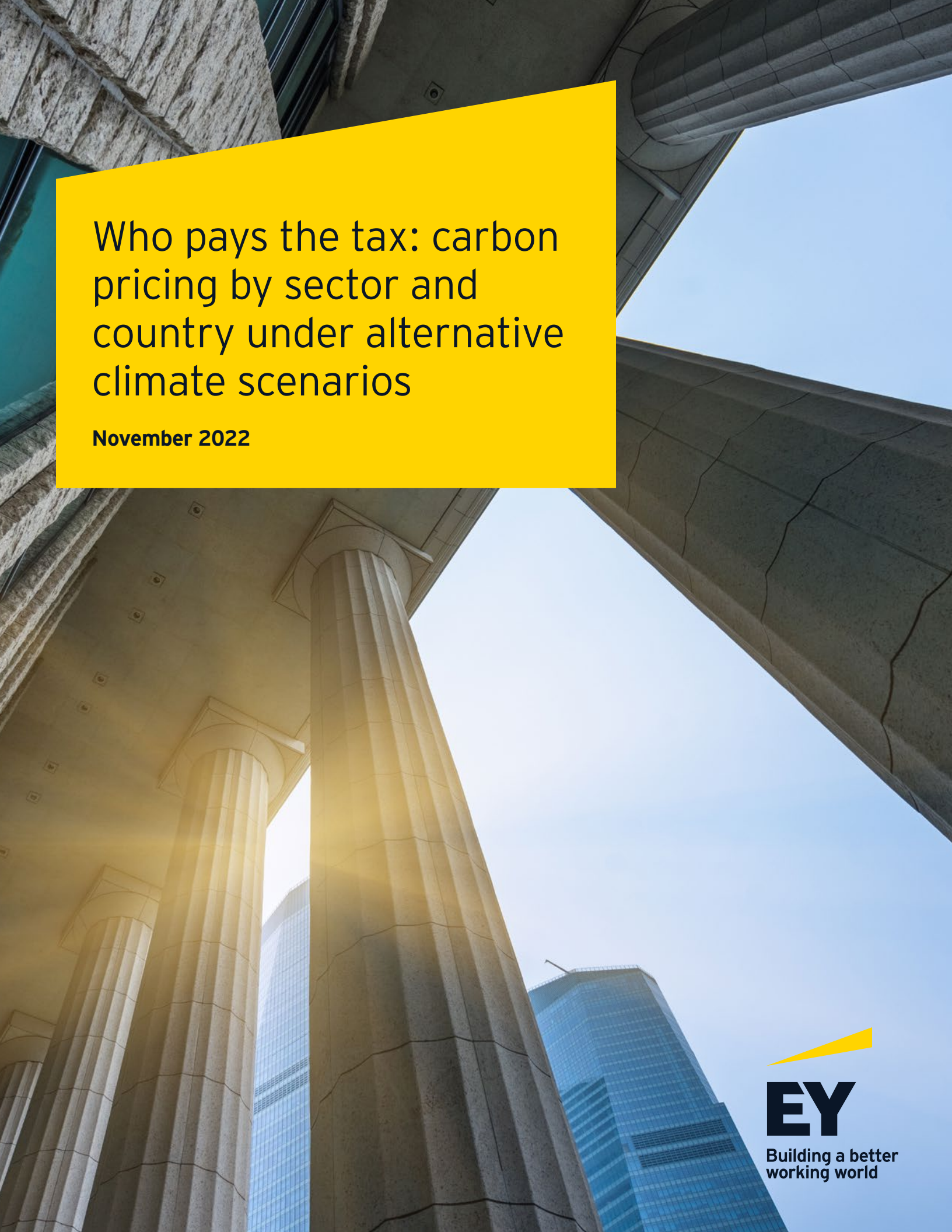


Who pays the tax: carbon pricing by sector and country under alternative climate scenarios

November 2022

EY
Building a better working world

Executive summary

Measures to limit global warming and address climate change are part of policy discussions happening around the globe. These policies can have broad implications for businesses, individuals, economies and the planet. Meeting the agreed-upon objectives of the Paris Agreement will require a significant shift in how countries approach climate change mitigation. This could include policies such as carbon pricing, border adjustments and other regulatory and tax measures.

At its most basic level, carbon pricing makes goods and services that are carbon intensive relatively more expensive than other less carbon-intensive goods and services. Businesses and households respond by purchasing less of the more expensive carbon-intensive goods and services, thus generally reducing greenhouse gas (GHG) emissions. Once carbon pricing is implemented, nearly all businesses are affected by the policy through additional direct or indirect business costs.

76% of the Group of Twenty (G20) and Organization for Economic Cooperation and Development (OECD) countries have already implemented some form of carbon pricing. Given the global focus on climate change and the range of possible policy paths that can be taken by governments worldwide, it is important that businesses formulate long-term strategies to adjust to the policies employed to make progress in the global transition toward a green economy. As part of this, businesses need to consider a variety of possible future scenarios.

To assist businesses in this effort, this report examines the carbon price liability by sector and country under alternative climate scenarios. The scope of this analysis is the G20 and OECD countries, which together account more than 90% of world GDP, approximately 80% of world population and above 80% of world carbon emissions.

Specifically, this report examines:[1]

1 **Business-as-usual** (BAU) scenario

This scenario assumes that policies in place remain in place at their current price and emissions coverage. Additionally, this analysis assumes that going forward sectors and countries continue to decarbonize at rates seen in recent years.

2 **Low-carbon-economy** (LCE) scenario

Estimated country-level decarbonization paths assume global net-zero carbon emissions by 2050. The LCE scenario is assumed to be achieved via use of carbon pricing.

This type of scenario analysis can be a useful tool for assessing the potential range of climate change implications. Businesses, for example, can use it to inform investors and stakeholders about how the organization is positioning itself in light of climate-related risks and opportunities.

[1] See body of report and endnotes for additional detail and assumptions. Additionally, see endnotes for caveats and limitations. Any modeling effort is only an approximate depiction of the economic forces it seeks to represent, and the economic model developed for this analysis is no exception.

Background

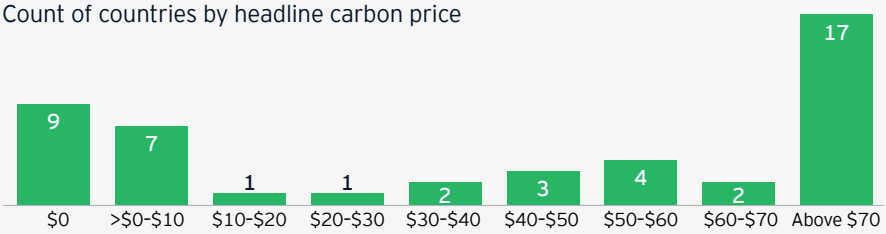
- Putting a price on carbon is viewed by many as a relatively easy and effective tool for lowering carbon emissions. Carbon pricing raises the relative cost of carbon-intensive commodities and services compared to other, less carbon-intensive goods and services.
- Regardless of who would be statutorily required to remit the price on carbon, nearly all businesses would be affected by a carbon price. A price would give rise to additional direct and indirect business costs, with emissions-intensive sectors incurring more of the former and other sectors more of the latter.
- Direct impacts are the costs that the carbon price would impose on carbon-emitting sectors. Indirect impacts include increased prices for goods and services purchased from other businesses due to those supplier businesses being subject to a carbon price.

Business-as-usual scenario

- In a BAU scenario, existing policies are assumed to remain in place at their current price and emissions coverage and future decarbonization is assumed to follow recent trends. Scenarios are not predictions but potential future paths that are useful to help evaluate possible future risks and opportunities.
- Across G20 and OECD countries, the average headline carbon price is $47/ton whereas the average effective carbon price is $23/ton.[2] Similarly, the median headline price is $50/ton, and the median effective carbon price is $25/ton. There are only three countries with an effective carbon price above $50/ton. In contrast, there are 23 countries with a headline carbon price above $50/ton. (Figures ES-1 and ES-2)
- Emissions coverage varies significantly by sector across G20 and OECD countries. Across all sectors, 30% of emissions are subject to a carbon price. This is highest in electricity (56%) followed by road transport (22%), industry (18%), buildings (13%), agriculture and fisheries (12%) and off-road transport (11%). (Figure ES-3)

Figure ES-1. Distribution of headline carbon prices in G20 and OECD countries, 2022

Count of countries by headline carbon price



Note: Analysis includes all G20 and OECD countries. Values are US$2022. Figures are rounded.
Source: EY analysis.

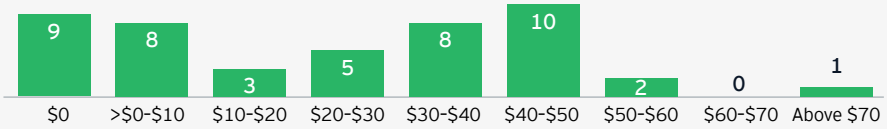
$47
Simple average

$25
Weighted average

$50
Median

Figure ES-2. Distribution of effective carbon prices in G20 and OECD countries, 2022

Count of countries by effective carbon price



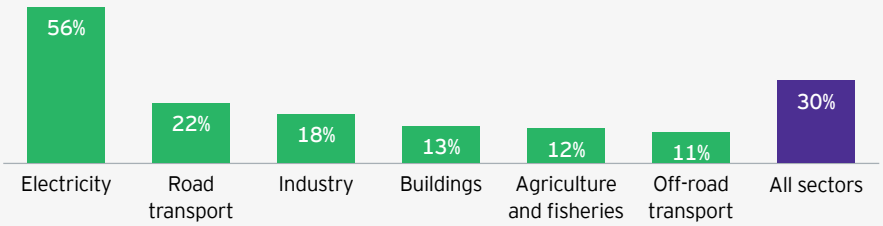
Note: Analysis includes all G20 and OECD countries. Values are US$2022. Figures are rounded.
Source: EY analysis.

$23
Simple average

$7
Weighted average

$25
Median

Figure ES-3. Share of emissions covered across G20 and OECD countries in 2022, by sector



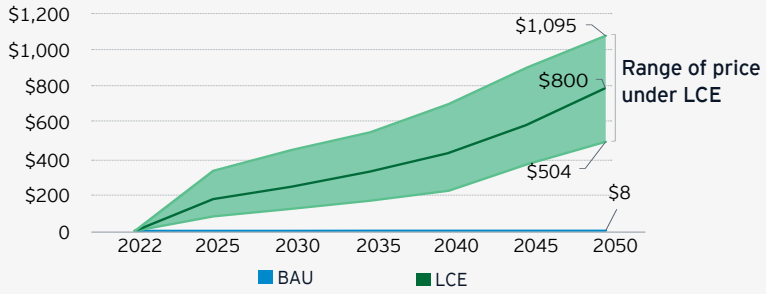
Note: Analysis includes all G20 and OECD countries. Figures are rounded.
Source: EY analysis.

[2] A headline carbon price is the price charged for each ton of carbon subject to a carbon price. For example, if a country has a carbon price of $100/ton but only 10% of the country's carbon emissions are subject to a carbon price the headline price is still $100/ton. An effective carbon price is the average price per ton of carbon across a country's total carbon emissions (i.e., not just carbon emissions subject to a price). For example, if a country has a $100/ton carbon price but only 10% of the country's emissions are subject to a price then the effective carbon price is $10/ton (=$100/ton x 10%).

Low-carbon economy scenario

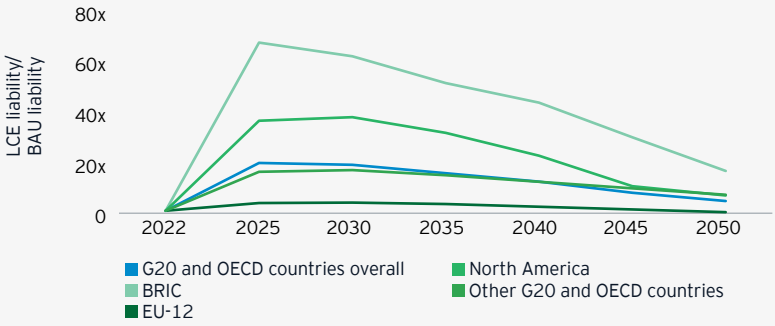
- This analysis includes a range for the effective carbon price necessary to achieve net-zero carbon emissions by 2050. This range, estimated by three prominent integrated assessment models, highlights both the significant uncertainty surrounding the necessary carbon price as well as the significant order of magnitude of the effective carbon price necessary to achieve net zero. In particular, by 2050, the effective carbon price in the LCE scenario ranges between $504 and $1095. This compares to the BAU scenario effective carbon price of approximately $8 in 2050. The average of the three LCE scenario effective carbon prices grows from $254 in 2030 to $440 in 2040 and $800 in 2050. (Figures ES-4)
- Under an LCE scenario, the 2050 carbon intensity declines to 2% of the level of carbon intensity of 2022 while under a BAU scenario, the 2050 carbon intensity declines to 46% of the level of carbon intensity of 2022.
- By 2030, the estimated carbon price liability under an LCE scenario would be 19 times the estimated carbon price liability under a BAU scenario across all G20 and OECD countries. By 2050, the estimated carbon price liability under an LCE scenario would decline to five times the estimated carbon price liability under a BAU scenario. This change is the net impact of a higher carbon price (increases liability) and higher decarbonization (decreases liability). This varies by sector and country. (Figures ES-5 and ES-6)

Figure ES-4. Effective carbon prices, BAU versus LCE



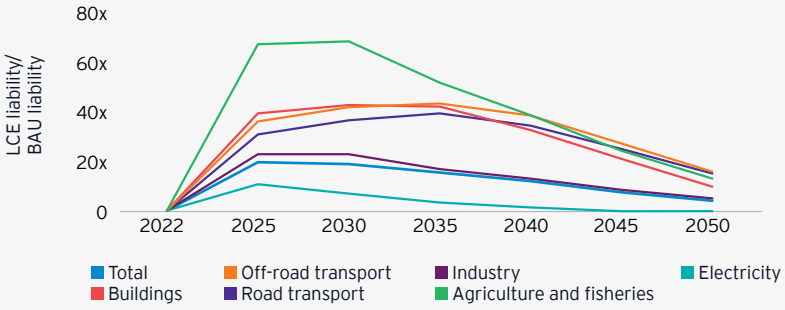
Note: Analysis includes all G20 and OECD countries. Values are US$2022. Figures are rounded.
Source: EY analysis.

Figure ES-5. Carbon price liability 2022-2050, BAU versus LCE



Note: Results are scaled to the size of the world economy in 2022. Analysis includes all G20 and OECD countries. Values are US$2022. Figures are rounded.
Source: EY analysis.

Figure ES-6. Carbon price paid by sectors 2022-2050, BAU versus LCE



Note: Results are scaled to the size of the world economy in 2022. Analysis includes all G20 and OECD countries. Values are US$2022. Figures are rounded.
Source: EY analysis.

Contents

1 Introduction

The Paris Agreement is an international treaty that aims to combat climate change and limit warming to well below 2°C, preferably to 1.5°C, as the present rate of global warming stands at about 1.1°C.[1]

Physical risks, such as severe weather events of the past year – from heatwaves to floods and wildfires – will continue to rise if the long-term objectives of the Paris Agreement are not realized. However, the action needed to realize the objectives of the Paris Agreement will require a significant shift in policy paths at a global scale. Such significant policy changes will introduce a range of unprecedented challenges for economies, businesses and households.

Given the uncertainty of the impact of climate change, the range of risks and opportunities and possible policy paths that can be taken by governments worldwide, it is important that businesses formulate long-term strategies as the world transitions toward a green economy. As part of this, businesses need to take into consideration a variety of possible future scenarios to fully understand the potential risks and opportunities. Scenarios are not predictions but potential future paths that are useful to help evaluate possible future risks and opportunities.

This report examines which sectors and countries pay a carbon price under alternative climate scenarios.[2] Specifically, this report examines:[3]

1 Business-as-usual (BAU) scenario

This scenario assumes that policies in place remain in place at their current price and emissions coverage. Additionally, this analysis assumes that going forward sectors and countries continue to decarbonize at rates seen in recent years.

2 Low-carbon-economy (LCE) scenario

Estimated country-level decarbonization paths assume global net-zero carbon emissions by 2050. The LCE scenario is assumed to be achieved via use of carbon pricing.

Components of this analysis include an overview of carbon pricing initiatives that are currently in place and a possible path for carbon pricing under an LCE scenario. This includes a description of the type of carbon price (i.e., carbon tax versus cap-and-trade or emissions trading scheme (ETS)) as well as a description of the sectoral and overall coverage of the carbon pricing. Decarbonization rates under both scenarios are also examined.

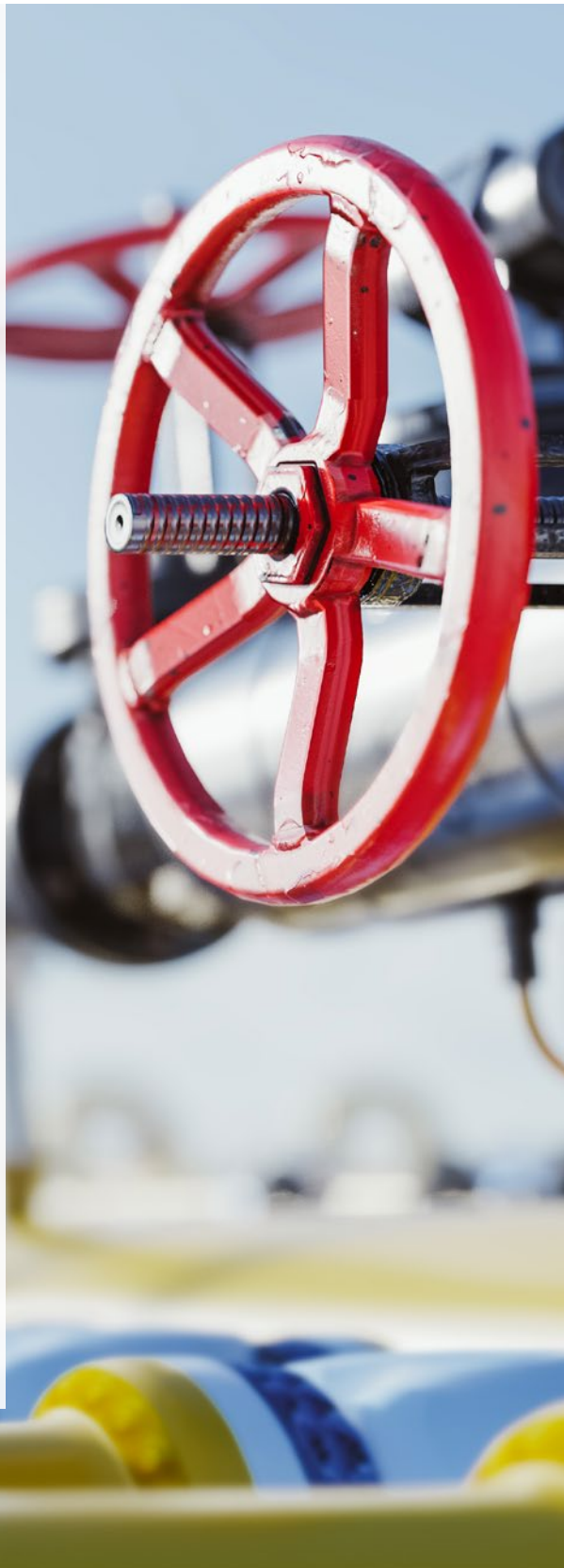
The scope of this analysis is the Group of Twenty (G20) and Organization for Economic Cooperation and Development (OECD) countries.[4] Together, these 46 countries account for more than 90% of world GDP, approximately 80% of world population and above 80% of world carbon emissions.[5]

While this analysis provides a general overview of carbon pricing, businesses should consider undertaking more detailed analyses that quantify the impacts for their specific company, sub-industry, suppliers, competitors and markets. This information can be helpful when formulating long-term strategies as the world transitions toward a green economy as well as in discussions with stakeholders and policymakers.

2 Primer on carbon pricing

Key insights

- Putting a price on carbon is viewed by many as a relatively easy and effective tool for lowering carbon emissions. Carbon pricing raises the relative cost of carbon-intensive commodities and services compared to other, less carbon-intensive goods and services. Businesses and consumers adapt by making fewer carbon-intensive purchases, hence reducing carbon emissions overall.[6]
- Regardless of who would be required, statutorily, to remit the price on carbon, nearly all businesses would be affected by a carbon price. A price would give rise to additional direct and indirect business costs, with emissions-intensive sectors incurring more of the former and other sectors more of the latter.
- Direct impacts are the costs that the carbon price would impose on carbon-emitting sectors. Indirect impacts include increased prices for goods and services purchased from other businesses due to those supplier businesses being subject to a carbon price.
- Because it is challenging to predict climate-related risks and opportunities, scenario analysis can be a useful tool for assessing the potential range of climate change implications. Businesses, for example, can use it to inform investors and stakeholders about how the organization is positioning itself in light of climate-related risks and opportunities.



Two commonly used methods for implementing carbon pricing are:

1. Setting a price on carbon emissions and allowing the quantity of carbon emissions to adjust (i.e., a carbon tax).
2. Limiting the quantity of carbon emissions and allowing the price to adjust (i.e., a cap-and-trade system or ETS).[7]

Regardless of who would be required to remit the price on carbon, nearly all businesses would be affected by a carbon price. A carbon price would give rise to additional direct and indirect business costs, with emissions-intensive sectors incurring more of the former and other sectors more of the latter.

Direct impacts are the costs that the carbon price would impose on carbon-emitting sectors.[8] Indirect impacts include increased prices for goods and services purchased from other businesses due to those supplier businesses being subject to a carbon price. Sectors that are not directly subject to the carbon price may still experience potentially significant overall cost increases if they rely heavily on inputs that use emissions-intensive production processes. As such, businesses across all sectors need to be informed and participate in the conversation as any debate over carbon pricing unfolds.[9]

Design considerations

When designing a carbon pricing policy, key points to consider include:

1. **Where to levy the tax:** Whether the carbon price should be levied on stationary sources, mobile sources or both. Stationary sources of carbon include facilities, such as factories and plants, while mobile sources include motor and off-road vehicles and engines.

2. **The initial carbon price and the rate by which it increases over time:** Examples of price escalation include increasing the price by a fixed dollar amount, a fixed dollar amount and an adjustment for inflation and a percent increase with an inflation adjustment.

3. **At what stage in the energy supply chain to apply the tax (e.g., upstream versus downstream):** Generally, the simplest administrative point at which to levy a carbon price is at the source of the energy supply. This is because there are fewer entities covering a large portion of carbon emissions sources.

4. **How to account for differences in carbon pricing regime obligations across the globe:** This requires a border adjustment or other mechanisms to account for the carbon price on domestic products relative to competing products from other countries with different decarbonization regimes. This can be achieved through taxing imports and subsidizing exports.

5. **How to use the revenue generated:** A key determinant of the long-run economic impact of a carbon price is the use of the revenue generated. A carbon price can be pro-growth (excluding the benefits of mitigating the physical impacts of climate change) depending on how the revenue it raises is used. This could occur, for instance, if the revenue raised is used for investment in productivity enhancing public infrastructure or to reduce capital taxes. In contrast, rebating the revenue to households would offset the impact of the carbon price on household income but would generally not be a pro-growth policy (excluding the benefits of mitigating the physical impacts of climate change).[10]

Scenario analysis

Because it is challenging to predict the magnitude of climate-related risks and opportunities, scenario analysis can be a useful tool for assessing the potential range of climate change implications. Businesses, for example, can use it to inform investors and stakeholders about how the organization is positioning itself in light of climate-related risks and opportunities.

It is good practice to use scenarios in larger sets to contrast different futures and choices. This analysis considers two scenarios (i.e., BAU and LCE) at both extremes so that businesses can understand the likely range in potential futures.[11]

A BAU scenario is a high-emissions scenario that is generally representative of current levels of action regarding decarbonization. In this scenario, physical risks are more pronounced, because emissions are only moderately reduced and the effects of climate change continue an upward trajectory. This includes increased acute physical risks such as floods, hurricanes and wildfires, as well as chronic physical risks such as sea-level rise.

An LCE scenario is a low-emissions scenario that is generally representative of a shift toward decarbonization and climate change mitigation. In this scenario, transition risks are more pronounced because policies will necessarily have a more pronounced impact.[12] These risks include increased carbon pricing and regulation, higher stakeholder pressure regarding environmental, social and governance (ESG) performance and rapid technological innovation to decarbonize sectors, among others.

The cost of transition can be significantly reduced when netted against the physical risks of climate change. Additionally, when a business delays decarbonization efforts it can increase transition costs.

While changes associated with a transition to a lower-carbon economy can present significant risks, they can also create opportunities. Opportunities associated with climate change will differ depending on a business's geography, market and sector. Resource efficiency, cost savings, adopting and using low-emission energy sources, creating new goods and services and building more resilient supply chains are some of the opportunities that can arise from efforts to mitigate climate change. This value-led sustainability approach can generate a competitive advantage in the market.

3 Carbon pricing under a BAU scenario

Key insights

- In a BAU scenario, existing policies are assumed to remain in place at their current price and emissions coverage and future decarbonization is assumed to follow recent trends. Scenarios are not predictions but potential future paths that are useful to help evaluate possible future risks and opportunities.
- Across G20 and OECD countries, the average headline carbon price is $47/ton whereas the average effective carbon price is $23/ton. Similarly, the median headline price is $50/ton, and the median effective carbon price is $25/ton. There are only three countries with an effective carbon price above $50/ton. In contrast, there are 23 countries with a headline carbon price above $50/ton.
- Emissions coverage varies significantly by sector across G20 and OECD countries. Across all sectors, 30% of emissions are subject to a carbon price. This is highest in electricity (56%) followed by road transport (22%), industry (18%), buildings (13%), agriculture and fisheries (12%) and off-road transport (11%).

In a BAU scenario, existing policies are assumed to remain in place at their current price and emissions coverage and future decarbonization is assumed to follow recent trends. It is a high-emissions scenario in which physical risks are more pronounced and transition risks are less pronounced.[13]

Current carbon pricing regimes

Currently, there are 63 implemented carbon pricing regimes that span 36 national jurisdictions and 37 subnational jurisdictions across G20 and OECD countries.[14] These are roughly 93% of the 68 carbon pricing regimes implemented throughout the world.

As shown in Figure 1, there are 36 carbon taxes within G20 and OECD countries covering 24 national jurisdictions and eight subnational jurisdictions. The highest carbon tax in place is in Sweden ($130/tCO2e).

Among G20 and OECD countries, there are 31 cap-and-trade or ETS regimes covering 31 national jurisdictions and 32 subnational jurisdictions. The highest ETS is the EU ETS ($87/ tCO2e).

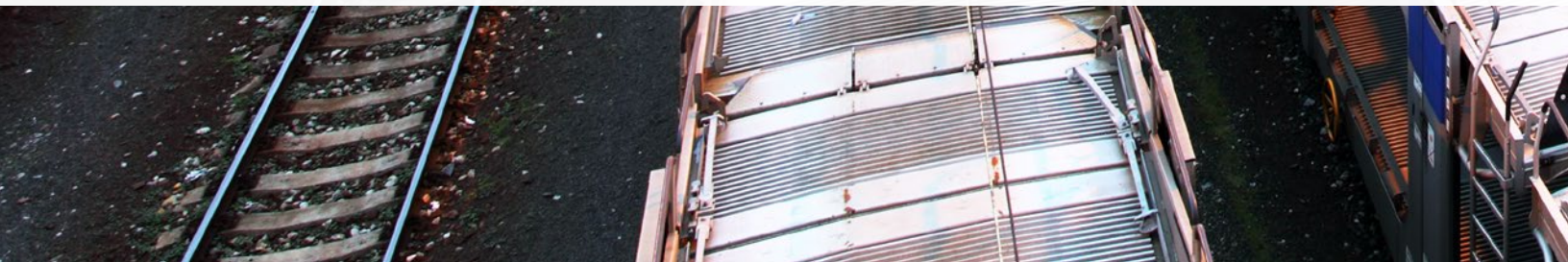
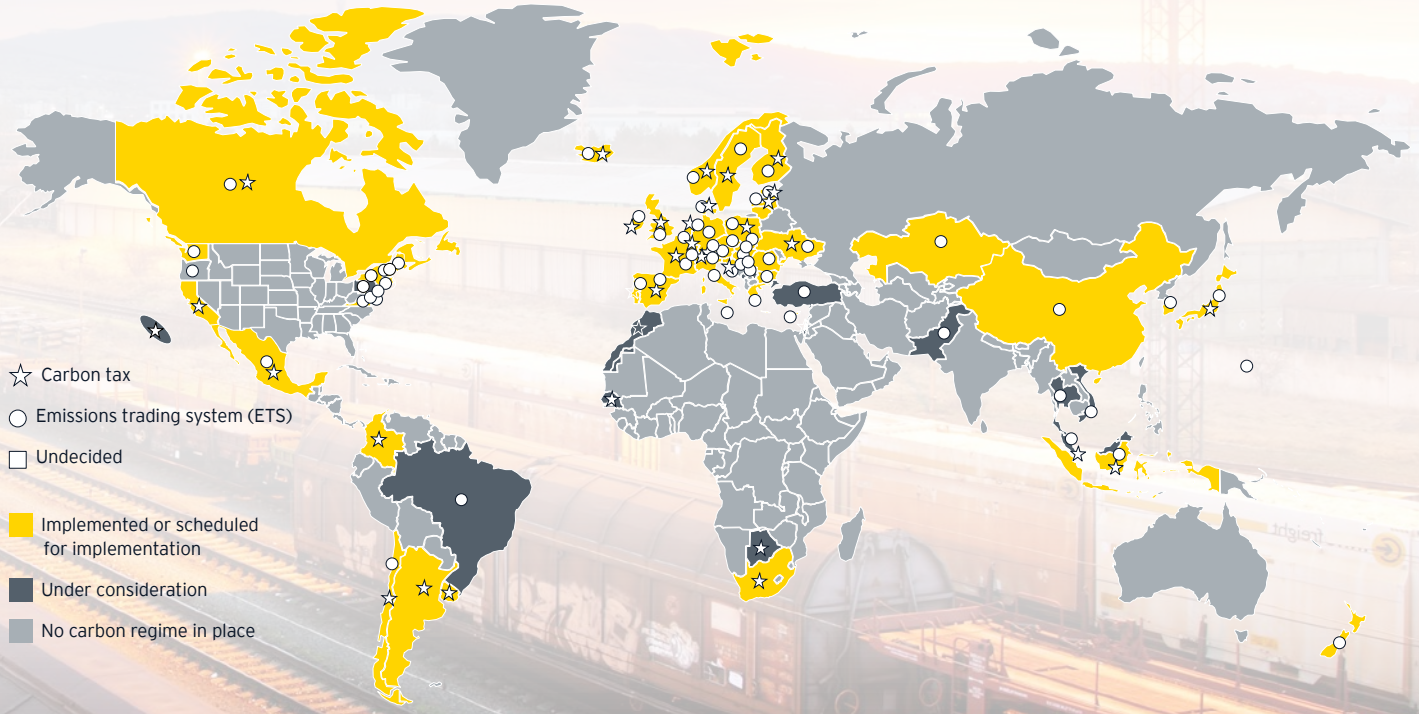


Figure 1. Global carbon pricing, 2022



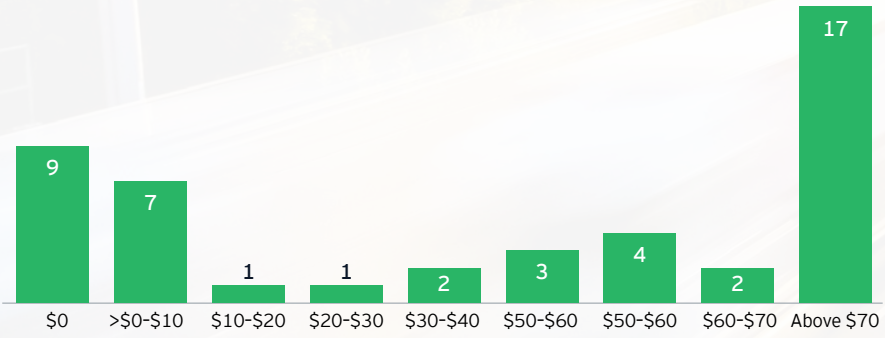
Source: The World Bank.

Headline carbon prices

A headline carbon price is the price charged for each ton of carbon subject to a carbon price. For example, if a country has a carbon price of $100/ton but only 10% of the country's carbon emissions are subject to a carbon price, the headline price is still $100/ton.[15] That is, there is no adjustment for the share of a country's emissions that are priced (see effective carbon prices below). Figure 2 displays the distribution of headline carbon prices in G20 and OECD countries in 2022. Values here and throughout the report are US$2022.

The simple average and median headline carbon prices are $47/ton and $50/ton, respectively. The weighted average headline carbon price is $25/ton. There are nine countries with a headline carbon price of $0/ton and 23 countries with a headline carbon price above $50/ton. The remaining 14 countries have a headline carbon price between $0/ton and $50/ton.

Figure 2. Distribution of headline carbon prices in G20 and OECD countries, 2022
Count of countries by headline carbon price

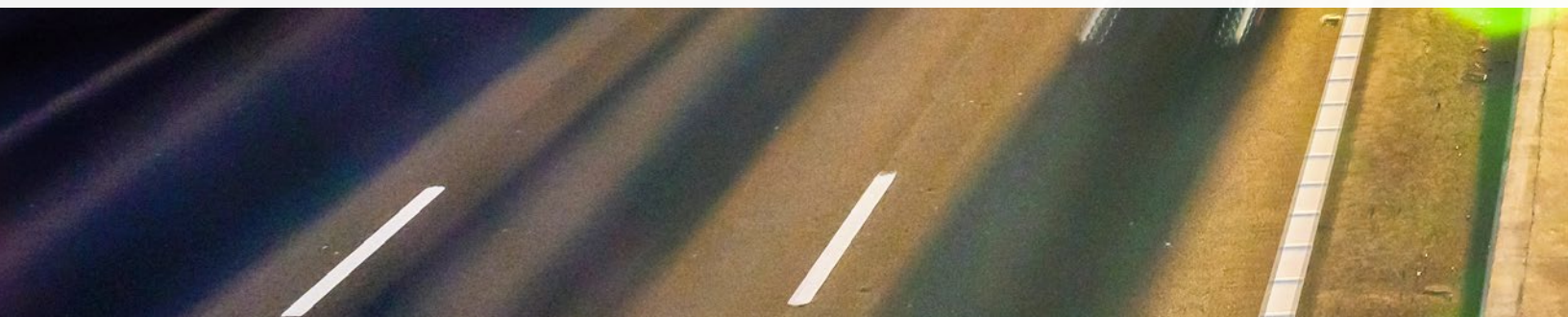


Note: Analysis includes all G20 and OECD countries. Values are US$2022. Figures are rounded.
Source: EY analysis.

$47
Simple average

$25
Weighted average

$50
Median

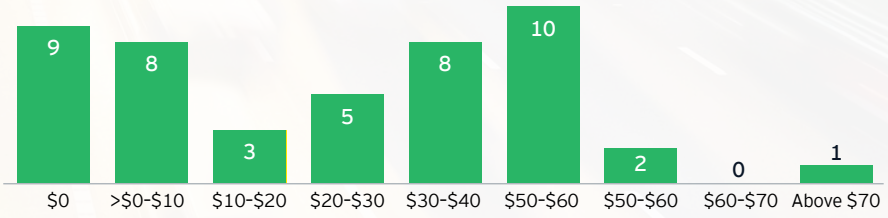


Effective carbon prices

An effective carbon price is the average price per ton of carbon across a country's total carbon emissions (i.e., not just carbon emissions subject to a price). For example, if a country has a $100/ton carbon price but only 10% of the country's emissions are subject to a price, the effective carbon price is $10/ton (=$100/ton x 10%).

Effective carbon prices in G20 and OECD countries for 2022 are shown in Figure 3. Effective carbon prices are always equal to or less than headline carbon prices. The simple average headline carbon price is $47/ton whereas the average effective carbon price is $23/ton. Similarly, the median headline carbon price is $50/ton whereas the median effective carbon price is $25/ton. The weighted average headline carbon price is $25/ton whereas the weighted average effective carbon price is $7/ton. There are only three countries with an effective carbon price above $50/ton (Figure 3). In contrast, there are 23 countries with a headline carbon price above $50/ton (Figure 2).

Figure 3. Distribution of effective carbon prices in G20 and OECD countries, 2022
Count of countries by effective carbon price



$23
Simple average

$7
Weighted average

$25
Median

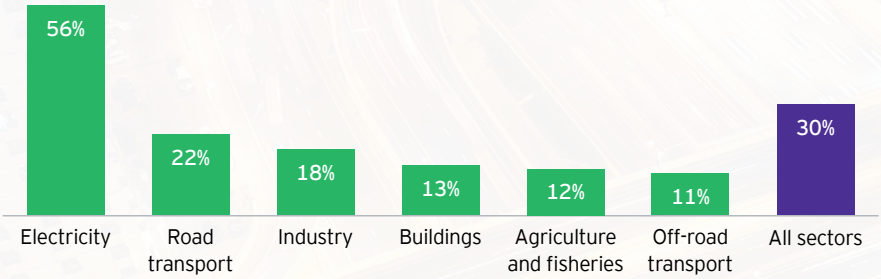
Note: Analysis includes all G20 and OECD countries. Values are US$2022. Figures are rounded.
Source: EY analysis.

Carbon pricing by sector

Carbon emissions coverage varies significantly by sector across G20 and OECD countries. The share of carbon emissions across those countries divides into six key sectors (as identified by the OECD): (1) agricultures and fisheries, (2) buildings, (3) electricity, (4) industry, (5) off-road transport and (6) road transport (Figure 4).[16]

Across these sectors, 30% of emissions are subject to a carbon price in G20 and OECD countries. The share of emissions subject to a carbon price is highest for the electricity sector (56%) followed by road transport (22%), industry (18%), buildings (13%), agriculture and fisheries (12%) and off-road transport (11%).

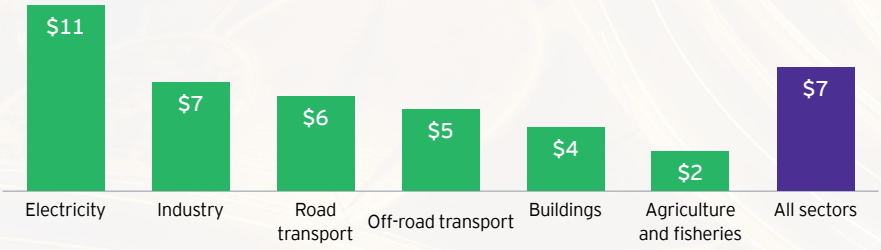
Figure 4. Share of emissions covered across G20 and OECD countries in 2022, by sector



Note: Analysis includes all G20 and OECD countries. Figures are rounded.
Source: EY analysis.

Figure 5 displays the weighted average effective carbon price for each of these six sectors. The weighted average carbon price across all sectors is $7/ton. The highest weighted average effective carbon price is in electricity ($11/ton) followed by industry ($7/ton), road transport ($6/ton), off-road transport ($5/ton), buildings ($4/ton) and agriculture and fisheries ($2/ton).

Figure 5. Weighted average effective carbon price in G20 and OECD countries by sector, 2022



Note: Analysis includes all G20 and OECD countries. Figures are rounded.
Source: EY analysis.

Decarbonization pathway

Decarbonization pathways show the extent to which emissions intensity (i.e., emissions per unit of output) change relative to their level in 2022. The BAU scenario assumes that, going forward, sectors and countries generally continue to decarbonize at rates that follow recent trends. The BAU decarbonization pathways are displayed in Figure 6 for G20 and OECD countries overall, as well as for the BRIC countries, the EU-12, North America and other G20 and OECD countries.[17] Across all G20 and OECD countries, the carbon intensity declines from 1.0 in 2022 to 0.46 by 2050 (i.e., 2050 carbon intensity declines to 46% of the level of carbon intensity of 2022).

Across BRIC countries, the carbon intensity declines from 1.0 in 2022 to 0.42 by 2050 (i.e., the 2050 carbon intensity declines to 42% of the level of carbon intensity of 2022). Across EU-12 countries, the carbon intensity declines from 1.0 in 2022 to 0.53 in 2050 (i.e., the 2050 carbon intensity declines to 53% of the level of carbon intensity of 2022). Carbon intensity across North America declines from 1.0 in 2022 to 0.48 in 2050 (i.e., the 2050 carbon intensity declines to 48% of the level of carbon intensity of 2022). Across other G20 and OECD countries (i.e., all G20 and OECD countries not part of BRIC, the EU-12 and North America), the carbon intensity declines from 1.0 in 2022 to 0.54 (i.e., the 2050 carbon intensity declines to 54% of the level of carbon intensity in 2050). These pathways vary by sector, country and region.

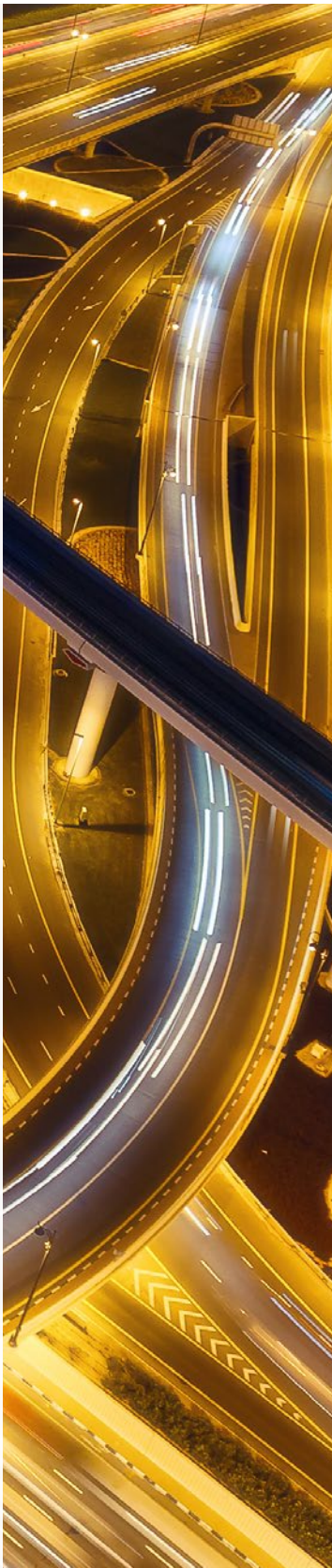
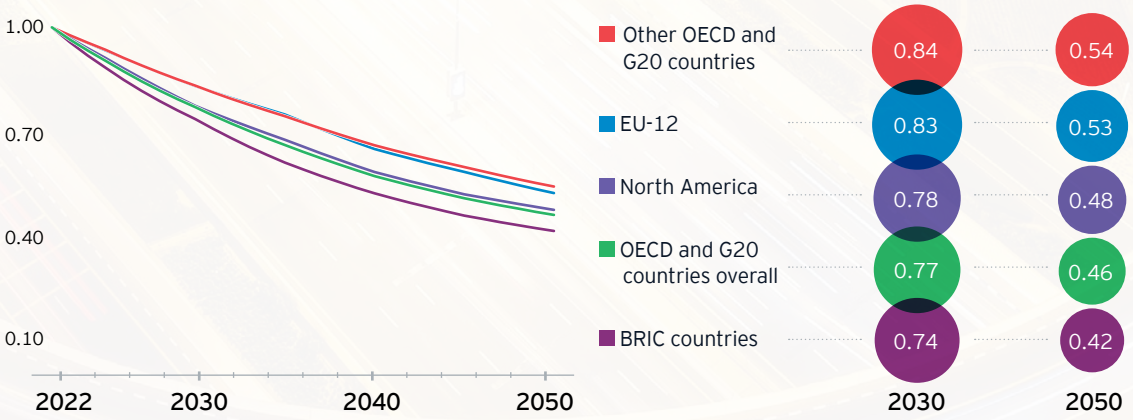


Figure 6. BAU decarbonization pathways by country and regions



Note: Scenarios are not predictions but potential future paths that are useful to help evaluate possible future risks and opportunities. This scenario assumes that, going forward, sectors and countries continue to decarbonize at rates following recent trends. Figures are rounded.
Source: EY analysis.

4 Carbon pricing under an LCE scenario

Key insights

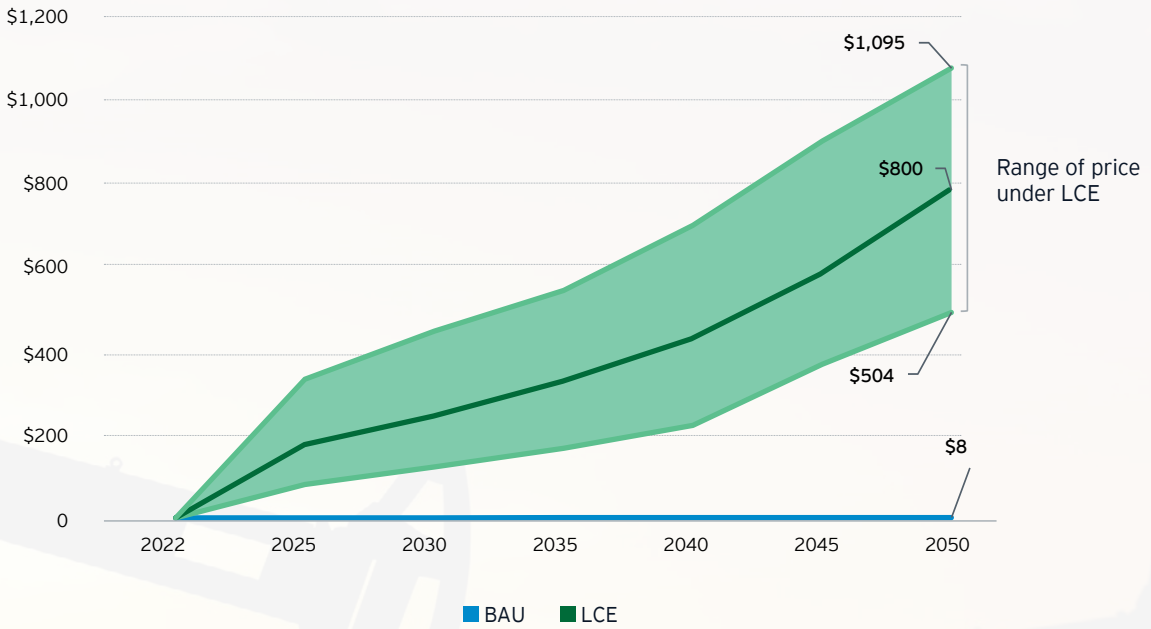
- This analysis includes a range for the effective carbon price necessary to achieve net-zero carbon emissions by 2050. This range, estimated by three prominent integrated assessment models, highlights both the significant uncertainty surrounding the necessary carbon price as well as the significant order of magnitude of the necessary carbon price. In particular, by 2050, the carbon price in the LCE scenario ranges between $504 and $1095. This compares to the BAU scenario carbon price of approximately $8 in 2050. The average of the three integrated assessment model carbon prices – which is used in estimates throughout this section – grows from $254 in 2030 to $440 in 2040 and $800 in 2050.
- Across all G20 and OECD countries, the carbon intensity declines from 1.0 in 2022 to 0.45 by 2030 in the LCE scenario (relative to 0.77 by 2030 under the BAU scenario) and 0.02 by 2050 in the LCE scenario (relative to 0.46 by 2050 under the BAU scenario). That is, under the LCE scenario, the 2050 carbon intensity declines to 2% of the level of carbon intensity of 2022 whereas under the BAU scenario the 2050 carbon intensity declines to 46% of the level of carbon intensity of 2022.
- Across all G20 and OECD countries, by 2030, the estimated carbon price liability under an LCE scenario would be 19 times the estimated carbon price liability under a BAU scenario. By 2050, the estimated carbon price liability under an LCE scenario would decline to five times the estimated carbon price liability under a BAU scenario. This reflects the net impact of a higher carbon price (increases liability) and higher decarbonization (decreases liability).

Estimated country-level decarbonization paths assume global net-zero carbon emissions by 2050. The LCE scenario is assumed to be achieved via use of carbon pricing. It is a low emissions scenario where physical risks are less pronounced and transition risks are more pronounced. Scenarios are not predictions but potential future paths that are useful to help evaluate possible future risks and opportunities.

Effective carbon prices

A comparison of the weighted average effective carbon price across G20 and OECD countries under a BAU and LCE scenario is shown in Figure 7. This analysis includes a range for the effective carbon price necessary to achieve net-zero carbon emissions by 2050. This range, estimated by three prominent integrated assessment models, highlights both the significant uncertainty surrounding the necessary carbon price as well as the significant order of magnitude of the necessary carbon price.[18] In particular, by 2050, the carbon price in the LCE scenario ranges between $504 and $1095. This compares to the BAU scenario carbon price of approximately $8 in 2050. The average of the three integrated assessment model carbon prices – which is used in estimates throughout this section – increases from $254 in 2030 to $440 in 2040 and $800 in 2050.

Figure 7. Effective carbon prices, BAU versus LCE



Note: Analysis includes all G20 and OECD countries. Values are US$2022. Figures are rounded.
Source: EY analysis.

Decarbonization pathway

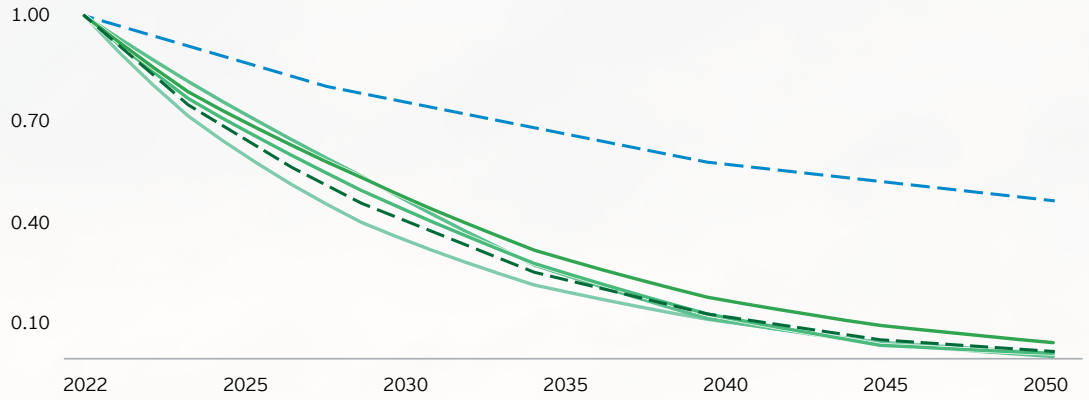
Decarbonization pathways show the extent to which emissions intensity (i.e., emissions per unit of output) will change relative to their level in 2022. This scenario assumes that, going forward, countries and sectors will decarbonize at higher rates relative to the BAU scenario to achieve net-zero carbon emissions by 2050. This is, of course, only one potential future pathway for decarbonization.

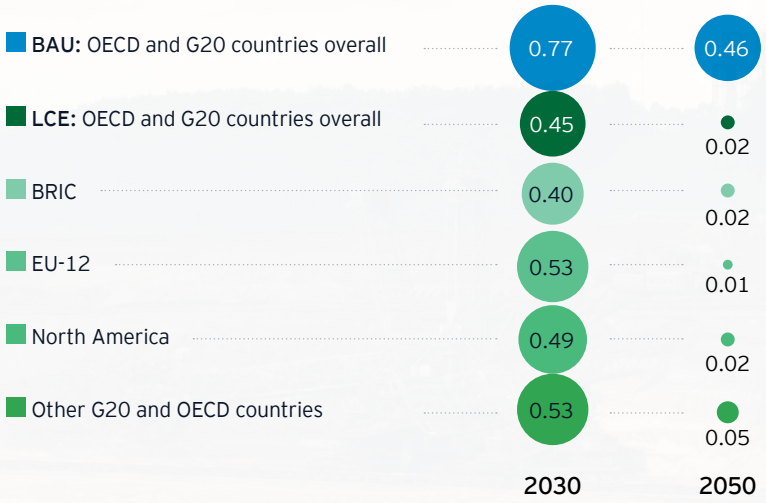
The LCE decarbonization pathways are displayed in Figure 8 for all G20 and OECD countries, as well as for the BRIC countries, the EU-12, North America and other G20 and OECD countries.

- Across all G20 and OECD countries, the carbon intensity declines from 1.0 in 2022 to 0.45 by 2030 (relative to 0.77 by 2030 under the BAU scenario) and 0.02 by 2050 (relative to 0.46 by 2050 under the BAU scenario). That is, under an LCE scenario, the 2050 carbon intensity declines to 2% of the level of carbon intensity of 2022, whereas under a BAU scenario, the 2050 carbon intensity declines to 46% of the level of carbon intensity of 2022.
- Across BRIC countries, the carbon intensity declines from 1.0 in 2022 to 0.40 by 2030 (relative to 0.74 by 2030 under the BAU scenario) and to 0.02 by 2050 (relative to 0.42 under the BAU scenario).
- Carbon intensity across EU-12 declines from 1.0 in 2022 to 0.53 in 2030 (relative to 0.83 by 2030 under a BAU scenario) and to 0.01 by 2050 (relative to 0.53 under the BAU scenario).
- Carbon intensity across North America declines from 1.0 in 2022 to 0.49 in 2030 (relative to 0.78 by 2030 under the BAU scenario) and to 0.02 by 2050 (relative to 0.48 under the BAU scenario).
- Across other G20 and OECD countries (i.e., all G20 and OECD countries not part of BRIC, the EU-12 and North America), the carbon intensity declines from 1.0 in 2022 to about 0.53 by 2030 (relative to 0.83 by 2030 under the BAU scenario) and to 0.05 by 2050 (relative to 0.54 under the BAU scenario).

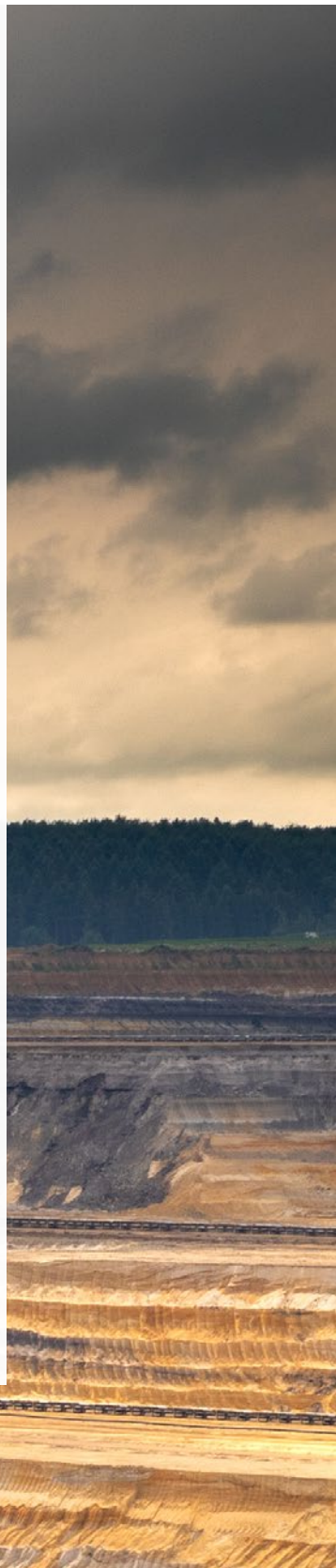
These pathways vary by sector, country and region. By 2050, each of these four country groupings will have achieved, or would be close to achieving, net-zero carbon emissions under the LCE scenario.

Figure 8. Decarbonization pathways by country and regions, BAU versus LCE





Note: Scenarios are not predictions but potential future paths that are useful to help evaluate possible future risks and opportunities. This scenario assumes that countries adopt aggressive decarbonization paths to achieve global net-zero carbon emissions by 2050. Figures are rounded.
Source: EY analysis.

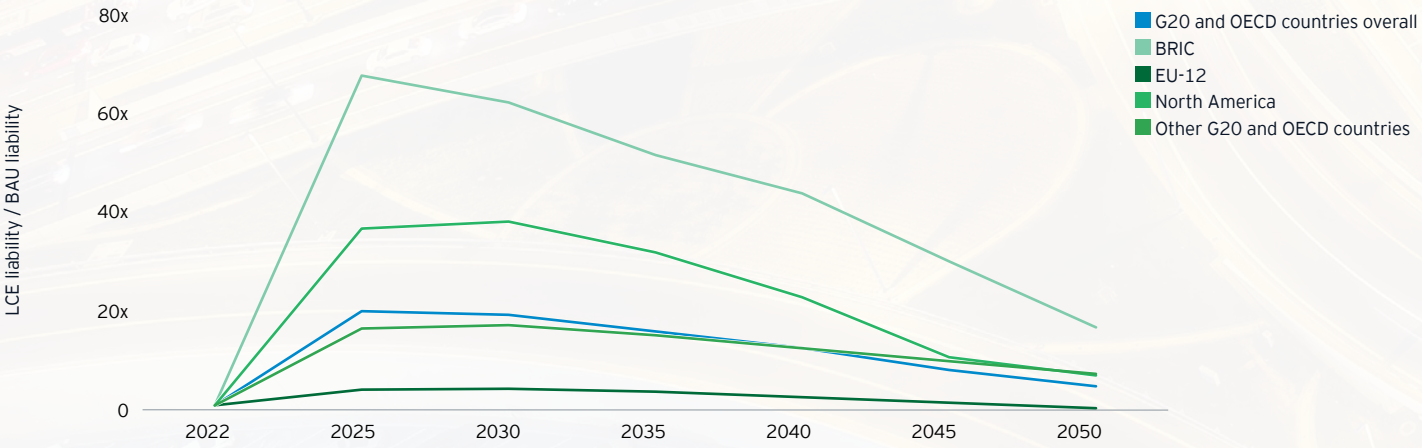


Estimated carbon price liability

Figure 9 displays the estimated carbon price liability across G20 and OECD countries from 2022 through 2050 under the LCE scenario. Results are also displayed for the BRIC countries, the EU-12, North America and other G20 and OECD countries. For ease of interpretation, all results are scaled to the size of the world economy in 2022.

- Across all G20 and OECD countries, by 2030, the estimated carbon price liability under an LCE scenario would be 19 times the estimated carbon price liability under a BAU scenario. By 2050, the estimated carbon price liability under an LCE scenario would decline to five times the estimated carbon price liability under a BAU scenario. This change is the net impact of a higher carbon price (increases liability) and higher decarbonization (decreases liability).
- For countries in the EU-12, by 2030, the estimated carbon price liability under an LCE scenario would be four times the estimated carbon price liability under a BAU scenario. By 2050, the estimated carbon price liability under an LCE scenario would be approximately zero.
- For BRIC countries, as of 2022, the estimated carbon price liability under an LCE scenario would be 63 times the estimated carbon price liability under a BAU scenario by 2030. The estimated carbon price liability under an LCE scenario would decline to 17 times the estimated carbon price liability under a BAU scenario by 2050.
- For countries in North America, the estimated carbon price liability under an LCE scenario would be 38 times the estimated carbon price liability under a BAU scenario by 2030. The estimated carbon price liability under an LCE scenario would decline to seven times the estimated carbon price liability under a BAU scenario by 2050.
- For other G20 and OECD countries, by 2030, the estimated carbon price liability under an LCE scenario would be 17 times the estimated carbon price liability under a BAU scenario. By 2050, the estimated carbon price liability under an LCE scenario would decline to seven times the estimated carbon price liability under a BAU scenario.

Figure 9. Carbon price liability 2022-2050 BAU versus LCE



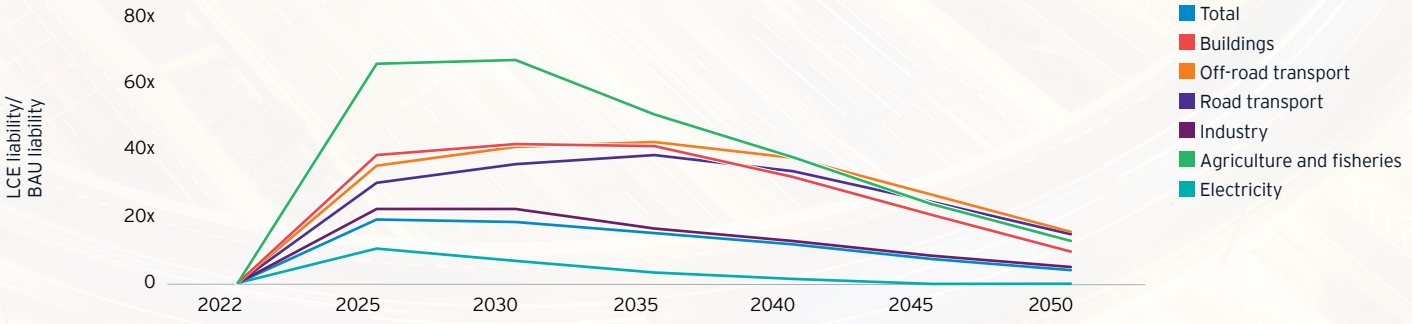
Note: Results are scaled to the size of the world economy in 2022. Analysis includes all G20 and OECD countries. Values are US$2022. Figures are rounded.
Source: EY analysis.

Estimated carbon price liability by sector

The estimated carbon price liability across six key sectors – (1) agriculture and fisheries, (2) buildings, (3) electricity, (4) industry, (5) off-road transport and (6) road transport – from 2022 to 2050 under the LCE scenario is displayed in Figure 10.[19]

- Across all six sectors, by 2030, the estimated carbon price liability under an LCE scenario would be 19 times the estimated carbon price liability under a BAU scenario. By 2050, the estimated carbon price liability under an LCE scenario would decline to five times the estimated carbon price liability under a BAU scenario.
- For the electricity sector, by 2030, the estimated carbon price liability under an LCE scenario would be eight times the estimated carbon price liability under a BAU scenario. By 2050, the estimated carbon price liability under an LCE and BAU scenarios would be approximately equivalent.
- For the industrial sector, by 2030, the estimated carbon price liability under an LCE scenario would be 23 times the estimated carbon price liability under a BAU scenario. By 2050, the estimated carbon price liability under an LCE scenario would decline to six times the estimated carbon price liability under a BAU scenario.
- For the road transport sector, by 2030, the estimated carbon price liability under an LCE scenario would be 37 times the estimated carbon price liability under a BAU scenario. By 2050, the estimated carbon price liability under an LCE scenario would decline to 16 times the estimated carbon price liability under a BAU scenario.
- For the buildings sector, by 2030, the estimated carbon price liability under an LCE scenario would be 43 times the estimated carbon price liability under a BAU scenario. By 2050, the estimated carbon price liability under an LCE scenario would decline to 10 times the estimated carbon price liability under a BAU scenario.
- For the off-road transport sector, by 2030, the estimated carbon price liability under an LCE scenario would be 42 times the estimated carbon price liability under a BAU scenario. By 2050, the estimated carbon price liability under an LCE scenario would decline to 16 times the estimated carbon price liability under a BAU scenario.
- For the agriculture and fisheries sector, by 2030, the estimated carbon price liability under an LCE scenario would be 68 times the estimated carbon price liability under a BAU scenario. By 2050, the estimated carbon price liability under an LCE scenario would decline to 14 times the estimated carbon price liability under a BAU scenario.

Figure 10. Carbon price liability by sectors 2022-2050, BAU versus LCE



Note: Results are scaled to the size of the world economy in 2022. Analysis includes all G20 and OECD countries. Values are US$2022. Figures are rounded.
Source: EY analysis.

5 Conclusion

As climate policy proposals evolve and more governments develop or sign onto plans that may involve carbon pricing, businesses need to determine what those policies could mean for their industries, companies, competitors and consumers. They should be cognizant of whether a carbon price proposal grants particular industries or mitigation technologies assistance, free allowances or exemptions, as well as how the revenue raised from a carbon price would be used. Additionally, because it is challenging to predict climate-related risks and opportunities, scenario analysis should be used for assessing the potential range of climate change implications. Businesses can use scenario analysis to then inform investors and stakeholders about how the organization is positioning itself in light of climate-related risks and opportunities.

Endnotes

1 Climate Change 2021: The Physical Science Basis Summary for Policy Makers. IPCC, 2021.

2 This analysis looks at where the carbon price is being applied and at what level. This statutory incidence differs from an analysis of the economic incidence of these carbon prices. The cost increases due to the carbon price could be passed forward to consumers or, to some extent, the burden may fall on labor (via lower wages) or capital (via reduced profits).

3 Decarbonization paths are calculated using emissions, energy and economic data from 3 prominent Integrated Assessment Models (IAMs): (1) GCAM, (2) MESSAGEix-GLOBIOM and (3) REMINDMAgPIE. IAMs combine macroeconomic, agriculture, land use, energy, water and climate systems into a common framework that enables the analysis of their effects on the economy and impacts on the climate. Under the BAU scenario estimated decarbonization paths assume that existing climate policies remain in place and that there is no strengthening of these policies. Under the LCE scenario the estimated decarbonization paths assume global net-zero carbon emissions by 2050. Countries with a clear commitment to a specific net-zero policy target are assumed meet their target. These decarbonization paths are based on modeling from the Network for Greening the Financial System (NGFS), which is a network of more than 100 central banks and financial supervisors aiming to help strengthen the global response to meeting the goals of the Paris agreement.

GCAM is a model based on the interaction between the energy, water, agriculture, land use and economy systems. Within GCAM agents use information from relevant data to make decisions about allocation of resources, a solution for market-equilibrium is found and agents continue making decisions in each period as they gain new information. The effects of climate change are included in the market-equilibrium solution.

MESSAGEix-GLOBIOM, is made up of MESSAGEix (Model for Energy Supply Strategy Alternatives and their General Environmental Impact), which is an energy model and GLOBIOM (Global Recursive Dynamic Partial Equilibrium Model), which is a land use model. The MESSAGEix optimizes land use data from GLOBIOM and feeds it into MAGIC (Model for the Assessment of Greenhouse Gas Induced Climate Change), which provides an estimate for projected climate implications.

REMIND-MAgPIE, is made up of the REMIND (Regional Model of Investments and Development) model, which optimizes energy and economic investments in the economy to maximize welfare and MAgPIE (Model of Agricultural Production and its Impacts on the Environment), which is a land use and agricultural emissions model. REMINDMAgPIE runs a subset of scenarios with implementation of internalized physical risk damage and has dynamics within and between water, air pollution, land use, energy, health, economy and climate systems.

4 OECD and G20 countries are: Argentina, Australia, Austria, Belgium, Brazil, Canada, Chile, China, Colombia, Costa Rica, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, India, Indonesia, Ireland, Israel, Italy, Japan, Republic of Korea, Latvia, Lithuania, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Russia, Saudi Arabia, Slovak Republic, Slovenia, South Africa, Spain, Sweden, Switzerland, Turkey, the United Kingdom, the United States. The European Union, which is a member of the G20, is excluded from the analysis because it is a supranational political and economic union.

5 Estimates on GDP and population use World Bank data. Estimates on emissions use the OECD dataset on Effective Carbon Rates 2021. Carbon emissions here and throughout the report refers to emissions from energy use. Carbon emissions do not include all greenhouse gas (GHG) emissions.

6 Of course, nearly all goods and services have at least some embedded carbon emissions in them somewhere in their production. For example, even if a particular company producing a good or service has no direct carbon emissions, the goods and services that companies purchase from their suppliers or, in turn, the goods and services their suppliers purchase from other companies may have resulted in carbon being emitted when being produced.

7 From a stylized modeling perspective, an ETS and a carbon tax have equivalent effects when the ETS allowances are sold. However, real-world considerations such as implementation and administration differ between the policies. See, for example, Avi-Yonah, R. S., & Uhlmann, D. M. (2009). Combating global climate change: Why a carbon tax is a better response to global warming than cap and trade. Stan. Envtl. LJ, 28, 3.

8 As discussed later in this report, there are, of course, many design choices when implementing a carbon price. One of these design choices is the stage of the energy supply chain at which to apply the price (e.g., upstream versus downstream).

9 See, for example, EY. (2020). How key industries would fare under a carbon tax. https://www.ey.com/en_us/tax/how-key-industries-would-fare-under-a-carbon-tax

10 See, for example: EY. (2018). Carbon regulations vs. a carbon tax: A comparison of the macroeconomic impacts, Prepared for the Alliance for Market Solutions. Also See EY. (2022). Macroeconomic impacts of carbon pricing relative to a higher corporate income tax rate, Prepared for the Alliance for Market Solutions.

11 The Representative Concentration Pathway (RCP) most similar to the BAU scenario is RCP6.0 and the RCP most similar to the LCE scenario is RCP2.6. RCPs fix the GHG concentration in the atmosphere and analyze the resulting changes in global temperatures at various future points relative to pre-industrial levels. See Intergovernmental Panel on Climate Change (IPCC), "Towards new Scenarios for Analysis of Emissions, Climate Change, Impacts, and Response Strategies," (accessed https://archive.ipcc.ch/pdf/supporting-material/expert-meeting-report-scenarios.pdf, Sept 7 2022).

12 Transition risks can be grouped into the following categories: Policy and legal risk (carbon pricing and reporting obligations, mandates on and regulation of existing products and services and exposure to litigation), technology risk (substitution of existing products and services with lower emissions options and unsuccessful investment in new technologies), market risk (changing consumer behavior, uncertainty through market signals and increased cost of raw materials) and reputation risk (shifts in consumer preferences, increased stakeholder concern and stigmatization of sector). See, for example, Task Force on Climate-related Financial Disclosures, Final Report: Recommendations of the Task Force on Climate-related Financial Disclosures,2017, (accessed https://assets.bbhub.io/company/sites/60/2020/10/FINAL-TCFD-Technical-Supplement-062917.pdf, Sept 5 2022).

13 The scope of this analysis is limited to carbon emissions from energy use and emissions from combustion of biomass. Other greenhouse gases are not within the scope of this analysis.

14 Headline carbon prices in 2022 are sourced from the World Bank and reflect carbon prices in the first trimester of 2022 for each carbon pricing initiative. These data, especially headline carbon prices for ETS initiatives, frequently change. These data were then combined with OECD data on covered emissions by sector by country generally following the OECD effective carbon rate methodology. These data also include information on other factors that can impact effective carbon pries such as exemptions and rate reductions for each sector in each country. Adjustments were generally not made for free allowances. Adjustments were made to update dated information or to include information when data were unavailable from the World Bank and OECD. Estimates are subject to revision as more recent data become available. Estimates are limited by available public information.

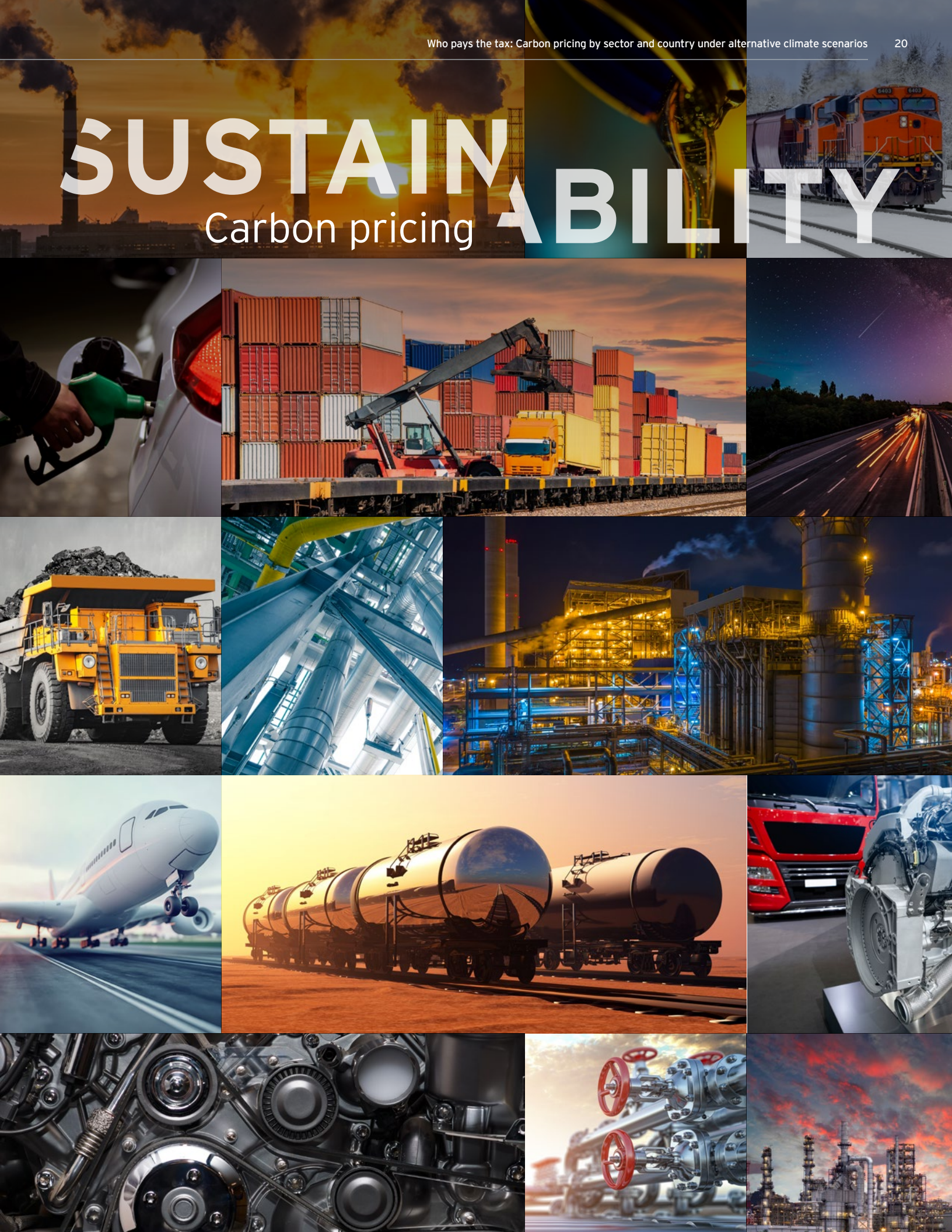
15 For countries with more than one carbon pricing initiative the headline carbon price is presented as the weighted average by covered emissions.

16 These sectors are defined by the OECD as follows: (1) Agriculture and fisheries includes "all primary energy used in agriculture, fisheries and forestry for activities other than electricity generation and transport"; (2) buildings include "all primary energy used by households, commercial and public services for activities other than electricity generation and transport"; (3) electricity sector coverage includes "all primary energy used to generate electricity (excluding auto-producer electricity plants which are assigned to industry)"; (4) industry includes "all primary energy used in industrial facilities (including district heating and auto-producer electricity plants)"; (5) off-road transport sector refers to "all primary energy used in off-road transport (including pipelines, rail transport, aviation and maritime transport)"; and (6) road transport sector includes "all primary energy used in road transport."

17 BRIC countries include Brazil, Russia, India, and China. The EU-12 includes Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, and the United Kingdom. North America includes Canada, Mexico, and the United States. Other OECD and G20 countries include Argentina, Australia, Austria, Chile, Colombia, Costa Rica, Czech Republic, Estonia, Finland, Hungary, Iceland, Indonesia, Israel, Japan, Republic of Korea, Latvia, Lithuania, New Zealand, Norway, Poland, Saudi Arabia, Slovak Republic, Slovenia, South Africa, Sweden, Switzerland, and Turkey.

18 See endnote 3 for more information on the methodology and the three integrated assessment models.

19 Beyond 2022, this analysis assumes a uniform carbon price across all sectors. A uniform carbon price would leverage the knowledge and behavior of consumers and producers to find where it is least costly to reduce emissions, as compared to differing prices by sector that can result in more costly ways to reduce carbon emissions.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