteria for footprint and investments



POLICYMAKERS

Near term

Longer term

Shape the evolving situation

Plan for economic resilience

Review long-term industrial strategy



Shape response against **geopolitical and business risks**, identify immediate actions and launch **collaborations** with other governments and private sector

Design **response plans to economic risks** (e.g., energy shortages) in collaboration with industrial players; identify **social & humanitarian actions** (e.g., emergency food supplies)

Review sector-by-sector prospects and design investment & growth plans to **strengthen strategic autonomy**

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