



Climate risks to EU commodity supplies

Protecting people and prosperity

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Introduction

Climate change poses a serious and growing threat to the world's ability to produce essential commodities. Even in a best-case scenario in which greenhouse gas emissions rapidly decline, climate change will cause extreme weather conditions to occur with far greater frequency and severity. These conditions, in turn, cause hardship for the miners and farmers who supply the commodities on which industries and communities depend. Unless commodity producers and consumers take preventive action now, they are likely to find their operations increasingly disrupted.

In this report, we examine how accelerating climate change may disrupt commodity supplies to one of the world's key economic blocs, the European Union (EU), that generates approximately 14% of global GDP.¹ Building on our [earlier work](#) that identified severe climate risks to global production of many essential commodities, this report drills down to climate risks to EU commodity supplies.

We examine climate disruption risks to the following nine commodities, all of which are important to the EU economy:

- **Three critical minerals: cobalt, copper, and lithium** that are integral to electronics, technology, energy systems, and a successful transition to a low carbon economy.

■ **Three vital metals: iron, aluminium, and zinc** that are widely used in manufacturing, transport, infrastructure, construction, consumer products, and more.

■ **Three food crops: maize, rice, and wheat** that together account for 42% of the calories people eat.

To carry out the analysis, we trace EU supplies of each commodity back to their points of origin at mines and farms across the world. Next, we analyse the degree to which these mines and farms will increasingly be subject to two climate impacts known to be detrimental to commodity production: heat stress and drought. Heat stress can make it difficult or even life-threatening for workers to work outside. Drought can decimate crops and harm mining which can be heavily dependent on water.² We class drought and heat stress risks as significant, high, or extreme.

Drought Risk Levels

Risk Category	Risk Levels / Duration of Severe Drought
Significant	20% of time in severe drought, over the 20 year span centred on each year being analysed
High	40% of time in severe drought, over the 20 year span centred on each year being analysed
Extreme	80% of time in severe drought, over the 20 year span centred on each year being analysed

Note: The term significant as we use it here has no relationship to statistical significance testing.

Severe drought: Defined as values below -1.5 on the Standardised Precipitation-Evapotranspiration Index, a multiscalar drought index.

Heat stress Risk Levels

Risk Category	Risk Levels / Duration	Impact
Significant	At least 10 days per year with an average daily WBGT of 26.3°C. Total days with WBGT at this level may be higher.	Reduces labour productivity by at least 25%
High	At least 10 days per year with an average daily WBGT of 28.9°C. Total days with WBGT at this level may be higher.	Reduces labour productivity by at least 50%
Extreme	Each year, an average daily WBGT of 32.2°C occurs on one or more days.	Reduces labour productivity by at least 75% and is dangerous to outdoor workers.

Source for labour productivity impact: Rockefeller Foundation Resilience Center, 'Extreme heat: Economic and social consequences for the US,' 2021

WBGT = Wet Bulb Globe Temperature, a measure of heat and humidity



Our analysis reveals the proportion of EU commodity supplies that will be exposed to significant, high, or extreme levels of heat stress and drought risk at their point of origin on mines and farms.

We identify climate risks at the present day (based on 2020), in 2035, and in 2050. We demonstrate how climate risks will vary according to how much progress the world makes in reducing emissions using these two scenarios defined by the UN's Intergovernmental Panel on Climate Change:³

- **A low-emissions scenario** in which substantive action is taken to curb emissions, keeping global average temperature increase below 2°C (Scenario SSP1-2.6).
- **A high-emissions scenario** in which no action is taken to follow a low-emissions pathway, resulting in a catastrophic rise in global average temperature of 4.4°C by 2100 (Scenario SSP5-8.5).

We analyse low and high emissions scenarios for the latest year in our analysis, 2050, because as time passes the effects of divergent paths become more apparent (For a full explanation of our methodology, please see our [first report](#) on global climate risks.).

Business leaders and policymakers will be better equipped to manage these risks if they know where the at-risk supplies come from. Therefore, we identify the sources of at-risk commodity supplies whether domestic or imports (and, if imports, from which source countries).

We examine whether imports arrive in unprocessed or processed form (unprocessed iron ore vs processed iron, for example). This matters because, if a commodity is processed, it is more likely to have passed through the hands of one or more middlemen and to have been combined with raw materials from multiple sources. As a result, the ultimate origins of processed commodities may be harder to trace than those of raw, unprocessed commodities. Therefore, we say that processed commodities may have a higher level of hard-to-trace or 'hidden' climate risk.⁴

Our analysis provides insight for business leaders and policymakers seeking to build robust supply chains as more extreme weather conditions become the new normal. It also underlines the necessity of business model reinvention to support businesses' long term success in more challenging climate conditions in the future.

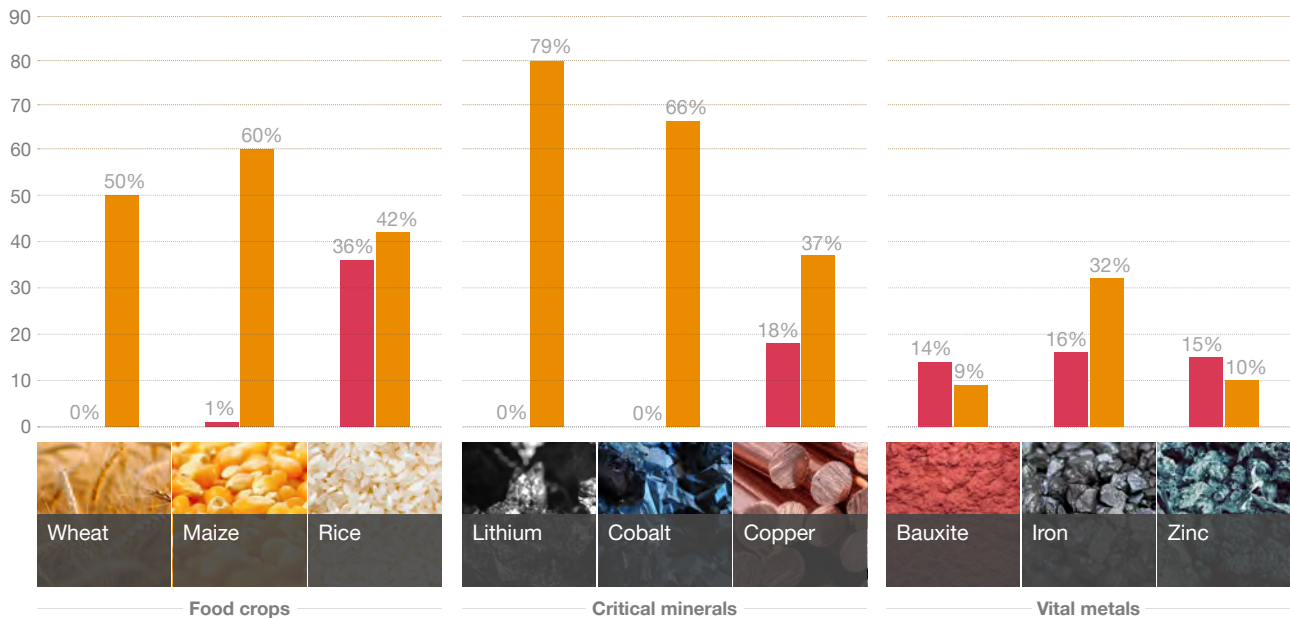
Key Findings

Even under an optimistic low emissions scenario in which emissions rapidly decline, EU supplies of all nine commodities face significant climate risks from heat stress or drought in the coming years.

For example, at least half of wheat, maize, lithium, and cobalt supplies in the EU face significant drought risk by 2050 in a low emissions scenario.

EU Commodities at risk

Low emissions scenario, Year 2050



■ % of EU commodity supply exposed to Significant, High or Extreme heat stress risk ■ % of EU commodity supply exposed to Significant, High or Extreme heat drought risk

Source: Protecting People and Prosperity

We can't assume that future emissions reductions will protect us from a changing climate. Even in an optimistic low emissions scenario, as we will see below, all commodities will see rising levels of risk from at least one of heat stress and drought by 2050, highlighting the importance of adapting to a changing climate while we strive to reduce carbon emissions.

In some cases, risks are rising sharply from low levels, underlining the need for commodity producers and commodity users to prepare to manage increasing risks that, in some cases, they may have little experience in managing.

Climate risks to essential commodities create risks for the global transition to net zero. Lithium, cobalt, and copper are essential for renewable energy technologies including the batteries needed for electric vehicles and storage of solar and wind power. All of these commodities face rising risks from climate change.

Most of the EU's lithium and bauxite supplies, have 'hidden' risks. These commodities arrive in the EU in processed form, making it trickier to know their places of origin and how exposed these places are to climate impacts. As a result, the full extent of these commodities' climate risk exposures at their points of origin may be hidden or unclear to commodity consumers.

Business leaders and policymakers may need to employ different strategies to manage risks to critical minerals and vital metals (which are often imported) vs food crops (which are often produced domestically).

Now is the time for commodity producers and consumers to prepare for growing disruption risk.

We offer three steps to help adapt to a changing climate. First, enhance resilience by identifying and managing climate risks throughout the supply chain. Next, capitalise on the opportunities to deliver products, services, or business models that help companies and communities adapt. Finally, join forces with stakeholders from governments to communities to shape collaborative outcomes and enhance adaptation at a policy and systemic level. We offer examples and case studies for each step.

Assumptions and Limitations

This report provides a summary of risks to the EU as a whole, and there will naturally be much variation in risks for individual EU countries. While the EU is a single political entity, it is also a vast and varied bloc with great geographical, climatic, and economic variety.

We assume production levels and supply chains remain the same. It is difficult to reliably predict through 2050 how the locations and volumes of commodity production will change. Therefore, we use today's locations and volumes of commodity production in our analysis. The advantage of this approach is that it enables us to estimate how the EU might be exposed to future climate risks given its current supply chains.

Our analysis reveals risk exposures, not actual disruptions to supply. We estimate the share of total supply that could be exposed to significant, high, or extreme levels of heat stress or drought. We do not quantify the potential disruption, such as how much the EU supply could fall. It is possible - and advisable - that commodity producers take action to protect their operations from climate disruption.





Chapter 1: Climate risks to EU commodity supplies

Key Findings

- EU supplies of all nine commodities face significant risks of disruption from rising heat stress and drought in coming years. At least half of the EU's wheat, maize, lithium, and cobalt supplies face significant drought risk by 2050 even in a low emissions scenario.
- While much of the EU's at-risk food crops are grown within the EU, most of the EU's at-risk critical minerals and vital metals are imported. Business leaders and policymakers may need to employ different strategies to manage risks to imported vs domestic supplies.
- The vast majority of the EU's at-risk lithium and bauxite arrives in the EU in processed form. This means that the full extent of these commodities' climate risk exposures at their points of origin may be hidden to commodity consumers.

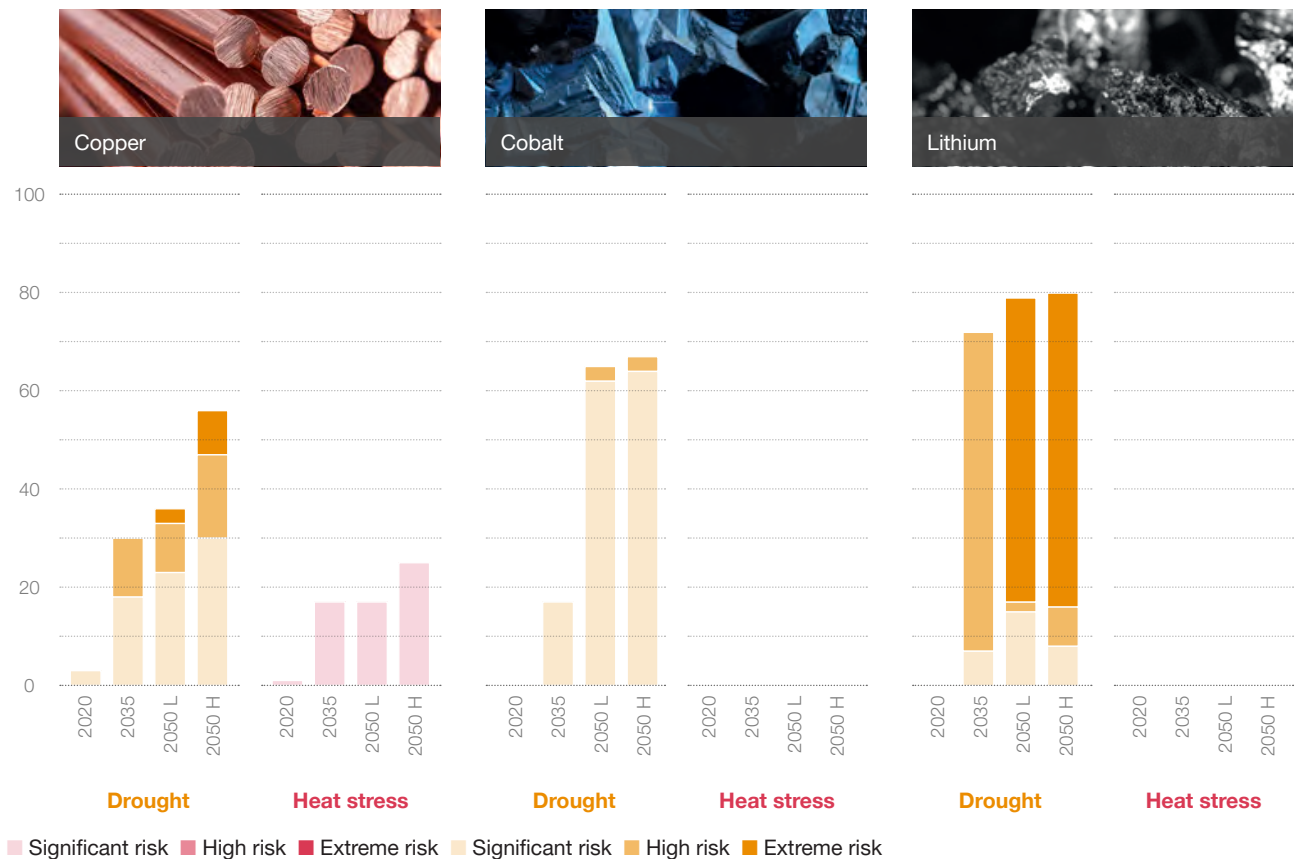
Below, we examine risk exposures to each commodity group (critical minerals, vital metals, food crops) in turn and the sources from which these risks arise.

Climate risks to EU critical minerals

Lithium is a key component in lithium-ion batteries which are used to power electric vehicles, for portable electronics, and to store renewable energy such as solar and wind power. The demand for lithium in the EU is expected to increase significantly over the next few years. It is estimated that Europe will soon need 18 times more lithium than it did in 2020 to meet the requirements of energy storage systems and electric vehicles.⁵

Cobalt is also a key component in lithium-ion batteries and is used in the production of superalloys, materials that can withstand extreme temperatures and are used in jet engines, gas turbines, and other high-performance applications. European demand for cobalt is expected to grow strongly from 20 kilotons (kt) a year in 2020 to almost 100 kt by 2050, driven primarily by the expansion of the electric vehicle market, renewable energy storage and advancements in battery technology.⁶

Copper is widely used in the EU for electronics, telecommunications, and construction due to its excellent electrical conductivity and durability. It is also vital for electrical wiring and components in renewable energy infrastructure such as wind turbines and solar panels.⁷ EU copper demand is expected to grow in the next three decades, averaging an annual growth rate of 1% from 2020 to 2050.⁸



Source: Protecting People and Prosperity



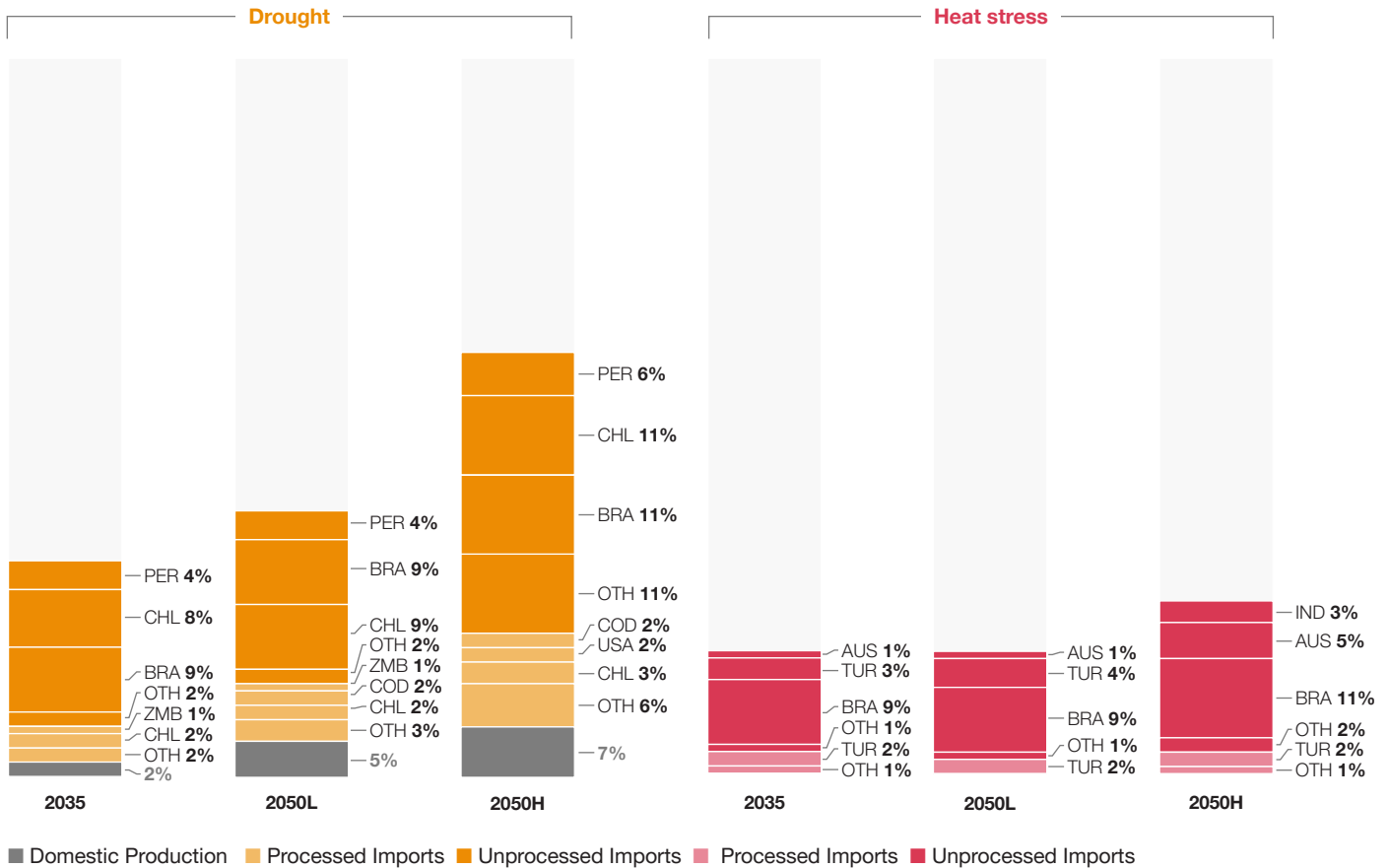
The EU’s lithium, cobalt, and copper supplies face steeply rising drought risks. Even in a low emissions scenario, over 30% of copper, 60% of cobalt, and 70% of lithium supplies may face significant drought risks by 2050.

We traced the EU’s at-risk critical minerals back to their points of origin in countries across the world. The charts below show the countries that provide the EU’s at-risk critical minerals, and the proportion of EU critical minerals that each country produces.

We used trade data to understand if the at-risk critical minerals arrive in the EU in processed or unprocessed form. Processed commodities are more likely to pass through the hands of one or more middlemen and to be combined with raw materials from multiple sources. As a result, the ultimate origins of processed commodities may be harder to trace than those of raw, unprocessed commodities. Therefore, we say that processed commodities may have a higher level of hard-to-trace or ‘hidden’ climate risk.⁹

The charts below show the % of EU supply that comes from various sources that face significant or higher climate risks.

Sources of the EU's at-risk Copper



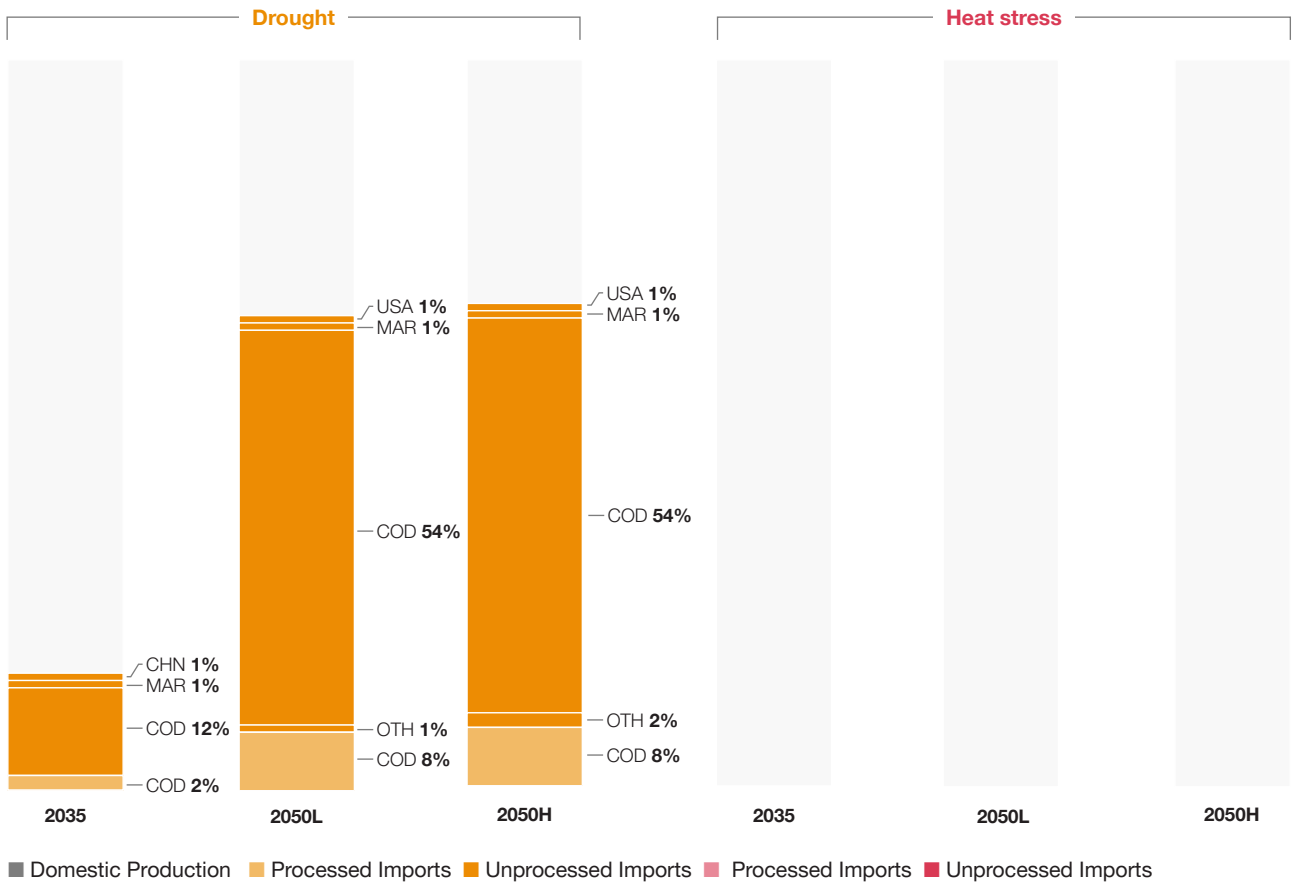
Source: Protecting People and Prosperity

COD = Democratic Republic of Congo, MAR = Morocco, PER = Peru, CHL = Chile, BRA = Brazil, ZMB = Zimbabwe, USA = United States of America, AUS = Australia, TUR = Turkey, IND = India

How to read this chart

Above, we saw the share of the EU copper supply that faces climate risk. In this chart, we break down the sources of that at-risk supply. Each % means the % of the total EU copper supply that comes from a certain at-risk source. For example, at the top of the tallest bar, we can see that 6% of the total EU copper supply is exposed to climate risk via its origins in Peru.

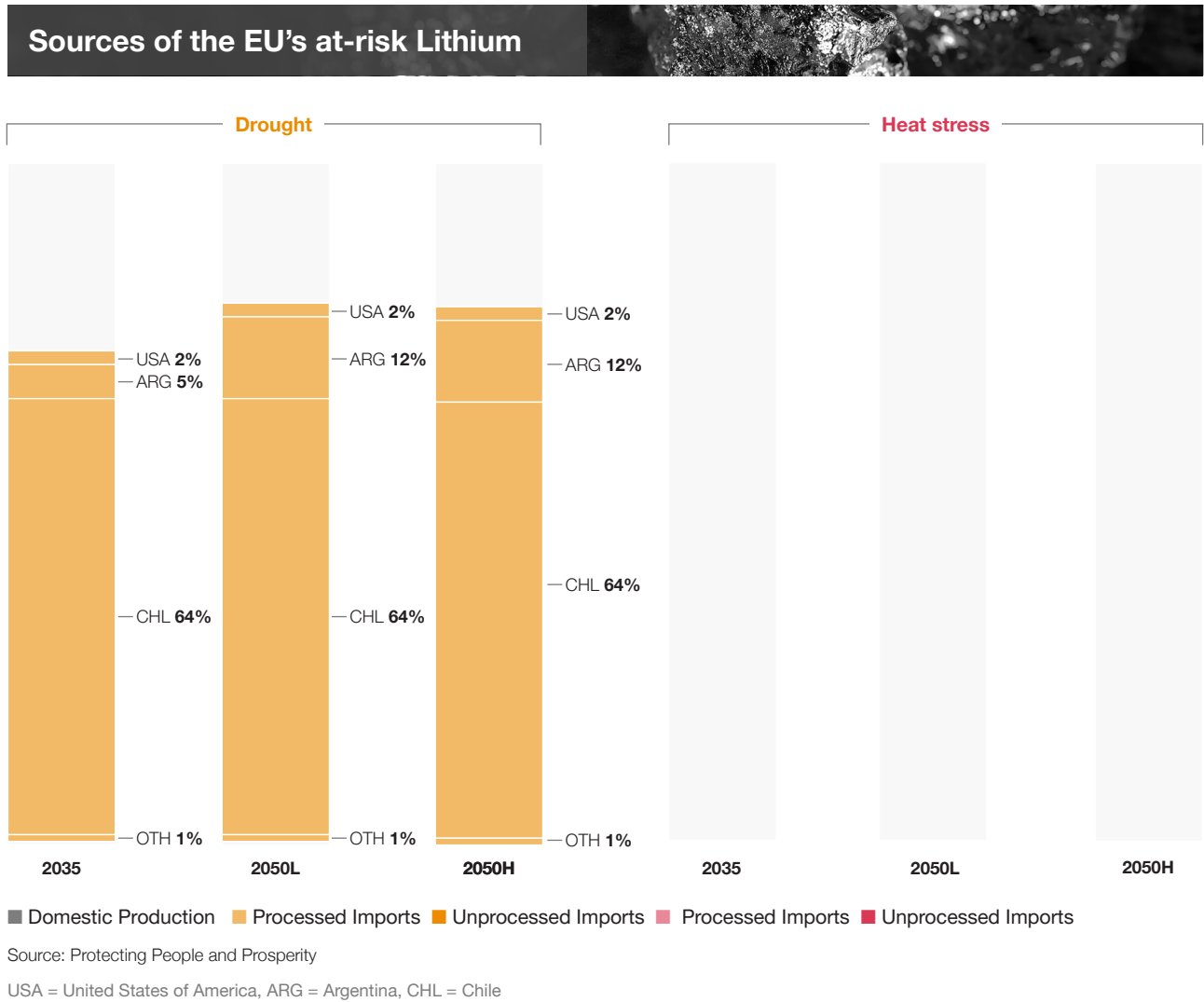
Sources of the EU's at-risk Cobalt



Source: Protecting People and Prosperity

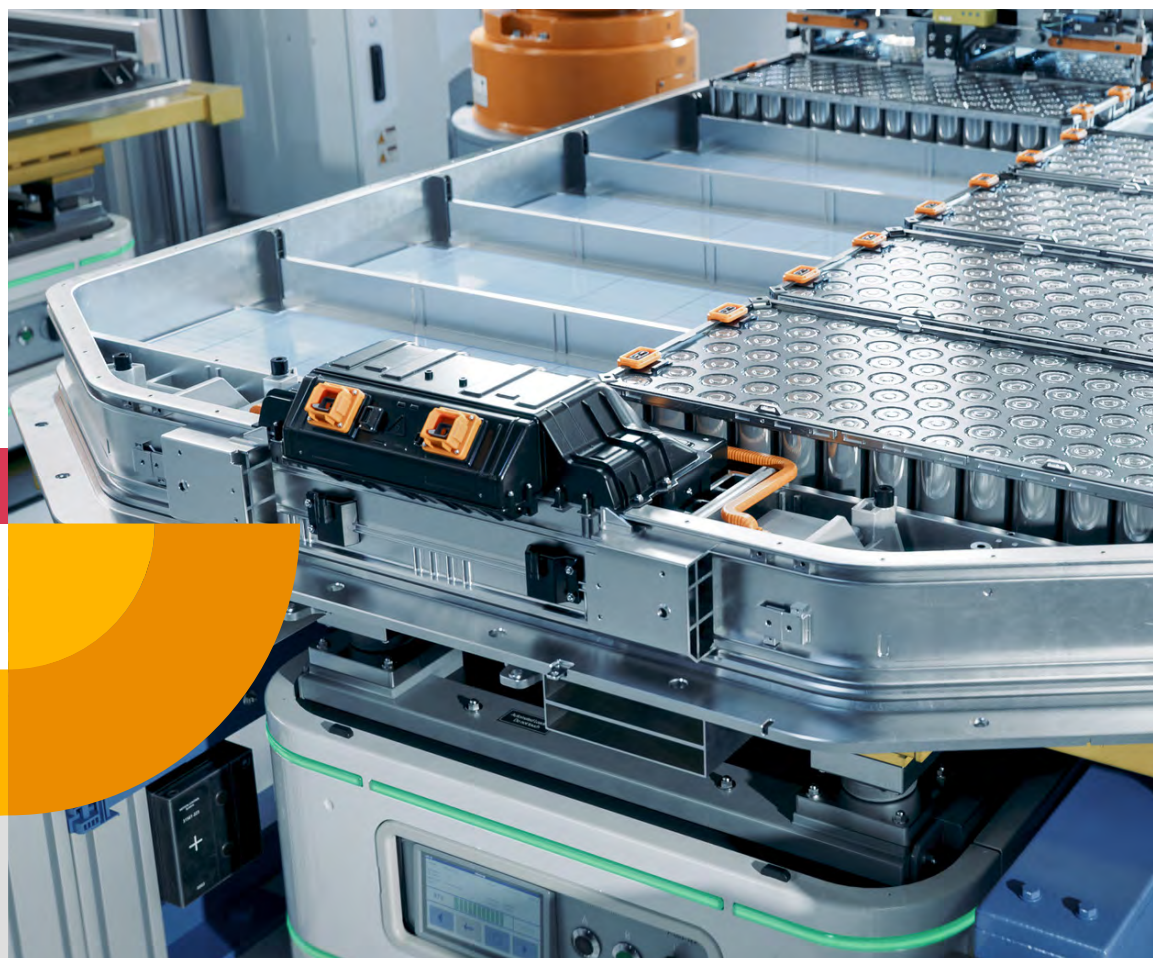
CHN = China, COD = Democratic Republic of Congo, MAR = Morocco, USA = United States of America





Most of the EU's at-risk cobalt comes from the Democratic Republic of Congo, the world's largest cobalt producer.¹⁰ The Democratic Republic of Congo was rated the fourth least prepared country in the world to address climate disruption by the Notre Dame Global Adaptation Initiative.¹¹ The EU's high reliance on Congolese cobalt could represent a considerable risk to its supply chain security.

Most of the EU's at-risk lithium arrives in the EU in processed form so may have more 'hidden' climate risks. Consumers of EU lithium would be well-advised to know the countries where their lithium originates and the climate risks to these locations.



Case study: Two ways to manage risk to EU lithium imports

The EU is expected to become one of the biggest consumers of lithium¹² with demand projected to rise to over 25% of the total global supply by 2030.¹³ The EU is heavily dependent on lithium imports, producing only around 3% of its total lithium supply domestically.¹⁴ According to our analysis, there is a substantial increase in drought risk by 2050 to the mines currently supplying lithium to the EU. Lithium mining is a water intensive process that can require millions of litres of water to produce one ton of lithium, so drought can be a significant challenge if not managed.¹⁵

There are two ways these risks can be managed. First, production sites can seek to adapt to a changing climate. Most of the EU's at-risk lithium comes from Chile. Chile is facilitating investment in desalination plants to support lithium production in drought prone regions.¹⁶

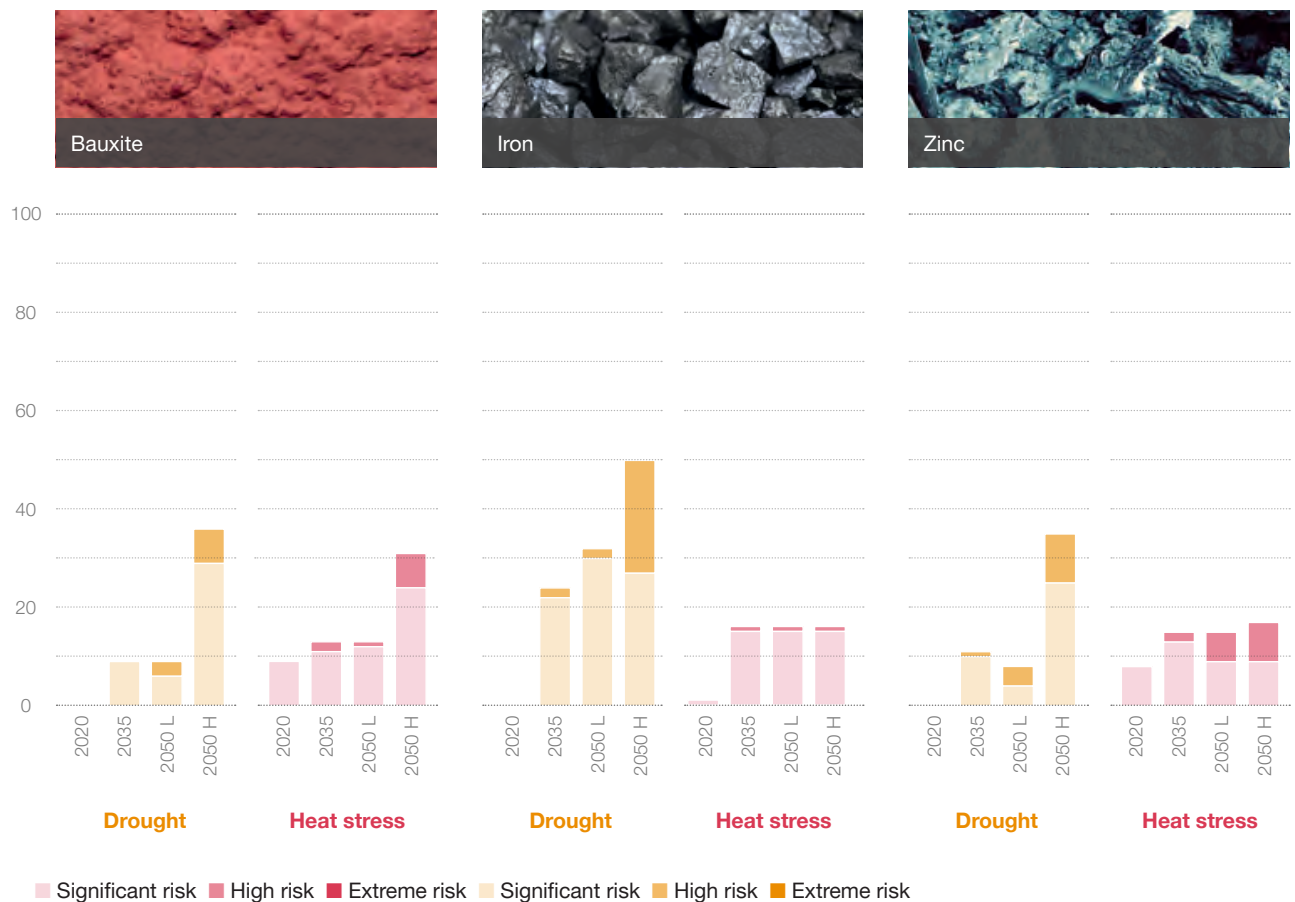
Second, commodity demand can be managed and may even ultimately be reduced, as the EU is doing with regulations to expand recycling and material recovery for lithium batteries. The EU's new "Battery Regulation" (Regulation 2023/1542) aligns with the European Green Deal's goals of climate neutrality by 2050 and reducing the environmental impact of industrial activities. The Green Deal will introduce and expand recycling efficiency and material recovery for batteries starting in 2025.¹⁷ Increased recycling and material recovery of lithium could help to decrease the reliance of the EU on lithium imports and add flexibility to the lithium supply chain.

Climate risks to EU vital metals

Aluminium is used extensively in the EU automotive, construction, and aerospace industries due to its lightweight and corrosion-resistant properties.¹⁸ It plays a vital role in the transition to a more sustainable circular economy as it is highly recyclable and a critical component in solar panels, electrical transmission systems, wind turbines, batteries, and electric vehicles. European demand for primary aluminium is expected to double from 9 million tonnes a year at present to 18 million tonnes a year by 2050.¹⁹ Increasing solar PV capacity from today’s 136 gigawatts to 600 gigawatts by 2030 as proposed by the EU Solar Strategy, for example, will require up to 10 million tonnes of aluminium.²⁰

Iron is the primary component of steel, which is essential for the construction of infrastructure such as bridges, railways, road and buildings.²¹ The European steel sector produces around 140 tonnes of finished steel a year and is worth 191 billion euros to the economy.²² Demand is expected to rise over the next few years, driven in part by the European Commission’s Green Deal²³ which includes significant investment in infrastructure projects.

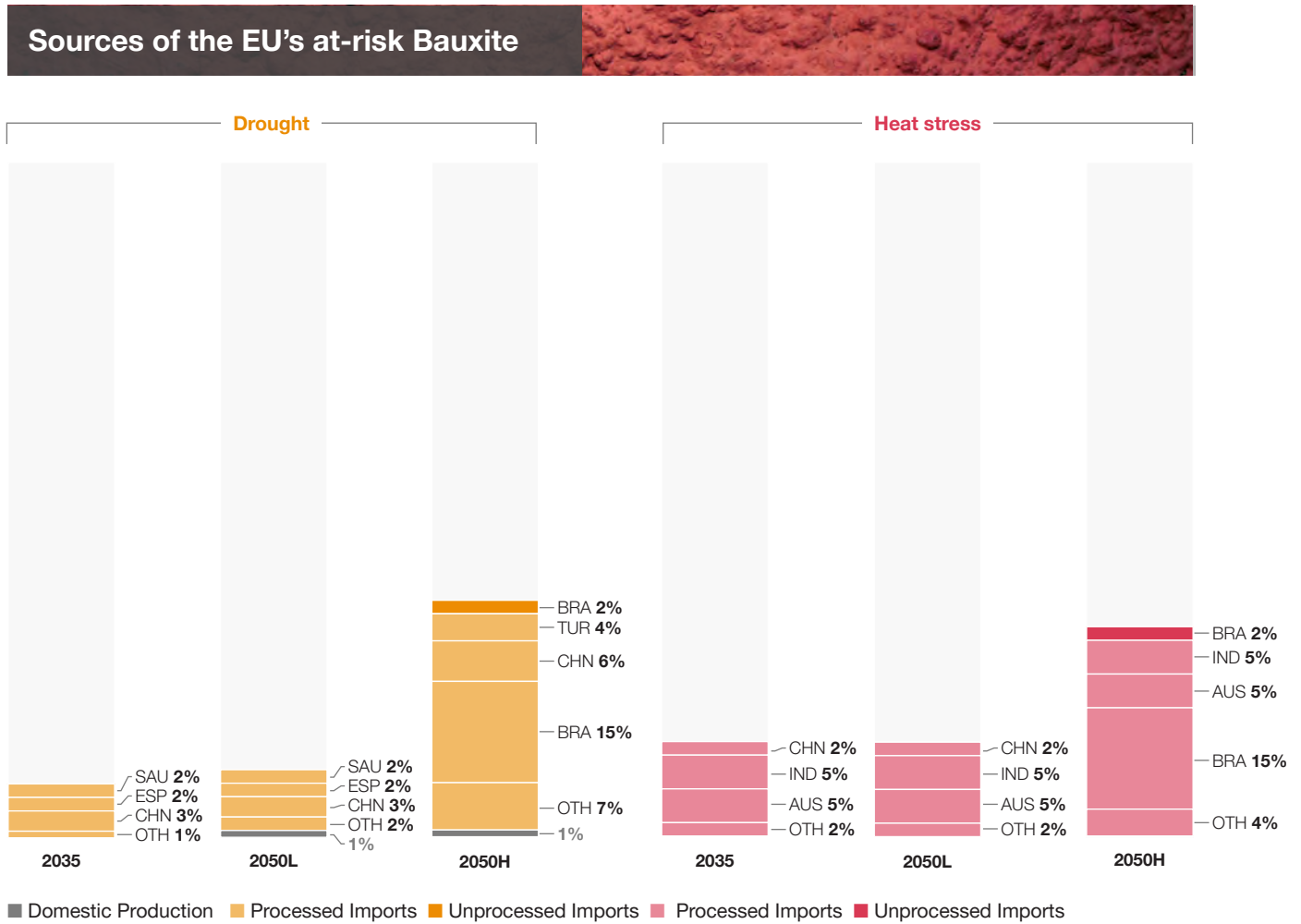
Zinc is an extremely versatile metal and is used in products across the healthcare, agriculture, manufacturing and industrial sectors. It is also used as a coating to protect steel from corrosion, extending the lifespan of infrastructure and projects²⁴ Total EU demand for zinc is expected to remain largely stable between now and 2030 with a low projected future growth from 2.8 Million tonnes a year to 2.9 Million tonnes a year.²⁵



EU supplies of all three vital metals face increasing disruption risks from climate change. Most notably, drought risks are rising to all three metals while bauxite also faces rising heat stress risk.

Turning to sources of risk for EU vital metals, it's worth noting that much of the EU's bauxite arrives in processed form so may have a greater degree of hidden risk than unprocessed bauxite. The EU's at-risk processed bauxite comes from a wide range of countries (Turkey, China, Brazil, Spain, Saudi Arabia and others).

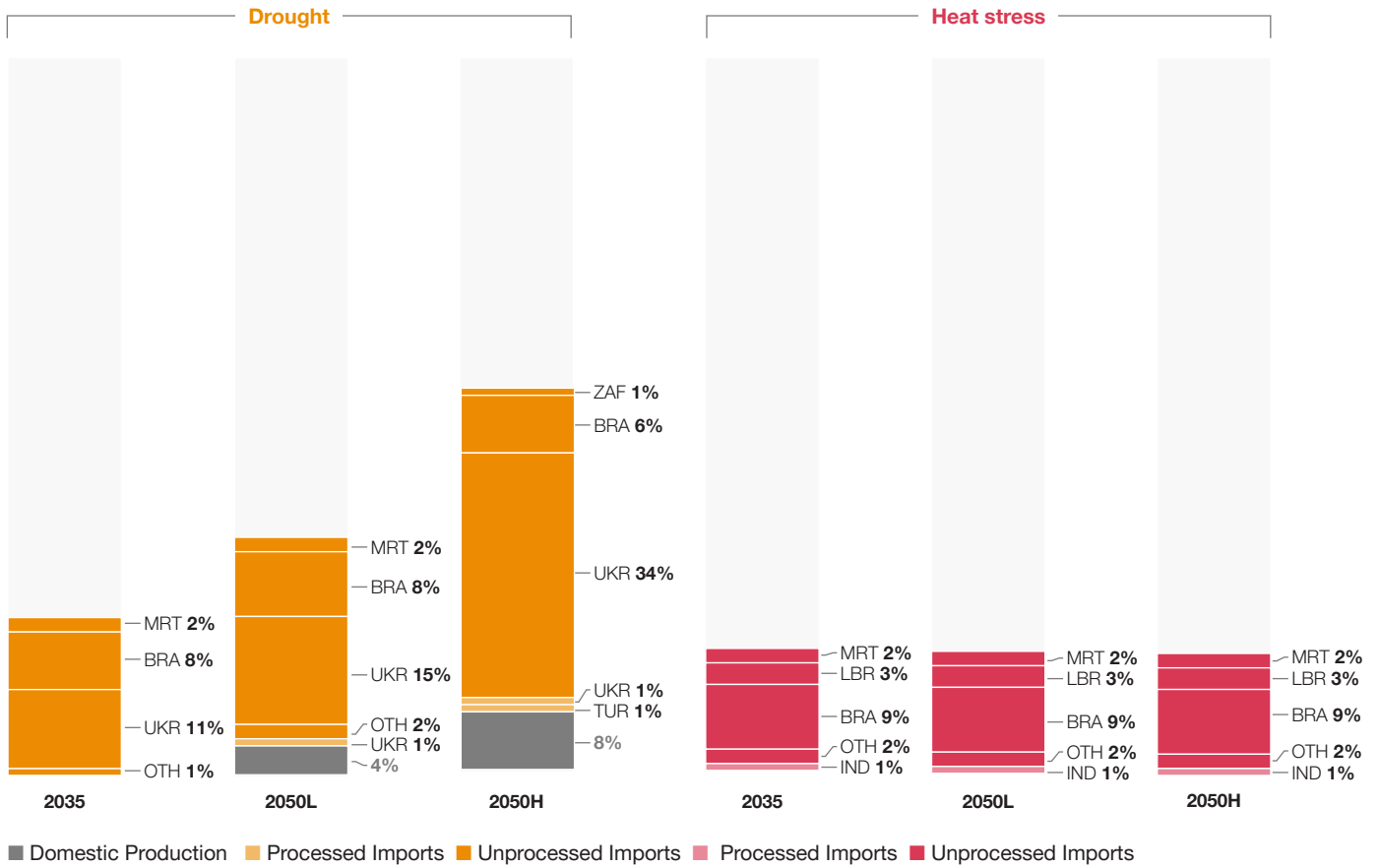
The charts below show the % of EU supply that comes from various sources that face significant or higher climate risks.



Source: Protecting People and Prosperity

SAU = Saudi Arabia, ESP = Spain, CHN = China, BRA = Brazil, TUR = Turkey, IND = India, AUS = Australia

Sources of the EU's at-risk Iron



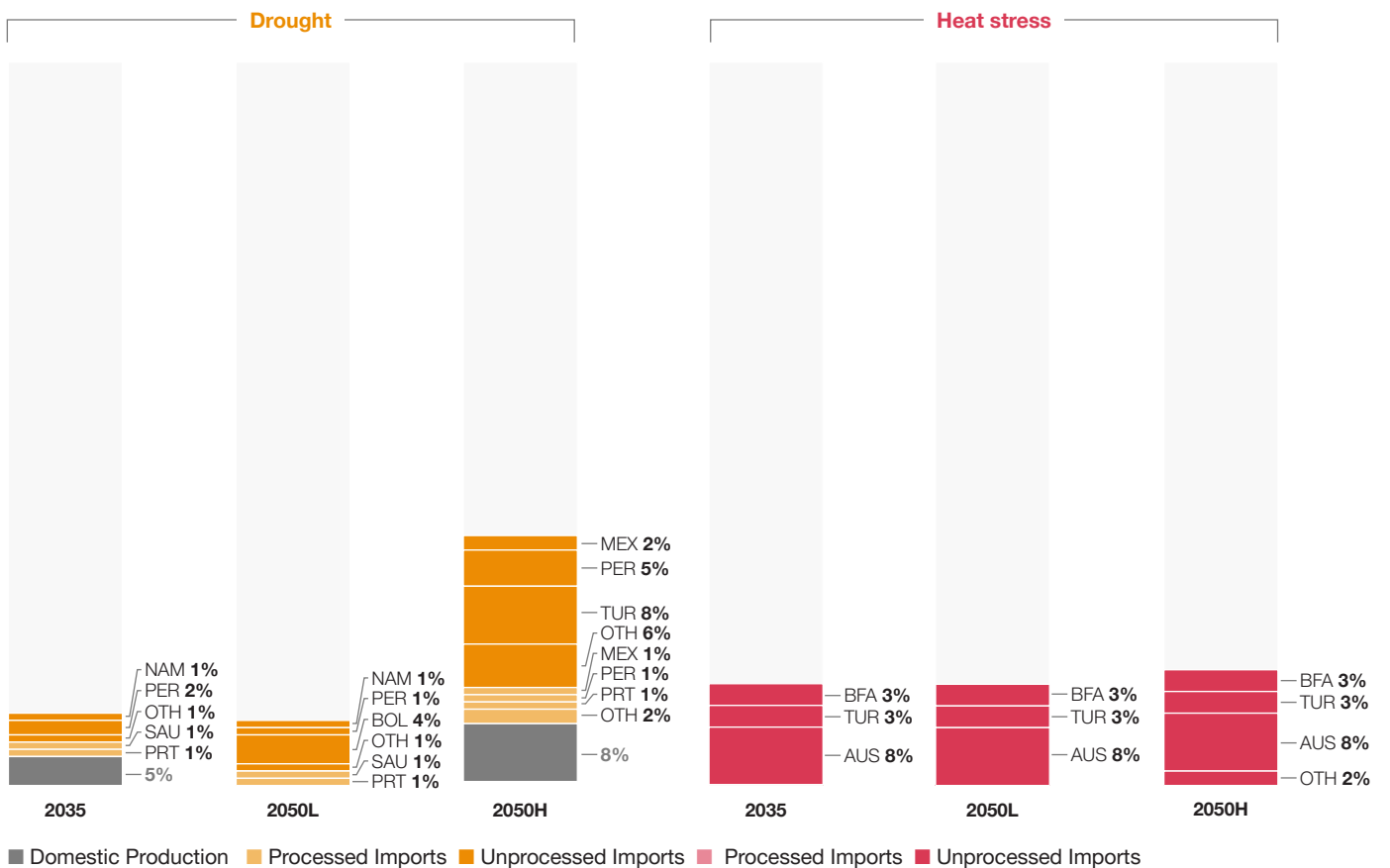
Source: Protecting People and Prosperity

MRT = Mauritania, BRA = Brazil, UKR = Ukraine, TUR = Turkey, LBR = Liberia, IND = India





Sources of the EU's at-risk Zinc

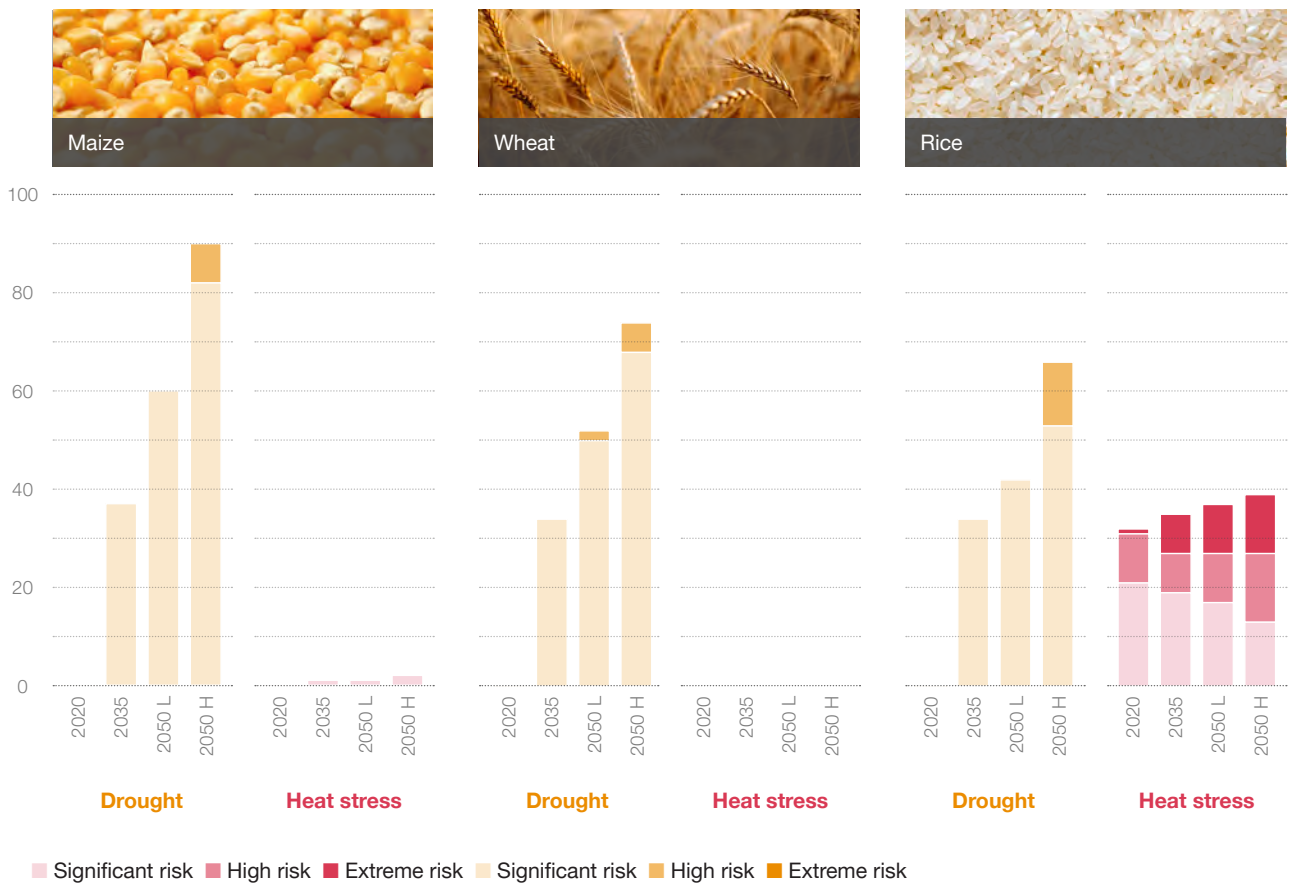


Source: Protecting People and Prosperity

NAM = Namibia, PER = Peru, SAU = Saudi Arabia, PRT = Portugal, BOL = Bolivia, MEX = Mexico, BFA = Burkina Faso, TUR = Turkey, AUS = Australia

Climate risks to EU food crops

Maize, wheat and rice form a significant part of the diet for both people and livestock in the EU.²⁶ Wheat accounts for more than half of the EU total cereal production of which nearly two thirds is used for animal feed and one third for human consumption.²⁷ Maize is used extensively for animal feed. Maize and wheat have broad industrial applications in the EU in biofuels like ethanol²⁸ and in bioplastics and adhesives.²⁹

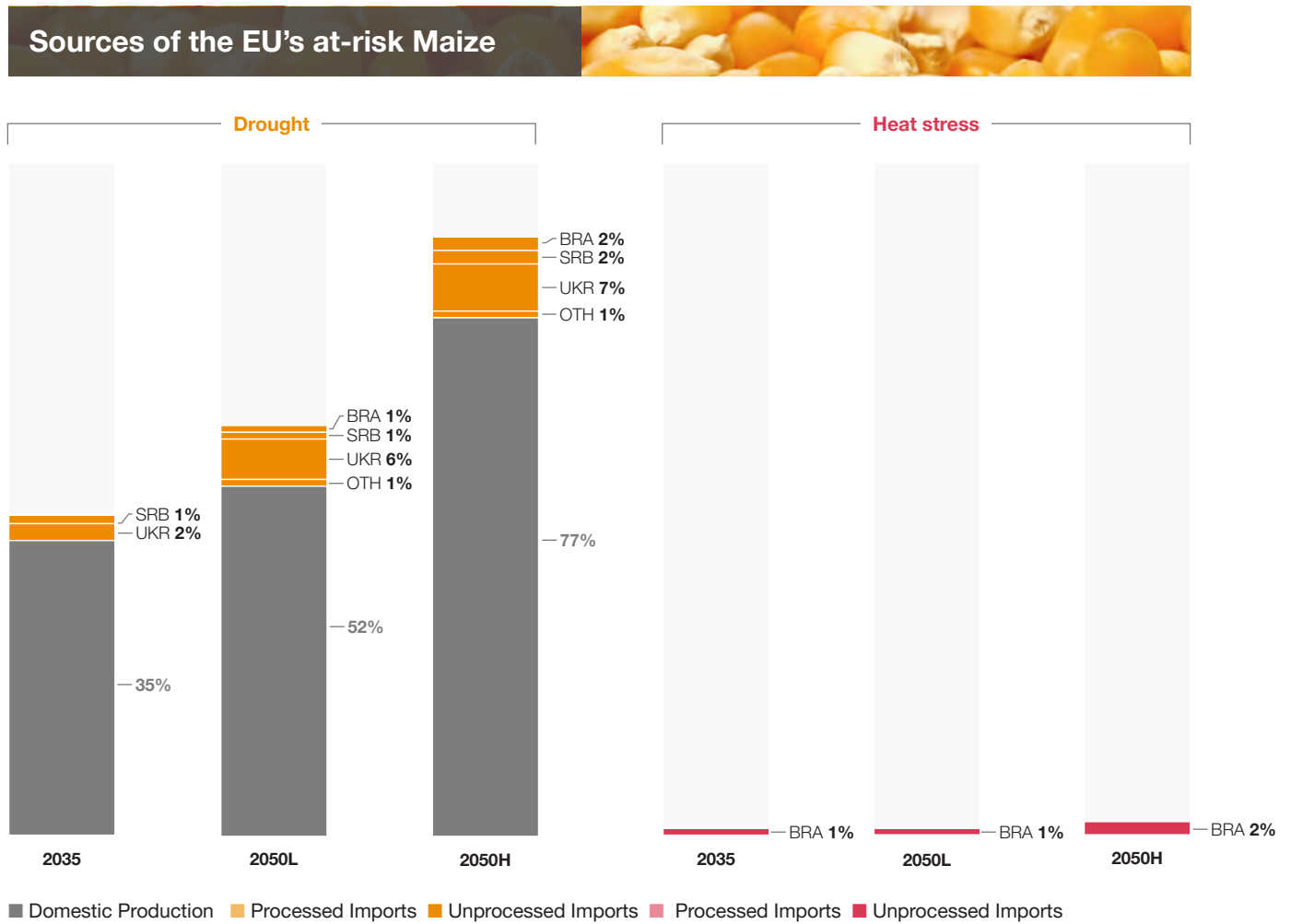


Source: Protecting People and Prosperity

EU supplies of all three food crops will experience steep increases in climate change-driven drought risk. EU rice supplies face higher heat stress risk in coming years.

The vast majority of EU crops at risk from drought come from the EU's own farms. This may mean that the EU has more scope to implement measures to help these farms adapt to a drier future. On the other hand, most EU rice at risk from heat stress is imported from Myanmar, Pakistan, Thailand, and other countries.

The charts below show the % of EU supply that comes from various sources that face significant or higher climate risks

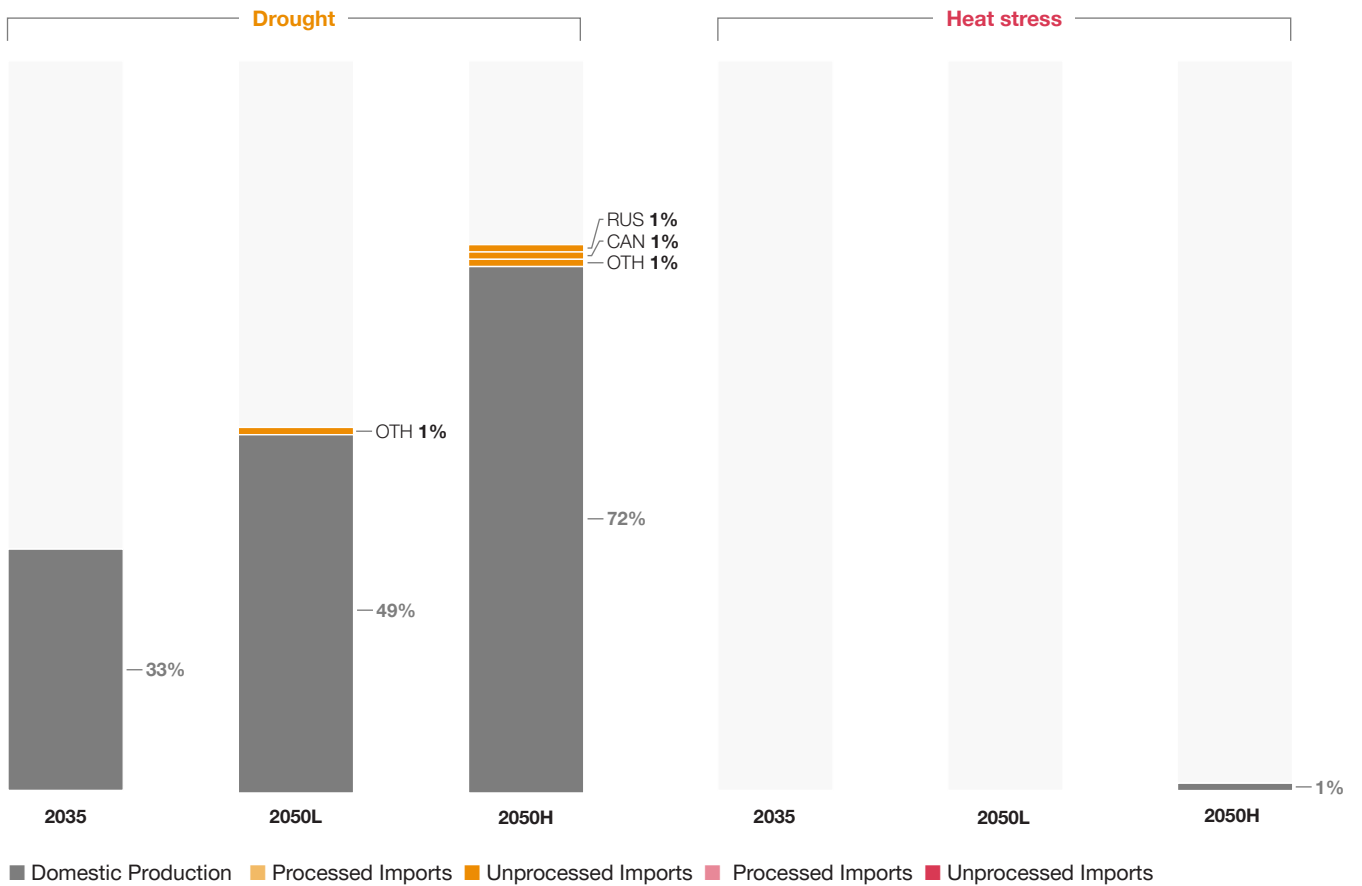


Source: Protecting People and Prosperity

SRB = Serbia, UKR = Ukraine, BRA = Brazil

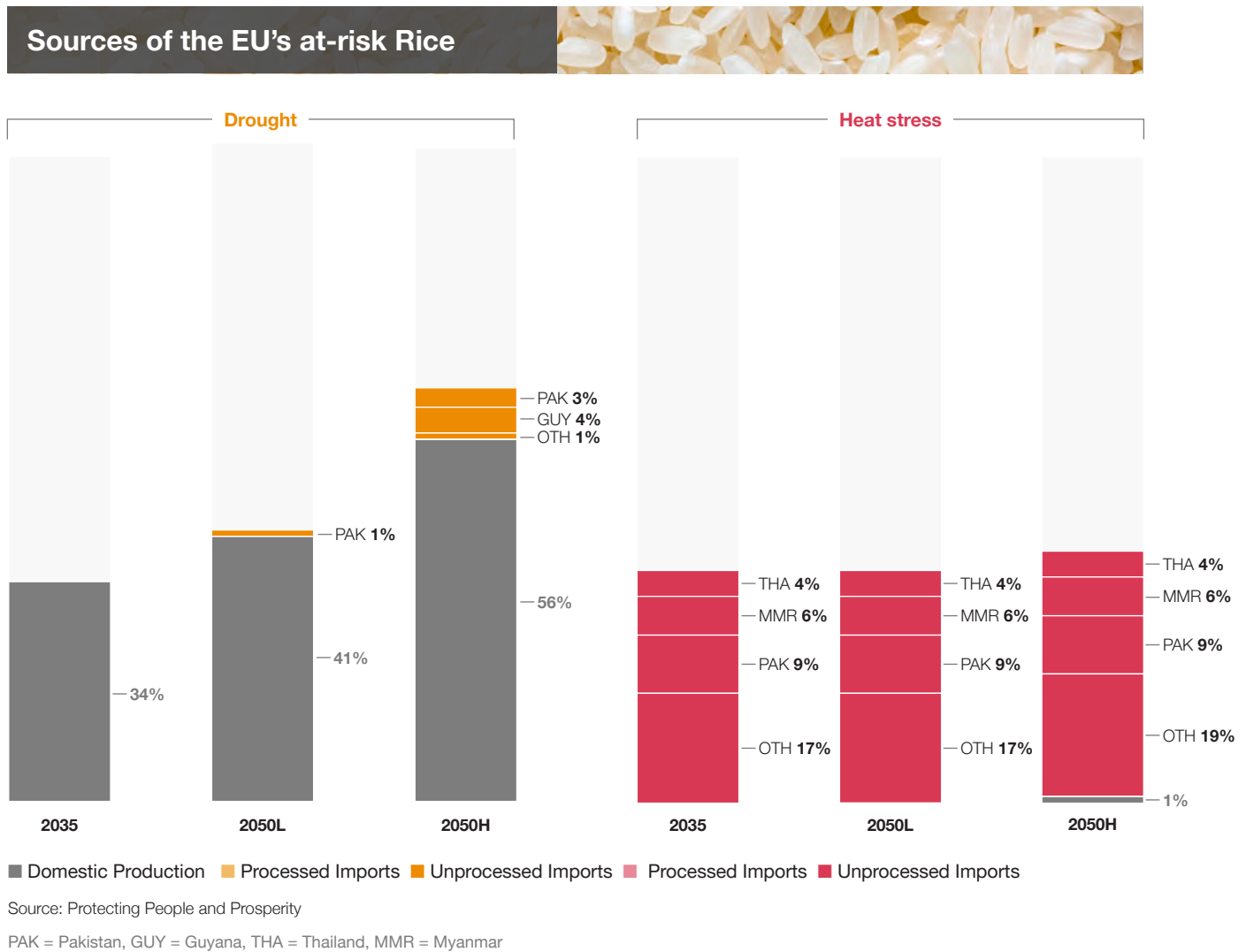


Sources of the EU's at-risk Wheat



Source: Protecting People and Prosperity

RUS = Russia, CAN = Canada



In conclusion

Our analysis identifies substantial climate-driven risks to the EU's supplies of all nine essential commodities. In many cases, these risks rise sharply in coming years, even in an optimistic low emissions scenario. Our analysis underlines the need for producers and consumers of EU commodities to manage the risks while continuing to strive to reduce emissions. The next chapter of this report outlines some steps that can be taken to manage climate risks to commodity supplies.



Chapter 2: Next steps for Businesses

Companies are realising the need to manage the impacts of climate change

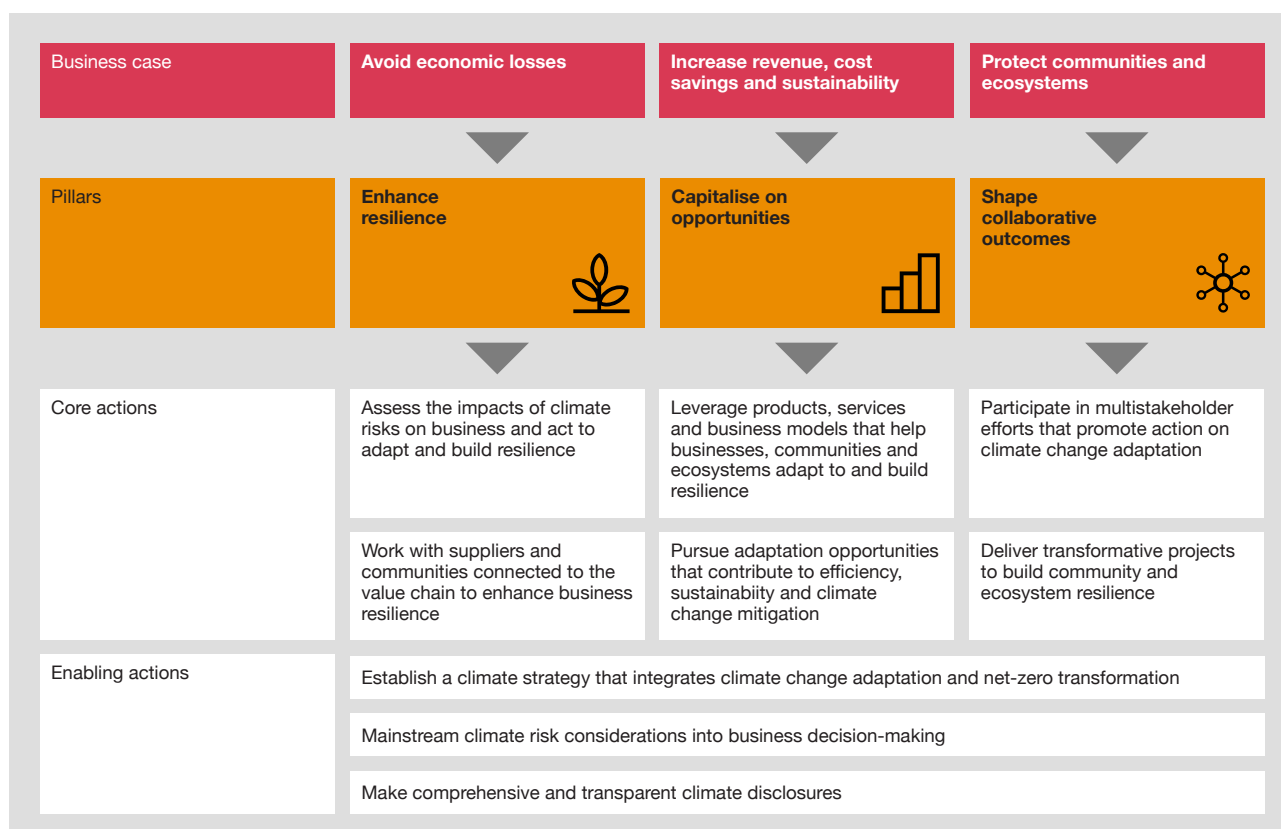
[PwC's 2024 Global CEO Survey](#) finds that 47% of CEOs are taking proactive measures to safeguard their workforces and physical assets from climate change.

Companies are wise to take action to adapt to a changing climate. As we have seen, climate-driven risks are rising at sites that produce nine essential commodities. Without preventive action, there may be increased disruption to global production of these commodities with knock-on effects for all nations and industries that depend on them.

In this chapter, we offer practical actions companies can take to adapt to the physical impacts of climate change. While this report so far has focused on a specific type of climate impacts (heat and drought threats to mines and farms), in this chapter we will survey a range of ways that companies in many industries are adapting to physical climate impacts. We trust this will make the chapter more useful to companies in a variety of sectors that would like to manage the full spectrum of ways that physical climate change impacts may affect their business.

Three pillars to adapt to a changing climate

How can companies take action to protect their operations, people, and supply chains from the effects of climate change? Below, we explore possible actions, grouped under three pillars, that businesses can take to help their business prepare for what lies ahead: 1. Enhance resilience by identifying and managing risks, 2. Capitalise on opportunities and 3. Shape collaborative outcomes.



These three pillars come from a framework that PwC developed with the World Economic Forum to [accelerate business action on climate change adaptation](#). We will focus most on Pillar 1 because our report is primarily about adapting to climate risk, and so this is where we will share the most examples of action to take. However, Pillars 2 and 3 are also important in the wider picture so we include some examples to illustrate these steps.

Pillar 1: Enhance resilience

Adapting to climate change - the ability to anticipate, manage, and recover from climate impacts - requires clearly understanding climate risks to commodities on which the business relies (these risks, as we have seen, can sometimes be hidden).

Climate change can have knock-on effects far beyond its direct physical impacts. For example, government actions to safeguard supplies can have consequences for global prices and availability. In 2023, for example, the Indian government banned exports of non-basmati white rice, partly due to fears of domestic

rice shortages caused by the disruption from El Nino, the weather event that causes sea temperatures to rise. This has caused global rice prices to rise sharply as available supplies are reduced.³⁰ Companies should consider these complex knock-on risks as well as direct physical ones.

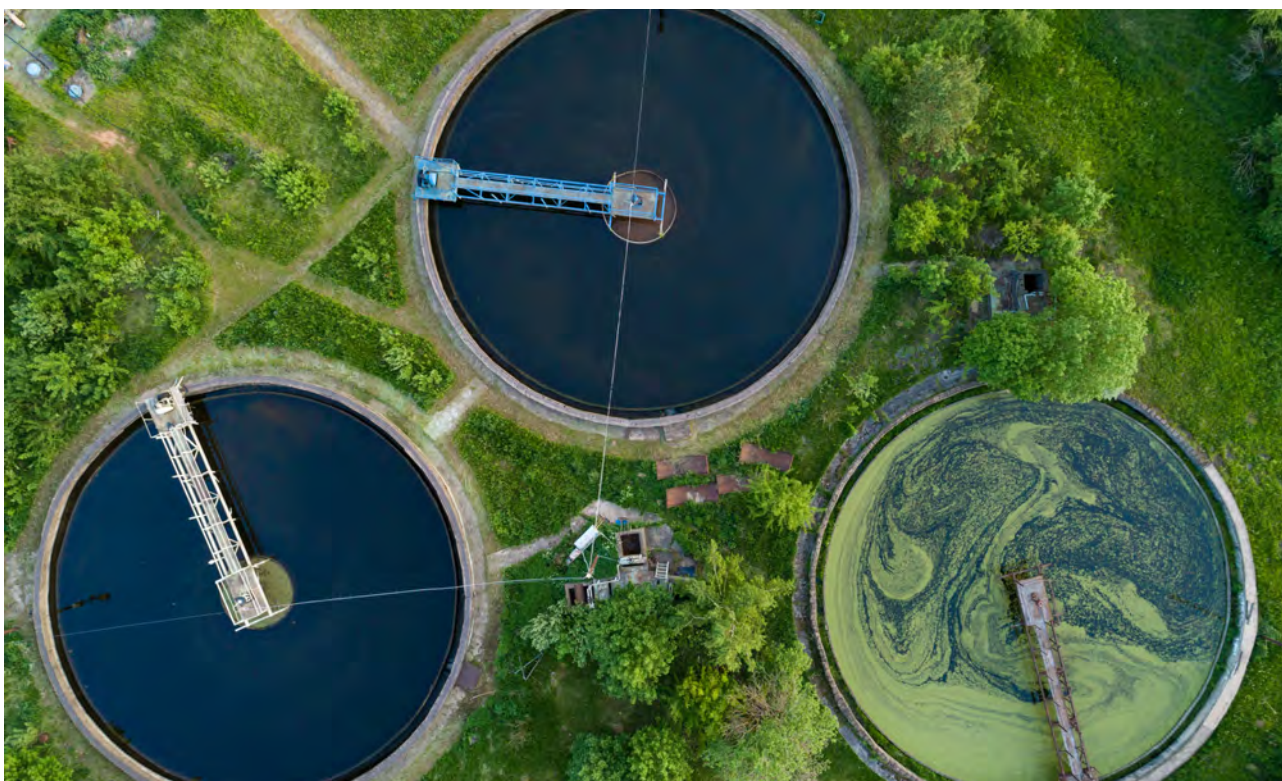
With climate risks identified, companies can plan adaptation measures and work in partnership with suppliers and communities across the value chain to adapt to climate change. Companies can (1) leverage tools, technologies and supplier relationships to obtain better transparency into climate risks at points of origin and (2) leverage supplier engagement strategies to educate, motivate and incentivise suppliers to drive adaptation strategies and manage their supply chain to follow suit. The Pepsi and Unilever case studies below illustrate this.

Finally, companies can implement these measures, monitor progress and evaluate their effectiveness.

Together, these steps can make a dramatic difference to a company’s resilience to a warming climate. Below, we share examples of how both producers and consumers of essential commodities are applying these steps.

How commodity producers are enhancing resilience

As water scarcity and unpredictability intensifies with climate change, some leading companies are adapting by using technology, for example by adopting advanced water management systems to prevent wastage. Such systems can help decision makers predict water needs, optimise usage, and promote sustainable consumption across all stages of production. Other businesses are considering adaptation to infrastructure; for example, building elevated storage facilities in areas prone to flooding or investing in structures to provide shade.





Case study: Chilean mines are combating water scarcity with desalination plants - and now Direct Lithium Extraction (DLE)

Chilean mines in 2020 produced 154,000 tonnes of lithium, equal to 25% of the global total. However our analysis shows that by 2025 many face a high risk of drought. In addition, intensive water use by Chilean mines has increased water stress in some local communities. In anticipation of rising drought risk, several mining companies in Chile have invested in desalination plants. There are 22 such plants currently in operation in Chile, with plans for a further nine.

Strategic investment in desalination has enabled Chilean mines to prepare for rising risk exposures and has supported production at scale in drought prone regions. Building a large desalination plant is a costly solution but investment may create a competitive edge in the longer term.³¹

In addition, Direct Lithium Extraction (DLE) has emerged as a game-changing technology, offering a more efficient, environmentally friendly, and cost-effective solution to extracting lithium. Unlike conventional methods, which rely on evaporation and mineral concentration, DLE involves the selective extraction of lithium ions directly from lithium-rich solutions. This method, which has been incorporated into Chile's national lithium strategy, bypasses the need for evaporation ponds, allowing for faster extraction rates, reduced water consumption, and minimized environmental impact.³²

In farming, adaptation strategies include, for example, introducing drought-resistant crop varieties, alternative cropping patterns, biologicals (crop protection products derived from living organisms), and automation and digital technologies. Policy makers can help to provide funding to widen access to adaptive measures as in this example:



Case study: Drones help farmers in India reduce exposure to heat stress

In India, the use of drones to spot-spray pesticides and/or nutrients has delivered several benefits to farmers. First, it has increased the ability of farmers to deliver pesticides and nutrients to their crops more precisely. Reducing the amount of pesticide needed limits the adverse impact on biodiversity, while reducing the amount of nutrients needed reduces wasteful farming practices and saves costs. But crucially, the use of drones has also reduced the need for farmers and other labourers to work outside, thereby reducing their exposure to heat stress and the dangers to health and well-being that this can cause. The government of India is incentivising the use of these drones by subsidising the cost of purchasing them, while startups are offering training programmes for farmers interested in learning about their application.³³

With a clear picture of their climate risks, commodity producers can build a plan to manage them, as for example Mosaic did:

Case study: PwC helped Mosaic manage climate change risks to its operations



Mosaic is a leading producer of concentrated phosphate and potash and wanted to better understand how physical climate change risks could [potentially impact its global operations](#). PwC US's team of climate risk specialists began by undertaking a broad qualitative risk assessment that outlined some of the most important potential climate-related risks to Mosaic's operations. Using future climate scenarios from a variety of established models and third party expert data sources, they then evaluated the potential business impact of each risk.

Together, Mosaic and PwC identified some of the highest-priority climate-related risks across the business, ranked by estimated likelihood of occurrence and severity of impact. Following this initial workshop, Mosaic identified four physical risks to study further. PwC analysed potential risk levels and associated business impacts of the largest physical risks to Mosaic. It leveraged 2°C and 4°C warming scenarios to examine the potential risks to the business under both a low-carbon economy and a high-emissions scenario, creating a risk spectrum for the company's assets. PwC then integrated Mosaic's future plans and mitigation efforts to give increased focus to the analysis.

The exercise helped Mosaic refine its estimates of the potential impacts that certain physical risks could have on its global operations. It will also enable it to make more informed decisions in the future.

How commodity consumers are enhancing resilience

Commodity consumers rely on a web of commodity producers, processors, shippers, and other players across the value chain - all of whom can be affected by climate impacts. For commodity consumers, adaptation starts with a crystal clear understanding of climate change risks throughout the value chain, considering both direct and indirect climate impacts - some of which may not be apparent without careful investigation.



Case study: Tracing climate risks throughout commodity supply chains

A growing number of businesses have begun using tools and methodologies including climate risk assessment models, satellite imagery and data analytics, to map and catalogue climate risks to their commodities.

Food company General Mills, for example, tracks commodities such as wheat, dairy and oats, using climate data to understand and mitigate risks related to extreme weather and growing conditions³⁴, while furniture company Ikea tracks materials such as wood and cotton to monitor climate risks related to deforestation, water usage and carbon emissions³⁵. Consumer goods firm Procter & Gamble maps the supply chains of commodities including palm oil and paper pulp to monitor climate risks.³⁶

Innovative technology software can help with analysing and managing supply chain risks as this example shows:

Case study: 'Check Your Value Chain' technology helps to reveal climate risks



It can be increasingly challenging for companies to gain visibility into complex supply chains in order to check that they adhere to climate and environmental standards, human rights protections, and other requirements.

For example, the EU is implementing new legislation that includes supply chain provisions such as the Corporate Sustainability Due Diligence Directive (CSDDD), the Carbon Border Mechanism Adjustment (CBAM) and the European Union Deforestation free Regulation (EUDR). In addition, in 2023, the German Supply Chain Due Diligence Act (SCDDA) came into force, requiring German companies (and those who have major trading relations with them) to assess potential human rights violations and environmental risks within their global supply chains.

A team at PwC Germany has created a multi-client, SAP-based software-as-a-service offering called [Check Your Value Chain](#) (CYVC) which enables businesses to automatically analyse extensive supplier data across their entire value chain to identify any environmental and social risks or violations.

The automated risk analysis, which includes an analysis of macroeconomic risks, evaluation of publicly available news sources and a review of SCDDA-relevant certificates and benchmarks, gives companies an overview of their full business partner portfolio to quickly identify risky business partners. The questionnaire functionality is automated and consists of a predefined, risk-based catalogue of questions as well as a free text option giving the client the option to ask additional questions.

PwC's solution enables companies to comply with supply chain regulations in a comprehensive and traceable way which could in turn help companies to identify and mitigate climate risks to their supply chain.³⁷

Many commodity consumers have used the Taskforce on Climate-related Financial Disclosures (TCFD) framework which is designed to help organisations analyse their climate-related risks and opportunities. For example, PwC France helped a large supermarket chain apply TCFD to assess the potential impact of climate-related changes to the supplies of fresh agricultural produce to its stores:

Case study: Supermarket chain assesses the reliability of its raw produce supply chain

A large French supermarket chain wanted to better understand how climate change could impact the supplies of the most important agricultural crops being sold in its supermarkets, across cereals, fruit and vegetables.

The company asked PwC France to support it in conducting a thorough analysis of climate change risks and opportunities for these crops according to the recommendations from the Taskforce on Climate-related Financial Disclosures (TCFD).

The first step was to identify the biggest-selling agricultural products across the supermarket chain by assessing the supplies going to its largest supermarkets. These were found to be wheat, maize, potatoes and strawberries.

PwC France then identified the main geographical areas where these four crops were grown in France, using geographical data from the French government and other public sources to identify the material climate hazards to these crops in the short and medium term up to 2050, according to different IPCC scenarios. These findings were used to highlight the climate risks for each region and type of produce.

Through this analysis we identified several different climate hazards that could affect and damage the crops, especially drought caused by rising temperatures and water scarcity.



Uncovering climate risks throughout the value chain can help to create urgency to adapt while providing the granular information needed to take the right protective actions, as PwC learned when we took the time to examine our own climate risks:

Case study: PwC uncovered climate risks to our own offices

Too often the impacts of climate change can feel distant, even abstract. At PwC, when we took the time to clearly understand how climate change might affect our own offices, the risks became tangible, immediate, and personal. Our climate risk teams showed us exactly how much each of our hundreds of offices worldwide are likely to be exposed to climate hazards such as drought and extreme heat.

When we could see that certain PwC offices from Tokyo to Tampa are likely to face up to 200 days a year of potentially deadly temperatures, climate change feels very real, very quickly. This stark picture of our risks helped to galvanize action and, more importantly, give our people the granular information they need to take [steps to adapt](#). Having clear data on our own risks helped to dispel misunderstandings that climate change's effects will happen only in the distant future, elsewhere, and to other types of businesses. We [made public](#) highlights of our climate risks, in part to encourage other companies to examine theirs.



Some forward-looking businesses are managing climate risks by adapting their sourcing and operational strategies, diversifying their supplier bases, and developing contingency plans to safeguard their supply chains. Businesses are adopting measures such as inventory planning, contractual climate resilience clauses, dynamic pricing mechanisms, transport resilience measures, quality assurance and adaptability, and climate risk insurance.

The experience of Nestlé, a major consumer of agricultural commodities, demonstrates how to use a clear picture of climate risks to develop a comprehensive climate strategy to manage risks and maintain business continuity:



Case study: Nestlé's climate resilience strategy

Nestlé, a global food and beverage company, undertook climate change risk assessments at the site, project and supplier levels. Having identified climate change as a key risk, the company used these assessments to better understand and manage climate-related risks and opportunities. It also used climate scenario analysis to better understand the impact of climate change over long time horizons.

Nestlé simulated physical climate risk for the period 2025 to 2040. The analysis considered a temperature rise beyond the 1.5°C target by 2040 to analyse impacts on direct operations due to damage to facilities and production issues due to input supply shocks. Informed by the climate risk assessment and scenario analysis, Nestlé developed a comprehensive climate strategy outlining its efforts to mitigate the physical risks of climate change to its business. The company also developed site-specific loss prevention, business continuity and water reduction strategies as measures to manage risks to facilities. It promoted sustainable sourcing, including promoting regenerative agriculture in the value chain. This climate strategy has been integrated into Nestlé's existing systems and processes, including risk management and executive compensation. It is implementing the adaptation measures identified under the strategy across all geographies and markets where the company operates. [Learn more.](#)

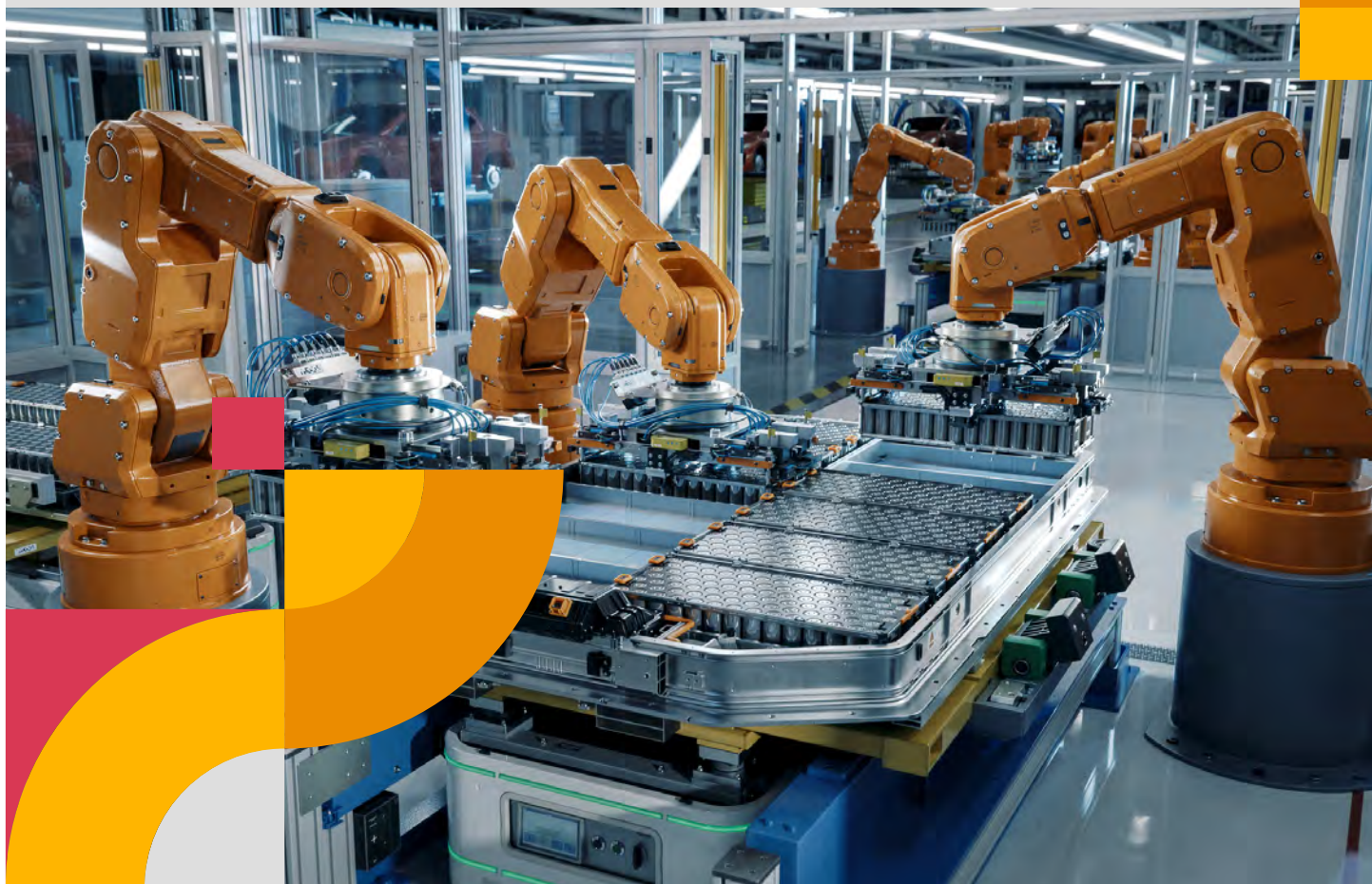
Tesla, a major consumer of lithium and cobalt, uses a range of adaptation strategies including collaborating with other battery makers:

Case study: Tesla's strategy to protect its supply of critical minerals

Tesla is one of the largest manufacturers of electric vehicles in the world and relies on regular supplies of lithium and cobalt to make the batteries for its cars. Both lithium and cobalt play an essential function in improving vehicle range and safety performance.

The company has therefore adopted a multi-pronged strategy to build vertical integration and help it establish a reliable lithium supply chain. It is currently building its own lithium refinery in Texas and has signed agreements with lithium and nickel producers in the United States and Canada to grow its supplier base. It is also collaborating with other battery makers to facilitate consistent supply. In addition to its own cell manufacturing operations, the company currently uses cells from four different suppliers with three different battery chemistries.

Tesla conducts an annual Enterprise Risk Assessment to identify physical climate-related risks to the business including site-specific reviews of its gigafactories and other manufacturing sites. Using the results from these analyses, Tesla is looking at ways to protect its manufacturing activities against medium-term and long-term climate impacts. [Learn more](#)



PwC helped a global consumer packaged goods company to quantify the value of commodities at risk and model the impacts of climate change on future prices of key commodities:

Case study: PwC quantified the value at risk and impact on future prices for a global consumer products company

The procurement team at a global consumer packaged goods company asked PwC to help it understand the potential impact of climate change on its ability to source 12 priority crops, including maize, soybeans and oranges. It also wanted to understand the potential impact of climate change on future orange yield and orange juice prices.

PwC performed extensive research, data acquisition and statistical analysis to arrive at future climate impacts for each of the 12 crops. To develop value at risk metrics, PwC identified crop-specific growing regions through satellite imagery and client-provided data. We then identified regions highly exposed to drought, extreme heat and extreme cold under low and high emissions scenarios by 2050 using output from IPCC climate models.

PwC then quantified the value at risk to the client by incorporating the client's procured volume and procurement spend for each crop and the climate exposure of their respective sourcing countries.

The client also had rising concerns about oranges due to their exposure to climate change and Citrus Greening disease, which is linked to rising temperatures caused by climate change. To address this PwC developed climate metrics for orange growing seasons in both Northern and Southern hemispheres as well as for the future prevalence of Citrus Greening disease. We then projected these metrics using IPCC climate model output under low and high emissions scenarios to map the changing suitability of growing oranges in different regions and the future likelihood of Citrus Greening disease.

PwC also developed a model using historical country-level yield data and projected changes in orange juice prices due to a potential spread in Citrus Greening disease under different climate scenarios to represent the financial impact of the disease on the future orange juice prices.



Recycling can help to protect commodity users from climate risks to mines by reducing dependence on newly mined commodities. For instance, recycling one tonne of steel in the US conserves 1.1 tonnes of iron ore, the raw material that makes steel. There has been a notable increase in the past few years in lithium-ion battery recycling, which reduces the need for freshly mined lithium.³⁸ Apple is one of several major companies which has been exploring their ability to increase the role of recycling in their supply chain:



Case study: Apple drives efforts to reduce its reliance on mining

Technology giant Apple is stepping up its efforts to reduce its reliance on mining with a new focus on using recycled or renewable materials in its products. At present around 20% of the materials used to make its products are from recycled or renewable sources, but by 2025 it plans to use 100% recycled cobalt in all its batteries, 100% recycled tin and gold plating in all its printed circuit boards, and 100% recycled rare earth elements in all magnets used in its products. This will reduce its reliance on mining, smelting and refining, with the long term aim of increasingly reducing its reliance on the mining of new materials.

The company is also collaborating with other businesses and organisations on an industry level by engaging in industry initiatives such as the Responsible Minerals Initiative (RMI) and the Platform for Accelerating the Circular Economy (PACE), a global collaboration platform for public and private decisions makers to share best practises towards a circular economy.³⁹



Recycling is a key element in the development of self-sustaining circularity as this example shows:

Case study: Making progress towards self-sufficient circularity for EV batteries

As demand grows for electric vehicles (EVs), so too does demand rise among EV battery makers for lithium, cobalt and other critical minerals required for battery manufacture. However, a survey by climate research organisation RMI⁴⁰ suggests that mineral extraction may be about to peak and subsequently fall as demand is reduced by a transition to circularity and recycling, thanks to advances in efficiency and innovation.

RMI's Mineral Battery Loop strategy suggests that the demand for lithium, nickel and cobalt would be between 60% and 140% higher than they are today if not for the improvements in chemistry mix, energy density and recycling that have been achieved in the past decade. Continuing this trend into the future suggests that demand for extracted battery minerals could peak in the mid-2030s and then start to fall to a point at which using recycled batteries will be a far more important source of supply than newly extracted minerals from the earth.

This progress to self-sufficient circularity could be made possible by accelerating six key solutions: deploying new battery chemistries, making batteries more energy-dense, recycling their mineral content, extending their lifetime, improving vehicle efficiency, and improving mobility efficiency. Indeed, RMI's projections suggest that as a result of this circularity virgin mineral extraction may eventually not be needed at all in future. Even if this is not the case, demand for newly mined materials may be significantly lower in future.

In the US, for example, recycling of EV lithium batteries is expected to increase substantially over the next few years. If all of the planned recycling facilities come online, the US will have sufficient capacity to process all of the expected end-of-life batteries from EVs until 2044. Many of these recycling facilities are being built next to battery manufacturers which helps to create a coherent manufacturing ecosystem.⁴¹



Pillar 2: Capitalise on Opportunities

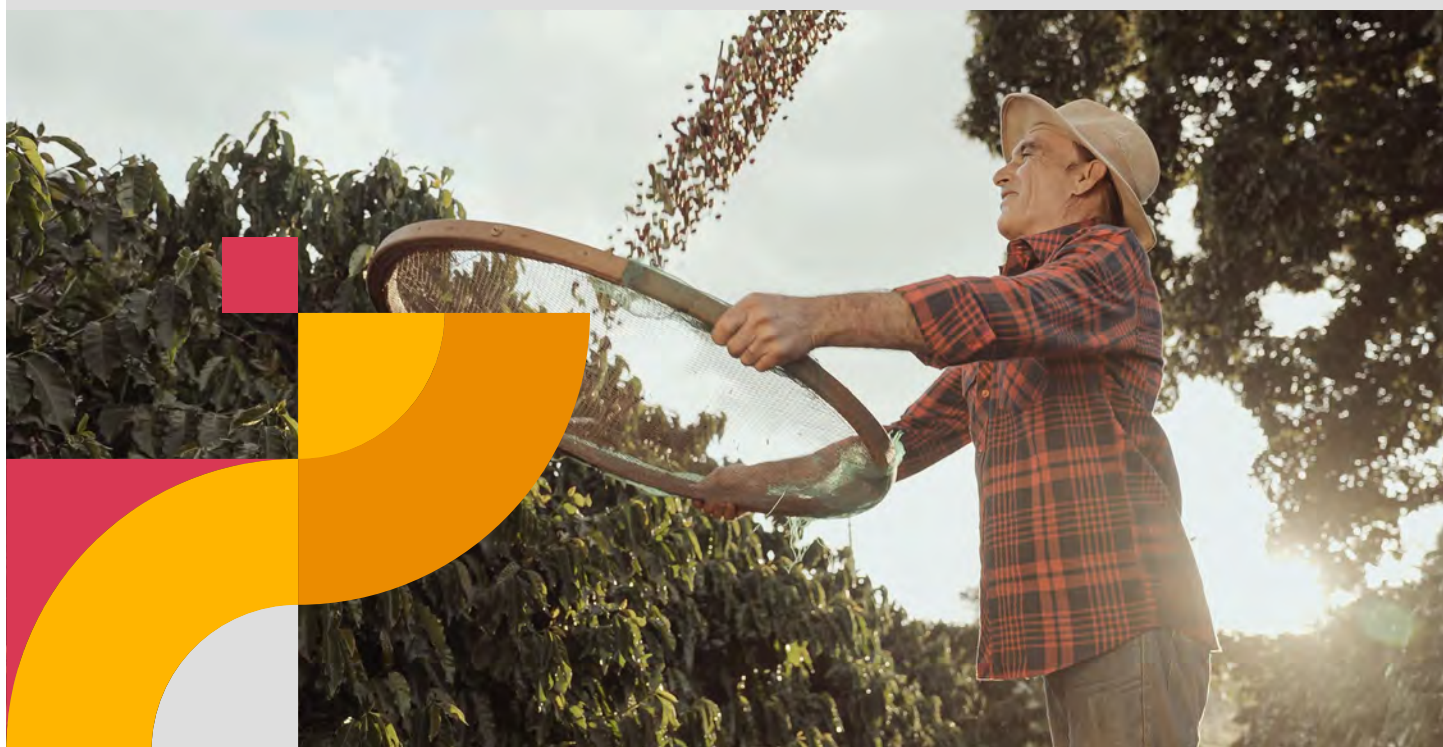
At the same time as managing their own climate risks, companies can seize opportunities to help the wider business community and ecosystem adapt. This is true for both producers and consumers of commodities. Companies can, for example: review how their existing or new products and services can support adaptation; invest in adaptation solution research, development and innovation; and collaborate with other businesses and stakeholders to develop and deploy new adaptation solutions at scale. The underlying aim is to seize opportunities to build society's shared arsenal of adaptation solutions, benefitting both a company and its wider community.

Below we share case studies that show how forward-thinking companies are creating platforms that help thousands of other businesses adapt to a changing climate.

Case study: Addressing the challenges facing coffee farmers

Climate change is making it increasingly difficult for farmers to grow a reliable supply of coffee beans, so coffee shop chain Starbucks has so far distributed more than 80 million climate-resistant coffee trees to farmers in El Salvador, Guatemala and Mexico as part of its target to distribute 100 million trees by 2025. It has also provided more than 53 million coffee seedlings to farmers in Colombia.

Starbucks' support for farmers is part of its wider efforts to assess and address the impact of changing climate conditions on coffee production in coffee-growing regions. It partners with organizations such as Conservation International to use data analytics, climate models and field surveys to monitor and predict changes caused by climate, as well as provide support for sustainable agricultural practices to preserve and enhance biodiversity.⁴²



Some commodity producers are partnering with others in their industry to develop methods of protecting operations from climate perils like extreme heat:



Case study: Aluminium industry collaborates to minimise climate impact on workers in mines and refineries and their communities

The International Aluminium Institute has embarked on a project to understand the potential impact of climate-related risks on the health of aluminium industry employees, and what actions can be taken to mitigate this.

The project's researchers found that temperatures produced by climate change can affect aluminium production by, for example, causing heat-related illnesses, vector-borne diseases and drought-related impacts. Climate change also causes an increased frequency of extreme weather events which can damage infrastructure, prevent employees from getting to work and even cause serious injuries or deaths to the workforce and communities.

A reliable labour force is essential to the operation and profitability of the aluminium industry and so these risks need to be properly managed. Adaptation options may include introducing new work practices such as providing shade or cooling for workers engaged in strenuous labour in high temperatures, and providing protective clothing and training workers to spot the early signs of heat-related illness.

The project has created an action plan for mine and refinery owners and communities to follow to enable them to easily identify and assess climate-related impacts on workers, and then put in place adaptations to minimise these impacts.

A great example of what can be achieved by identifying opportunities to mitigate the impact of climate risk is this innovative solution from PwC’s Middle East team:



Case study: Managing climate change impacts with AI resilience tool

Floods caused by climate change are a severe global challenge that affect the lives and livelihoods of millions of people. An estimated 25% of the world’s population are exposed to flood risks. In the past decade alone flooding has displaced approximately 24 million people and caused economic losses of approximately US \$453 billion. Realizing the global need to address the devastating impact that flooding can cause, a team from PwC Middle East used AI to create a Flood Resilience tool.

The Flood Resilience AI tool, which is currently at prototype stage, uses advanced technology such as geospatial AI to create dynamic simulations which show possible flooding scenarios. Real-time data such as the slope of an area, rainfall, speed and direction of a cyclone and distance from the ocean are used to create the simulations which are then presented in a visual 3D environment, making it easy for people to understand the likely flow of the flood at the level of individual properties.

These immersive simulations can help government agencies, emergency services, first responders and homeowners, as well as other organisations such as insurance agencies, to create plans and strategies that will reduce the impact of the flooding in the event of a real-life emergency, for example by carrying out targeted emergency evacuations to safeguard communities.⁴³ Tools like this can help to increase commodity producers’ ability to manage climate risks.

Pillar 3: Shape collaborative outcomes

Many companies are collaborating on climate action with a range of stakeholders from governments and investors to academics and local communities. Companies are working within these ecosystems to develop new measures that will support their operations for the long term. In so doing, they are protecting both their own strategic interests and the interests of future generations.

For example, mining and farming companies are tapping into academic and research insights, aligning with technological innovators, talking with regulators and investors, and working to understand local community perspectives. Car makers are collaborating with other industry players to secure supplies of materials to their manufacturing processes. Food producers are working with their suppliers to enable consistent supplies while helping those suppliers protect their own livelihood. By joining forces, companies can work towards establishing unified standards, consolidating research efforts, and fortifying links across the global supply chains.⁴⁴ All these efforts recognise that a richer dialogue and a shared sense of purpose will spur more innovation and help companies thrive in new operating environments.

Below are case studies that show what shaping collaborative outcomes looks like in practice, and how pragmatic action on this front can help further adaptation for all involved. First, PepsiCo's experience shows the value of partnerships between commodity producers and consumers:

Case study: PepsiCo's Regenerative Agriculture Strategy

PepsiCo, one of the world's largest food companies, relies on a secure supply of more than 30 agricultural crops and ingredients - including maize, wheat and rice - from approximately 60 countries. In order to enable these supplies to be protected from the impact of climate-related risks PepsiCo works with its farmers to adopt regenerative agriculture practices — a set of techniques designed to improve and restore ecosystems in areas which could be affected by climate change to make soil healthier, capture carbon, improve watershed health, protect and enhance biodiversity and strengthen farmer livelihoods by optimizing their long-term yields and farm income.

The company supports a wide range of regenerative practices including planting cover crops to protect the soil, reducing tillage to maintain soil health and fertility, and encouraging livestock and other diversity onto farms. These practices help maintain and add nutrients, improve fertility, maintain soil carbon, control pests and weeds through sustainable management, improve biodiversity, maintain water quality and protect watersheds. By supporting farmers in this way, PepsiCo aims to help secure its supply while helping farmers address the challenges of climate change and prepare for agricultural challenges of the future. [Learn more.](#)

Businesses may be able to find ways to work closely with their suppliers over the long term to manage climate risks and ensure consistent supplies, as brewer Molson Coors has done:

Case study: Molson Coors supports local farmers to grow climate-resilient barley

US brewer Molson Coors has developed an industry-leading barley program that produces all the barley it needs for its US production and 20% of the barley for its Canadian operations.

The program was created in 1946 and has grown to encompass more than 800 farmers across 200,000 acres in prime barley-growing regions in four US states, providing the brewer with consistently high-yield, high quality barley. The program incorporates the knowledge of a team of researchers based in Idaho who crossbreed variants of barley, developing new ones that can withstand growing conditions that have become harsher over the last few decades. Farmers are also supported by a team of seven Molson Coors agronomists who consult on growing conditions and help them implement best practices in terms of water efficiency, soil health, pest control and more.

The barley program increasingly incorporates technology that makes growers more efficient, including mapping and data collection using drones and satellite imagery, tools to measure water content in soil and precision planting equipment.

As a result farms are able to adapt their agricultural practices to account for unpredictable weather patterns, drought and poor soil. The result is a win-win, with the program providing stability for the farmers, many of them family-owned operations who have worked with Molson Coors for decades, and consistently high quality barley for the business.



Businesses may choose to work together with their suppliers to introduce regenerative farming practices which protect and support the land, as Unilever is doing:

Case study: Unilever supports farmers to build climate resilience

Consumer products company Unilever launched a Climate & Nature Fund in 2020 to help accelerate and scale regenerative agriculture amongst its farmer suppliers. Unilever has committed to invest €1 billion by 2030 through the fund in meaningful climate, nature, and resource efficiency projects, in order to transform the way its products are made and reach end of life.

At a farm level, Unilever has developed its Regenerative Agriculture Principles to foster regenerative agriculture practices which are focused on delivering positive outcomes in terms of nourishing the soil, increasing farm biodiversity, improving water quality and climate resilience, capturing carbon, and restoring and regenerating the land.

The projects supported by the fund aim to help Unilever progress towards its goal to improve the health of the planet, including reaching net zero by 2039, while also driving growth and increasing resilience.⁴⁵

Businesses may be able to support their suppliers in modifying crops to make them more able to withstand challenging conditions:

Case study: Modified wheat offers hope for farmers dealing with drought

Argentinian company Bioceres Crop Solutions has developed a type of wheat that has been genetically modified to tolerate drought. Its HB4 wheat is good news for farmers grappling with drought and more irregular weather patterns, which can affect the yield and quality of conventional wheat.

The US Department of Agriculture has recently approved HB4 wheat for cultivation in the US, clearing the way for field trials of the crop. Argentina, Brazil and Paraguay have also approved the production of HB4 wheat, while several other countries including Australia, New Zealand and South Africa have approved HB4 wheat for food and feed use. Australia has also granted a license to undertake field trials to gather the necessary data for an eventual production application.

Genetic modification involves altering a plant's makeup by transferring DNA from one organism to another and is already commonly used in crops such as corn and soybeans. In the case of HB4 wheat, drought tolerance was achieved by incorporating a sunflower gene. By enabling crops to tolerate drought, genetic modification can protect yields achieved by farmers in adverse weather conditions, which are likely to increase with climate change, maintaining profitability and reducing the risk of food shortages.⁴⁶

Some companies are seeking innovative ways to find partners with specialist expertise that can support their suppliers. This example suggests one way in which this can be done:

Case study: Nestlé pilots a scheme to help coffee farmers manage the risks of unpredictable weather

Nestlé has undertaken a number of collaborative measures to safeguard its supply chain. Recognizing the pressure on coffee-growing areas due to climate change, in 2023 Nestlé launched a pilot weather insurance scheme in collaboration with Blue Marble, a specialist in climate insurance, to provide financial protection for more than 800 smallholder coffee farmers in Indonesia that supply coffee to its brand Nescafé. The insurance provides financial protection to help farmers cope with unpredictable weather patterns of rainfall and severe drought. The insurance uses satellite-based climate data to determine when coffee output has been impacted by either too much or not enough rainfall during key phases of the crop cycle. Payments are issued automatically to registered coffee farmers that have been affected, according to the severity of the weather.

Based on the results of the pilot, Nestlé will determine whether to expand the approach to other Nescafé sourcing locations around the world. As part of its efforts to support its farmer suppliers, Nestlé is also sharing expertise on regenerative agriculture, encompassing practices that restore soil health, reverse biodiversity loss and strengthen ecosystems.⁴⁷



Partnerships can also span countries and nations to deliver added impact, as the examples below show:

Case study: Minerals Security Partnership drives international cooperation

The Minerals Security Partnership (MSP) is a transnational association focused on international cooperation. It is made up of 13 countries and the EU and works to accelerate the development of critical energy minerals supply chains, targeting the minerals and metals which are crucial for clean energy technologies. This collaborative initiative underscores the importance of international cooperation in ensuring the resilience of critical mineral supply chains amid evolving global challenges.⁴⁸



Case study: International collaboration and funding to protect supply chains

The EU and other countries are seeking to strengthen their commodity supply chains through international agreements. For example in 2023 the US and Japan signed a Critical Minerals Agreement (CMA).⁴⁹ Both countries agreed that they would not restrict imports or exports of five critical minerals, which include lithium, copper and cobalt, or impose export duties. Similar collaborations may become more common as countries seek to build resilience against political and climate-related disruptions affecting their supply chains.

Governments from the EU and elsewhere are also supporting countries to adapt to the impacts of climate change. The EU is the biggest provider of climate finance in the world, with the funds supporting climate action in developing countries in order to tackle the adverse effects of climate and help with their green transition.⁵⁰ Similarly, the US aims to mobilise US\$100 billion per year to build resilience and adapt to the impacts of climate change.⁵¹ Helping the key producers of critical commodities mitigate climate risks in turn strengthens the supply chains of EU industries.



Endnotes

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2. Academic research finds that climate change has already reduced the growth of overall global agricultural productivity by 21% since 1961. Source: 'Anthropogenic climate change has slowed global agricultural productivity growth,' Nature Climate Change
3. For more information, please see the IPCC's Sixth Assessment Report.
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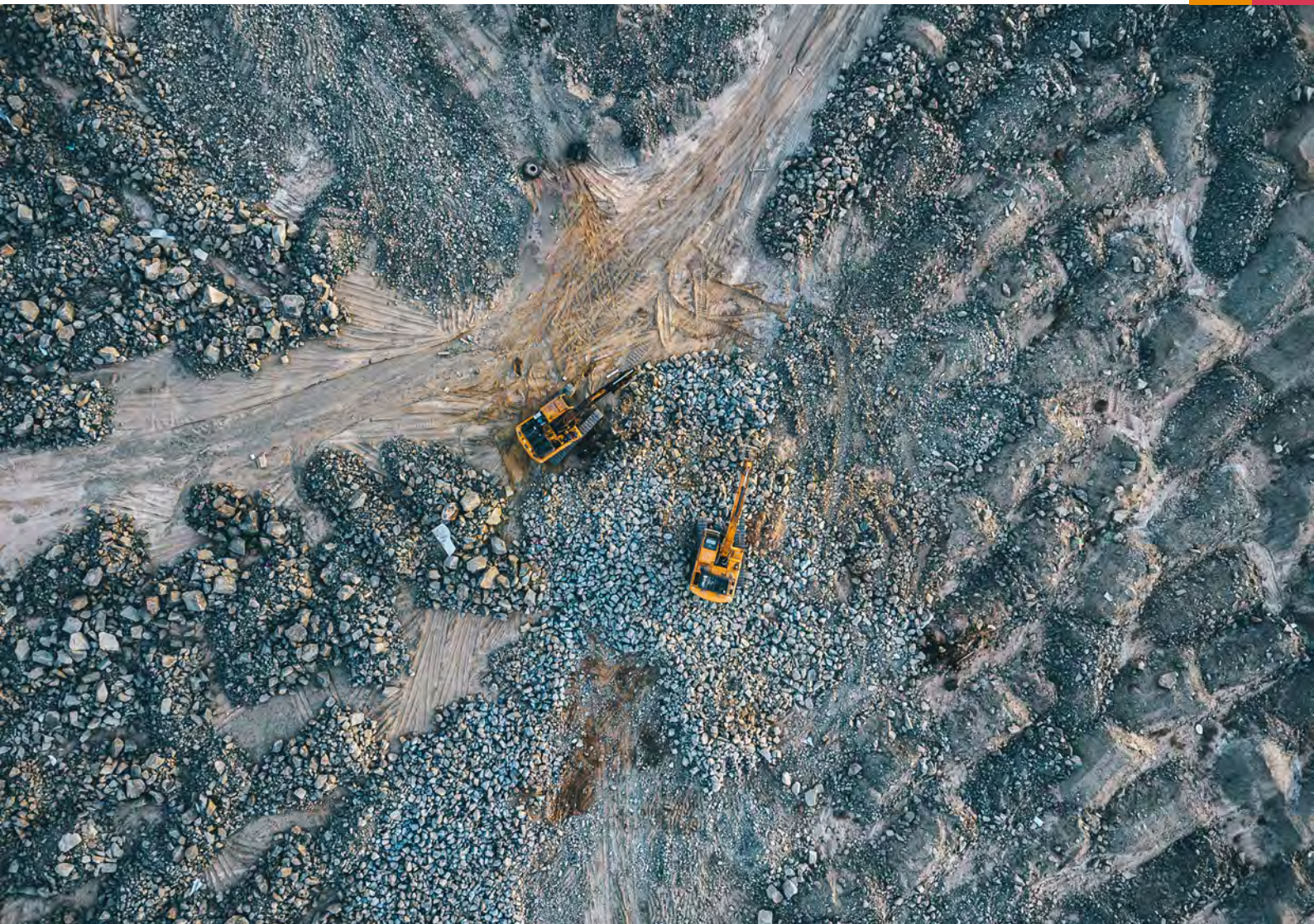
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