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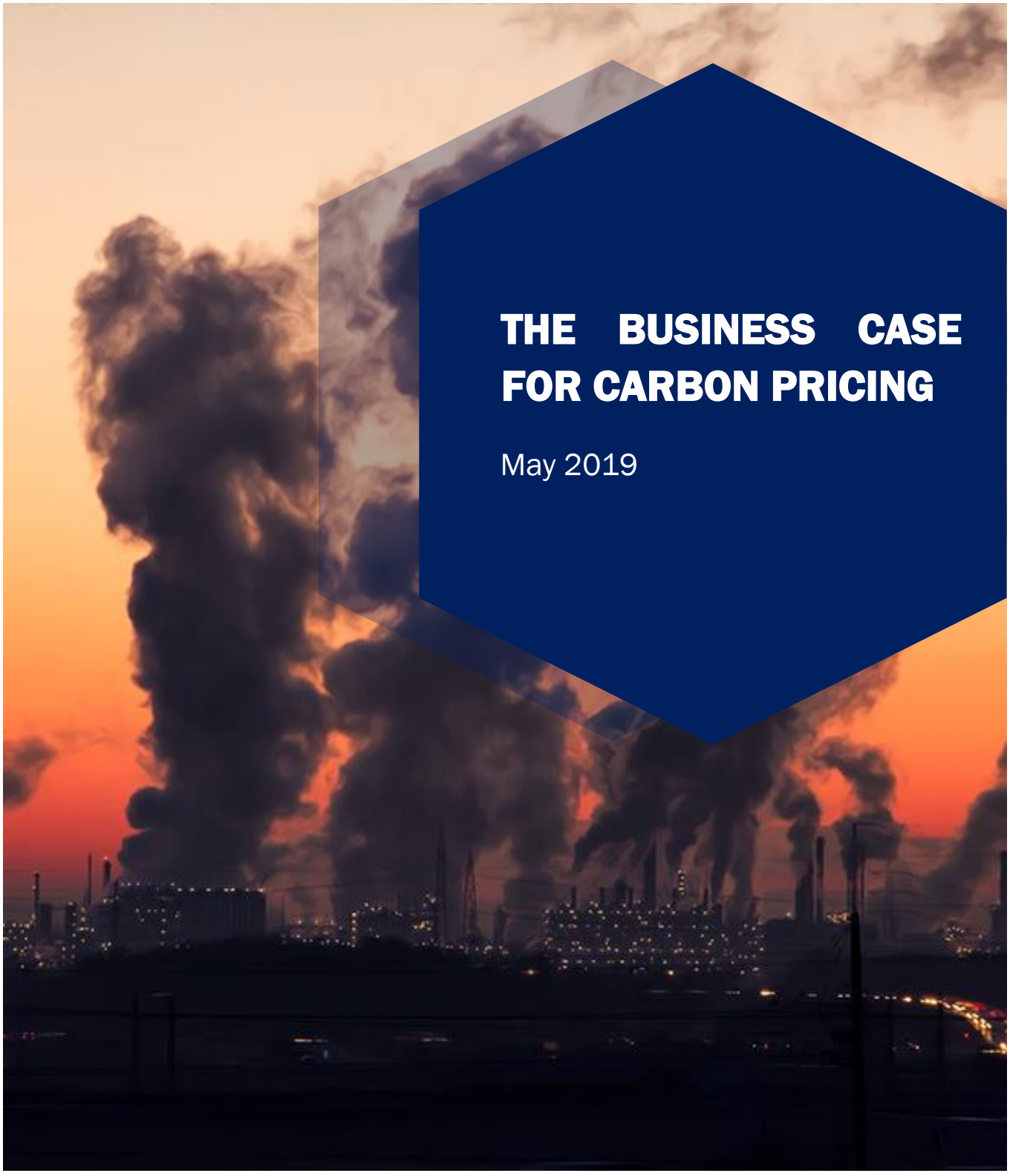

THE BUSINESS CASE FOR CARBON PRICING

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CARBON PRICING – 9 KEY TAKEAWAYS

1 Increasing temperatures caused by climate change may cost the world economy over US$2 trillion in lost productivity by 2030

2 Carbon pricing is an important tool for governments to mitigate climate risks by creating appropriate monetary incentives for firms to improve energy efficiency, reduce reliance on fossil fuels, and encourage the adoption of low-carbon technologies

3 There are currently 57 carbon pricing initiatives that are either implemented or scheduled for implementation by governments globally (only 16 initiatives in 2009), covering about 20 percent of global emissions

4 A carbon tax puts an explicit price on carbon in dollars per tonne of greenhouse gas emissions. A cap-and-trade system establishes an implicit price on carbon by placing a limit on the total quantity of emissions

5 Businesses are also increasingly adopting internal carbon pricing to achieve its emissions targets, hedge against carbon regulations, reap cost savings, and demonstrate leadership in sustainability issues

6 As of 2017, nearly 1,400 companies including large multinationals such as Microsoft, have disclosed their current practices or plans to use internal carbon pricing as compared to only 150 in 2014

7 Companies can implement internal carbon pricing in 4 different ways: a) shadow price; b) internal carbon fee; c) implicit price or d) internal cap-and-trade programme

8 With the establishment of the Singapore chapter of the World Bank Carbon Pricing Leadership Coalition, Singapore companies are playing a central role in facilitating carbon pricing initiatives and low carbon innovations in the region

9 Both governments and businesses need to significantly increase their ambition levels on carbon pricing to effectively tackle climate change

GOVERNMENTS USE 2 KEY MECHANISMS TO PRICE CARBON

	Advantages	Disadvantages
1 CARBON TAX 	• **Ease of implementation.** Easier to structure and implement relative to cap-and-trade but could be politically difficult to get broad consensus • **Prices stability.** Carbon tax rates are typically fixed for predictable periods, reducing the risks for businesses to make long-term investments in low-carbon technologies • **Stable revenue recycling potential.** Revenue from carbon tax could be used to enhance energy efficiency incentives such as clean energy subsidies	• **Uncertainty around emissions reduction.** Does not guarantee the desired level of reduction, and possible for monopolistic firms to pass on the entire tax to consumers • **Likelihood of consumer pushback.** High visibility of carbon tax policy may trigger opposition due to perceived costs to consumers
2 CAP-and-TRADE 	• **Certainty around emissions reduction.** Helps countries achieve pre-determined emissions targets, and to apply a falling emissions cap over time • **Less likelihood of consumer pushback.** Perceived less as a tax on consumers - more politically feasible to adopt relative to a carbon tax	• **Complex to implement.** Need to develop regulations for trading emission permits; business likely to incur high compliance costs • **Price volatility.** Market determined prices for permits may lead to excessive price swings • **Uncertain revenue recycling potential.** Generates less revenue to be used for energy efficiency programmes compared to carbon taxes

4 COMMON MECHANISMS FOR BUSINESSES TO IMPLEMENT INTERNAL CARBON PRICING

	Advantages	Disadvantages
1 SHADOW PRICE 	• Effective hedge against future potential increases in carbon price levels • Straightforward to implement across units	• Challenging to derive appropriate price • Limited impact on carbon emissions reduction
2 INTERNAL CARBON FEE 	• Directly links financial incentives of business units to reduction targets • Fees collected maybe used to fund emissions reduction projects	• Challenging to implement and get buy-in as seen as punitive to units with operations that generate more emissions by default
3 IMPLICIT FEE 	• Provides businesses with a clearer understanding of its carbon footprint • May be used as benchmarks for more efficient adoption of other carbon pricing mechanisms	• Does not have direct impact on emissions reduction targets
4 INTERNAL CAP-and-TRADE 	• Useful for conglomerates with diverse operations as it gives carbon-intensive units more flexibility while reducing emissions company-wide	• Complex structure and high implementation costs

THE BUSINESS CASE FOR CARBON PRICING

On 15 March 2019, Temasek organised a discussion by Mr Benedict Chia (Director for Strategic Issues at the National Climate Change Secretariat) and Ms Goh Swee Chen (President of Global Compact Network Singapore) on carbon pricing, as part of the Ecosperity Conversations series.

The session discussed the impacts of climate change and how carbon pricing policies could help mitigate climate risks. An overview of carbon pricing mechanisms and global initiatives to implement carbon pricing by governments and businesses was provided. The speakers also discussed how a carbon tax could support the suite of mitigation outlined in Singapore's Climate Action Plan, which was launched in 2016 with the aim of reducing greenhouse gas emissions intensity by 36 percent compared to 2005 levels by 2030.

This summary report covers the key topics discussed during the session with additional insights to complement the discussion on the effectiveness of carbon pricing in reducing carbon emissions and best practices for implementation.

1. Impacts of climate change

Climate change has caused detrimental and wide-reaching impacts across the globe. Its physical effects can be observed in the form of extreme weather events that have occurred around the world as well as in Singapore. These include:

- **Increase in temperature**. According to the World Meteorological Organization, the last four years[1] have been the four warmest years on record. In fact, the global average temperature in 2018 was around 0.4 degrees Celsius above the 30-year average between 1981 and 2010.[2] In Singapore, the ten warmest years on record occurred within the last 25 years.[3] The implementation of existing Nationally Determined Contributions (NDCs) will put the world on a 3 degrees Celsius temperature rise pathway - well above the 1.5 to 2 degrees Celsius Paris goal. Furthermore, the recent Intergovernmental Panel on Climate Change (IPCC) report concluded that the world

[1] From 2015 to 2018
[2] World Meteorological Organization (2019), *WMO confirms past 4 years were warmest on record.* Available at: https://public.wmo.int/en/media/press-release/wmo-confirms-past-4-years-were-warmest-record
[3] Meteorological Service Singapore (2018), "2018 is Singapore's Eighth Warmest Year on Record". Available at: http://www.weather.gov.sg/2018-is-singapores-eighth-warmest-year-on-record/

has already warmed by around 1 degree Celsius, and at current rates, 1.5 degrees Celsius is likely to be breached as early as 2030.[4]

- **Rising sea levels.** Thermal expansion caused by the warming of the ocean and increased melting of land-based ice has led to rising sea levels - the global mean sea level rose by 190 millimetres. More alarming is the fact that the rate of increase in the global mean sea level has risen faster over the last three decades than any other comparable period before the 1990s. Indeed, these effects are even more acute in Singapore, where the mean sea level rose two times faster than the global rate between 1993 and 2009.[5] This presents particular risks for its shipping industry, food and water security and public health.[6]

- **Increased frequency of extreme weather events**. Climate change is associated with a higher frequency of extreme weather events such as droughts, floods and heatwaves.[7] For example, Japan experienced a series of flooding and landslides in Hiroshima and Okayama. The country also suffered from an extreme and prolonged heatwave between July and August, and a typhoon in September that was dubbed to be the strongest in 25 years.[8]

Although situated in a geologically stable location, Singapore is not insulated from natural hazards. Rainfall has become more intense in recent years with a general upward trend in annual average rainfall from 2,192 millimetres in 1980 to 2,727 millimetres in 2014. In 2001, the Typhoon Vamei swept north of Singapore and caused large-scale flooding in the region.[9]

The physical effects of climate change have and will create substantial economic costs. It is estimated that global warming could cost the world economy over US$2 trillion in lost productivity by 2030,[10] while the 10 worst climate-

Global warming may cost the world economy **over US$2 trillion in lost productivity** by 2030

[4] See the latest IPCC Special Report available at: https://www.ipcc.ch/sr15/
[5] Up to 4.6 millimetres per year around Singapore as compared to 2.8 millimetres per year globally for the same period. See: P. Tkalich, P. Vethamony, Q.-H. Luu and M. T. Babu (2012), "Sea level trend and variability in the Singapore Strait", Ocean Science. Available at: https://www.oceansci.net/9/293/2013/os-9-293-2013.pdf
[6] For more information, please refer to Ecosperity (2019), *Climate Change and rising sea levels: Mitigating and adapting to the looming threats*. Available at: https://www.ecosperity.sg/content/dam/ecosperity/en/reports/Climate-Change-and-Rising-Sea-Levels_Jan2019.pdf
[7] IMF (2017), "Climate Change Will Bring More Frequent Natural Disasters & Weigh on Economic Growth". Available at: https://blogs.imf.org/2017/11/16/climate-change-will-bring-more-frequent-natural-disasters-weigh-on-economic-growth/
[8] The Straits Time (2018), "Earthquakes, rains, heatwave, typhoon: Japan's brutal summer of 2018". Available at: https://www.straitstimes.com/asia/east-asia/earthquakes-rains-heatwave-typhoon-japans-brutal-summer-2018
[9] National Climate Change Secretariat (2018), Impact of climate change on Singapore. Available at: https://www.nccs.gov.sg/climate-change-and-singapore/national-circumstances/impact-of-climate-change-on-singapore
[10] VOA (2016), "Global Warming to Cost $2 Trillion in Lost Productivity by 2030". Available at: https://www.voanews.com/a/global-warming-cost-two-trillion-dollars-lost-productivity/3424781.html

linked disasters in 2018 caused at least US$85 billion in damage.[11]

Southeast Asia is prone to considerably high economic impacts of climate change. Singapore's annual heat-related losses (i.e. from reduced productivity due to heat stress) is estimated to reach US$200 million by 2030, while its regional peers with less access to air conditioning are also expected to be significant.[12]

2. Governments are using carbon pricing as a tool to mitigate climate risks

Under the Paris Climate Change Agreement, 184 countries[13] pledged to take actions in order to keep global temperature increase within 2 degrees Celsius above pre-industrial levels, with an aspirational target to limit this increase to 1.5 degrees Celsius.[14] According to the IPCC, in order to achieve this target, global carbon emissions would need to decline by 45 percent from 2010 levels by 2030 and reach net zero[15] by 2050.

To effect a change of such magnitude, rapid and far-reaching transitions in energy, land, urban infrastructure, and industrial systems are needed. Carbon pricing is an increasingly prominent policy tool used by governments across the world to keep carbon emissions in check. If implemented effectively, it can incentivise the adoption of low-carbon technologies and reduce reliance on fossil fuels by leveraging market dynamics.

57 carbon pricing initiatives have been implemented or scheduled for implementation globally

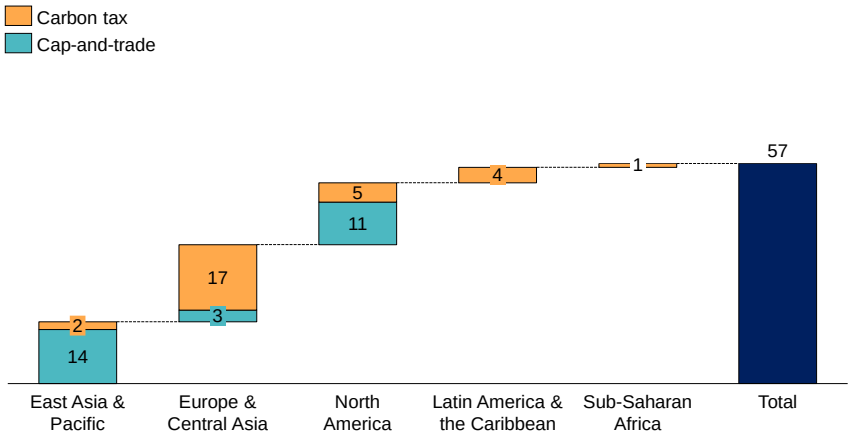
Globally, there are currently 57 carbon pricing initiatives which have either been implemented or scheduled for implementation, as compared to only 16 initiatives in 2009 (Exhibit 1).[16] Of these 57 initiatives, 20 are in Europe and Central Asia, compared to 16 initiatives in East Asia and the Pacific. Yet in terms of emissions generated, East Asia and Pacific accounts for 48 percent of global emissions – more than 2.5 times the amount generated by Europe and Central Asia.

[11] The Straits Times (2018). "10 worst climate disasters in 2018 cause $116b in damage". Available at: https://www.straitstimes.com/world/10-worst-climate-disasters-in-2018-caused-116b-in-damage
[12] Channel NewsAsia (2017), "Commentary: In this heat, Southeast Asia's economies may take a hit". Available at: https://www.channelnewsasia.com/news/asia/commentary-heat-southeast-asia-economies-productivity-9277846
[13] As of November 2018, 184 countries have ratified the Paris Agreement.
[14] Sources include: United Nations Framework Convention on Climate Change [UNFCCC] (2018), *The Paris Agreement.* Available at: https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement
International Institute for Sustainable Development (2018), "Paris Agreement Reaches 184 Ratifications". Available at: https://sdg.iisd.org/news/paris-agreement-reaches-184-ratifications/
[15] Net zero carbon dioxide (CO_2) emissions are achieved when anthropogenic CO_2 emissions are balanced globally by anthropogenic CO2 removals over a specified period.
[16] The World Bank, *Carbon Pricing Dashboard.* Available at: https://carbonpricingdashboard.worldbank.org/map_data

EXHIBIT 1

Governments are increasingly adopting carbon pricing initiatives, including carbon taxes and cap-and-trade systems

Number of carbon pricing initiatives implemented or scheduled for implementation; as of 2019[1]



1. These include initiatives at the subnational level (i.e. there are a total of 16 carbon pricing initiatives across states in North America)

SOURCE: The World Bank, Carbon Pricing Dashboard, Carbon Atlas, AlphaBeta Analysis

There are two common mechanisms that governments use to price carbon: (i) a carbon tax, and (ii) a cap-and-trade system. These initiatives cover around 11 gigatonnes of carbon dioxide equivalent ($GtCO_2e$), representing about 20 percent of global emissions.[17] The carbon tax covers approximately 5 percent of global emissions while the cap-and-trade system covers around 15 percent.[18] Each country's choice of carbon pricing mechanism depends on its economic, social and political context. The next section discusses their differences and the pros and cons of each pricing mechanism.

[17] World Bank Group (2018), *State and Trends of Carbon Pricing 2018*. Available at: https://openknowledge.worldbank.org/bitstream/handle/10986/29687/9781464812927.pdf
[18] The World Bank, *Carbon Pricing Dashboard. Available at: https://carbonpricingdashboard.worldbank.org/map_data*

Box 1: Positive impacts of carbon pricing on emissions reduction

Carbon prices raise the price of carbon-intensive energy compared to carbon-efficient energy, encouraging users to switch to more carbon-efficient energy sources. Hence, it is unsurprising that countries with lower carbon pricing gaps (the measure of how much a country falls short of pricing emissions in line with levels needed for decarbonisation) are generally more carbon efficient.[19]

However, this does not necessarily imply a direct causal effect – a smaller carbon pricing gap could incentivise more carbon efficient operations but economies that are already carbon-efficient (e.g. economies with lower emissions per unit of GDP) may find it easier to price emissions. Nevertheless, several country examples support the impact of carbon pricing on emissions reduction. Two examples, from the United Kingdom and Australia, are shown below.

Example 1: United Kingdom (UK)

In the UK, carbon prices in the electricity sector were raised by almost 350 percent (from around €7/tCO_2 to €32/tCO_2) between 2012 and 2016, leading to a decline in emissions of 58 percent from the electricity sector over the same period. At the same time, overall UK emissions from energy use fell by 25 percent, of which 19 percentage points were due to cleaner electricity generation (see Table 1 below). [20]

Table 1: Emissions from electricity generation fell sharply with the introduction of a carbon price support

		2012	2016	Change 2012-2016)	Change (%)
Electricity sector	CO_2 emissions in Mt	158	66	-92	-58
	Effective carbon rate in € per tonne of CO_2	7.24	32.40	25.16	347
Entire economy	CO_2 emissions in Mt	474	356	-118	-25

Source: OECD (2018), Effective Carbon Rates 2018

[19] *OECD (2018). Effective carbon rates 2018. Available at: https://read.oecd-ilibrary.org/taxation/effective-carbon-rates-2018_9789264305304-en#page62*

[20] OECD (2018). *Effective carbon rates 2018.* Avail*able at: https://read.oecd-ilibrary.org/taxation/effective-carbon-rates-2018_9789264305304-en#page62*

Example 2: Australia

A carbon price of AUD 23 per tonne was applied to around 500 of Australia's biggest polluters from 1 July 2012.[21] In the second full year since the policy was enacted, the country's greenhouse gas emissions dropped 1.4 percent - the largest recorded annual decrease in the past decade. In this same period, emissions from the electricity sector, the industry most affected by carbon pricing, fell 4 percent.[22] Despite its apparent effectiveness at reducing emissions, the carbon price was abolished after a new government came into power, replacing the tax with an AUD 2.55 billion fund that will provide voluntary grants to businesses to support emissions reduction efforts.[23]

Carbon tax

A carbon tax establishes an explicit price on carbon in dollars per tonne of greenhouse gas emissions, which could be factored into the price of goods and services based on their carbon content. This creates a direct economic incentive for companies to reduce the level of carbon emissions in their operations.[24]

Singapore began implementing a carbon tax at the start of 2019. As discussed by both speakers, this is part of the nation's effort to achieve the target of reducing emissions intensity[25] by 36 percent from 2005 levels by 2030 as outlined in its Climate Action Plan.[26] For the first five years, the carbon tax rate will be set at S$5 per tonne of greenhouse gas emissions (tCO_2e) (about US$4 per tCO_2e). The government will review the tax rate by2023 with the intention to increase it to between S$10 and S$15 per tCO2e (between US$7 and US$11 per tCO2e) by 2030.[27] To help households adjust to the carbon tax, a utilities rebate

[21] Centre for Public Impact (2017). "The Carbon Tax in Australia". Available at: https://www.centreforpublicimpact.org/case-study/carbon-tax-australia/
[22] The Guardian (2014). "Australia records biggest emissions drop in a decade as carbon tax kicks in". Available at: https://www.theguardian.com/environment/2014/dec/24/australia-records-biggest-emissions-drop-in-a-decade-as-carbon-tax-kicks-in
[23] The Guardian (2014). "Australia records biggest emissions drop in a decade as carbon tax kicks in". Available at: https://www.theguardian.com/environment/2014/dec/24/australia-records-biggest-emissions-drop-in-a-decade-as-carbon-tax-kicks-in
[24] World Resources Institute (2016), *Putting a Price on Carbon: Reducing Emissions.* Available at: https://wriorg.s3.amazonaws.com/s3fs-public/Putting_a_Price_on_Carbon_Emissions.pdf?_ga=2.236568577.1887678164.1552643388-1623580161.1552643388
[25] Emissions Intensity refers to GHG Emissions per dollar of GDP, measured in CO_2-equivalent per $
[26] National Climate Change Secretariat (2016), *Singapore's Climate Action Plan: Take Action Today, For a Carbon-Efficient Singapore*. Available at: https://www.nccs.gov.sg/docs/default-source/publications/take-action-today-for-a-carbon-efficient-singapore.pdf
[27] National Environment Agency, *Carbon Tax.* Available at: https://www.nea.gov.sg/our-services/climate-change-energy-efficiency/climate-change/carbon-tax

of S$20 (US$15) per year will be given to eligible households for three years from 2019 to 2021 to help cover any expected increase in electricity and gas expenses.[28]

A carbon tax has three main advantages:

1. Ease of implementation. A carbon tax is easier and faster for governments to implement, as compared to a cap-and-trade system. Establishing a carbon tax is relatively simpler and faster than the cap-and-trade system (see below) and can rely on existing administrative structures for taxing fuels, even though could be politically difficult to get broad-based consensus.[29]

2. Price stability. Carbon tax rates are typically fixed for predictable periods of time, with rate revisions instituted at stipulated intervals (e.g. Singapore is set to review its carbon tax rate periodically, with the first review by 2023). In an environment of minimal price volatility, businesses are encouraged to make long-term investments and pursue innovations in low-carbon technologies.[30] A carbon tax ensures that the price signal will not be weakened under unforeseen economic circumstances by maintaining incentives to reduce emissions even during economic downturns when emissions levels are low.[31]

3. Stable revenue recycling potential. Carbon taxes are a source of revenue for governments. In some cases, carbon tax revenues are returned to citizens through reliefs in other taxes such as in British Columbia (Canada).[32] They can also be used to subsidise clean energy or energy efficiency improvements as in the case of the European Union (EU).[33] Similarly, Singapore has plans to recycle carbon tax revenue for emissions reduction efforts such as enhancing energy efficiency incentives.

However, using a carbon tax could pose two key disadvantages:

1. Uncertainty around emissions reduction. While a carbon tax pre-determines the carbon price, it does not guarantee a level of reduction in carbon emissions. The degree of reduction depends on how businesses respond to the tax levied, which may lead to suboptimal

[28] The Straits Time (2018), "Singapore Budget 2018: Carbon tax of $5 per tonne of greenhouse gas emissions to be levied". Available at: https://www.straitstimes.com/singapore/singapore-budget-2018-carbon-tax-of-5-per-tonne-of-greenhouse-gas-emissions-to-be-levied
[29] David Suzuki Foundation (2017), "Carbon tax or cap-and-trade?". Available at: https://davidsuzuki.org/what-you-can-do/carbon-tax-cap-trade/
[30] World Resources Institute (2016), *Putting a Price on Carbon: Reducing Emissions.* Available at: https://wriorg.s3.amazonaws.com/s3fs-public/Putting_a_Price_on_Carbon_Emissions.pdf?_ga=2.236568577.1887678164.1552643388-1623580161.1552643388
[31] World Resources Institute (2016), "Carbon Tax vs. Cap-and-Trade: What's a Better Policy to Cut Emissions?".Available at: https://www.wri.org/blog/2016/03/carbon-tax-vs-cap-and-trade-what-s-better-policy-cut-emissions
[32] World Bank, *Putting a Price on Carbon with a Tax.* Available at: http://www.worldbank.org/content/dam/Worldbank/document/SDN/background-note_carbon-tax.pdf
[33] International Carbon Action Partnership (2019), *EU Emissions Trading System (EU ETS).* Available at: https://icapcarbonaction.com/en/?option=com_etsmap&task=export&format=pdf&layout=list&systems[]=43

reductions. Nevertheless, this could be addressed through design elements such as allowing an upward tax adjustment if the initial emissions reduction does not meet a certain specified threshold.[34] Another potential limitation is that companies may choose to pass on the entire tax to consumers (particularly in monopolistic industries) instead of sharing the responsibility of reducing emissions by improving their energy efficiencies.

2. Likelihood of consumer pushback. A carbon tax is highly visible and may trigger opposition due to the perceived costs associated with the tax. As a result, policymakers may face resistance in adopting such policies.[35] For example, France's decision to almost double the carbon tax from €45 (US$50) per tonne of carbon emissions in 2018 to €86 (US$98) by 2020 triggered weeks of violent protests, eventually leading to the suspension of the proposed hike. [36]

Box 2: Sweden's carbon tax policy

An example of a country that has successfully implemented a carbon tax is Sweden. As early as 1991, Sweden introduced a carbon tax at the rate of kr250 (US$27) per tonne of carbon dioxide emitted and gradually increased it to kr1,180 (US$128) in 2019. The Swedish carbon tax relied on existing revenue collecting systems for other excise taxes on fuels.

By increasing the tax level gradually, households and businesses were given time to adapt, rendering such tax rate increases more viable. Since the introduction of the carbon tax, the total amount of greenhouse gas emissions in the country has decreased by 26 percent.[37] Sweden's carbon tax has also been credited with spurring the innovation and use of green heating technologies that have significantly phased out burning oil for heating.[38]Today, Sweden's economy is one of the most carbon efficient in the world based on the amount of emissions produced per dollar of GDP.

[34] World Resources Institute (2016), "Carbon Tax vs. Cap-and-Trade: What's a Better Policy to Cut Emissions?".Available at: https://www.wri.org/blog/2016/03/carbon-tax-vs-cap-and-trade-what-s-better-policy-cut-emissions
[35] Wood, J. (2018). *The Pros and Cons of Carbon Taxes and Cap-and-Trade Systems*. School of Public Policy, University of Calgary. Available at: https://journalhosting.ucalgary.ca/index.php/sppp/article/view/52974/43930
[36] Global News (2018), "France cut its carbon tax after deadly riots. Here's how it compares to Canada's". Available at: https://globalnews.ca/news/4728184/france-carbon-tax-riots-canada/
[37] Anthesis (2018), *The Swedish CO_2 tax – an overview*. Available at: http://www.enveco.se/wp-content/uploads/2018/03/Anthesis-Enveco-rapport-2018-3.-The-Swedish-CO_2-tax-an-overview.pdf
[38] David Suzuki Foundation (2017), "Carbon tax or cap-and-trade?".Available at: https://davidsuzuki.org/what-you-can-do/carbon-tax-cap-trade/

Cap-and-trade system

A cap-and-trade system establishes an implicit price on carbon by placing a limit on the total quantity of emissions within a jurisdiction. With a cap on the number of emissions permits that are granted to companies, companies with low emissions could sell their extra permits to larger emitters. A price for greenhouse gas emissions will then be determined by market forces.[39]

There are two main advantages to a cap-and-trade system:

1. Certainty around emissions reduction. An advantage that a cap-and-trade system has over a carbon tax is that it provides certainty around the quantity of emissions that could be reduced. This helps countries achieve pre-determined emissions reduction targets by setting a falling emissions cap over time.[40] For example, the EU's cap-and-trade system was designed to help achieve its target of reducing emissions by 20 percent by 2020 (from 2008 levels).[41] Proponents of the cap-and-trade mechanism have highlighted the benefit of "emissions certainty" in light of the escalating impacts of climate change and the need to limit total carbon emissions to certain thresholds.[42]

2. Less likelihood of consumer pushback. Without the perception as a tax on consumers, the cap-and-trade policy may be more politically feasible to adopt (relative to the carbon tax).[43]

Conversely, a cap-and-trade system has three major disadvantages:

1. Complex to implement. Not only do governments need to develop an approach to allocate or auction available emissions permits, regulations are also needed to outline the rules of trading the permits. The allocation of permits can be done based on historical emissions or benchmarked against production levels.[44] Additional compliance burden is also placed on businesses who have to spend resources to navigate the complex process. A case study of

[39] Carbon Pricing Leadership Coalition, "What is carbon pricing?". Available at: https://www.carbonpricingleadership.org/whatsni
[40] World Resources Institute (2016), "Carbon Tax vs. Cap-and-Trade: What's a Better Policy to Cut Emissions?". Available at: https://www.wri.org/blog/2016/03/carbon-tax-vs-cap-and-trade-what-s-better-policy-cut-emissions
[41] In 2008, the EU set a series of climate and energy targets to be met by 2020 in its pathway towards a low-carbon competitive economy, known as the "20-20-20" targets. These targets were established using economic modelling to imply the least costs for the EU economy as a whole. For more information, see: European Commission, *EU ETS Handbook.* Available at: https://ec.europa.eu/clima/sites/clima/files/docs/ets_handbook_en.pdf
[42] World Resources Institute (2016), *Putting a Price on Carbon: Reducing Emissions.* Available at: https://wriorg.s3.amazonaws.com/s3fs-public/Putting_a_Price_on_Carbon_Emissions.pdf?_ga=2.236568577.1887678164.1552643388-1623580161.1552643388
[43] Sources include: Joint Transport Research Centre (2008), *The cost and effectiveness of policies to reduce vehicle emissions.* Available at: https://www.oecd-ilibrary.org/docserver/235407601737.pdf?expires=1553584616&id=id&accname=guest&checksum=F6A662F6B14C6CEC4BB38E715D8060E2
Wood, J. (2018). *The Pros and Cons of Carbon Taxes and Cap-and-Trade Systems*. School of Public Policy, University of Calgary. Available at: https://journalhosting.ucalgary.ca/index.php/sppp/article/view/52974/43930
[44] Brookings Institution (2014), "Pricing Carbon: A Carbon Tax or Cap-And-Trade?". Available at: https://www.brookings.edu/blog/planetpolicy/2014/08/12/pricing-carbon-a-carbon-tax-or-cap-and-trade/

companies participating in the EU's emissions trading system showed transaction costs ranging from €0.14 (US$0.16) to €0.79 (US$0.89) per allowance.[45]

2. Price volatility. As the price levels are determined by market forces in the cap-and-trade system, prices may decline to the point where the emissions reduction is less than that of a carbon tax. For example, in the initial stages of the EU's cap-and-trade system, the European Commission predicted that allowance prices would steadily increase to about €39 (US$44) per tonne by 2020.[46] However, after peaking at almost €30 (US$34) in 2008, prices sharply fell to as low as €3 (US$3.4) per tonne before recovering in 2018.[47] It was assessed that the EU would have achieved significant additional emissions reductions had it implemented a carbon tax at the expected allowance price levels.[48]

3. Uncertain revenue recycling potential. A cap-and-trade policy only generates revenue if emissions permits are auctioned. If all permits are distributed freely, no revenue will be generated for governments to allocate to energy efficiency projects. Also, under cap-and-trade, there could be more lobbying for free allowances as seen in other jurisdictions, resulting in distortionary outcomes where sector associations may be allocated more allowances not because these sectors are more deserving, but due to their stronger lobbying power.

Even when auctions are used to allocate emissions permits, the amount of revenue collected from a cap-and-trade system may be substantially lower than what a carbon tax can help to generate. For instance, it was determined that Quebec generated much less than what could be achieved using a carbon tax, despite auctioning more than 70 percent of permits in 2015.[49]

[45] Frasch, F. (2006). *Transaction costs of the EU Emissions Trading Scheme in German companies*. Sustainable Development Law & Policy. Available at: https://digitalcommons.wcl.american.edu/cgi/viewcontent.cgi?referer=https://www.google.com/&httpsredir=1&article=1308&context=sdlp
[46] World Resources Institute (2016), *Putting a Price on Carbon: Reducing Emissions.* Available at: https://wriorg.s3.amazonaws.com/s3fs-public/Putting_a_Price_on_Carbon_Emissions.pdf?_ga=2.236568577.1887678164.1552643388-1623580161.1552643388
[47] Refinitiv (2018), "Will high European carbon prices last?". Available at: https://www.refinitiv.com/perspectives/market-insights/will-high-european-carbon-prices-last/
[48] World Resources Institute (2016), *Putting a Price on Carbon: Reducing Emissions.* Available at: https://wriorg.s3.amazonaws.com/s3fs-public/Putting_a_Price_on_Carbon_Emissions.pdf?_ga=2.236568577.1887678164.1552643388-1623580161.1552643388
[49] Wood, J. (2018). *The Pros and Cons of Carbon Taxes and Cap-and-Trade Systems*. School of Public Policy, University of Calgary. Available at: https://journalhosting.ucalgary.ca/index.php/sppp/article/view/52974/43930

Box 3: California's cap-and-trade programme

A positive case study of a cap-and-trade programme that has made important strides in addressing the shortcomings of this pricing mechanism can be observed in California, US. The programme started in 2013 with the aim of reducing emissions to the 1990 levels by 2020. 35 percent of the state's emissions were covered during the first compliance period (2013-2014) and up to 85 percent were regulated in the second phase (2015-2017).

The programme was well-designed to address the risk of price volatility by incorporating a US$10 price floor with a 5 percent escalation rate per year. The government also introduced an allowance price-containment reserve that allowed regulators to remove or add allowances to the market.

The revenue collected from allowance auctions has been channelled to projects addressing climate change. As a result of the programme, covered sectors have steadily reduced emissions to 9 percent below the 2014 cap. With the current progress, California is on track to achieving its emissions targets by 2020.[50]

While each carbon pricing approach has its own strengths and limitations, if designed well, both approaches can help to reduce carbon emissions, spur innovations and investments in clean technologies and encourage consumers to shift to energy-efficient products.[51]

3. Besides governments, the private sector is also actively adopting internal carbon pricing

Companies are also subjected to rising risks from changing climatic conditions and extreme weather events. Potential risks include lack of raw materials, damages to physical assets, commodity price volatility, disruption of distribution channels, and worker health and safety hazards.[52] As shared by Mr Chia during the discussion, proper accounting of physical risks could potentially reduce current enterprise value of companies by 2-3 percentage points on average.[53] Given this, companies are increasingly adopting internal carbon pricing as a

[50] Center for International Environment and Resource Policy (2017*), Carbon Pricing in Practice: A Review of the Evidence*. Available at: https://sites.tufts.edu/cierp/files/2017/11/Carbon-Pricing-In-Practice-A-Review-of-the-Evidence.pdf
[51] World Resources Institute (2016), "Carbon Tax vs. Cap-and-Trade: What's a Better Policy to Cut Emissions?". Available at: https://www.wri.org/blog/2016/03/carbon-tax-vs-cap-and-trade-what-s-better-policy-cut-emissions
[52] Green Biz (2013), "Climate change as real business risk". Available at: https://www.greenbiz.com/blog/2013/04/24/climate-change-real-business-risk
[53] Schroders (2018), *Climate change: the forgotten physical risks*. Available at: https://www.schroders.com/en/sysglobalassets/digital/insights/2018/thought-leadership/climate-change---the-forgotten-physical-risks_final.pdf

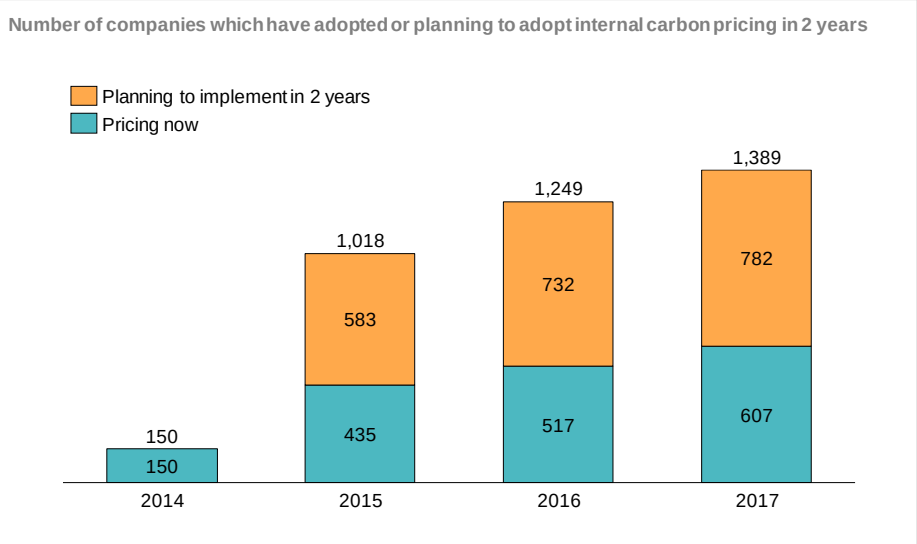
strategic risk management tool to inform decision-making and prepare for a carbon-constrained future.

As of 2017, nearly 1,400 companies have disclosed their current practices or plans to use internal carbon pricing – up from 150 in 2014 (Exhibit 2). This includes more than 100 "Fortune Global 500" companies with collective annual revenues of US$7 trillion.[54]

Nearly **1,400 companies** have disclosed their current practices or plans to use internal carbon pricing

EXHIBIT 2

The private sector is actively adopting internal carbon pricing



SOURCE: CDP (2017)

There are five key motivations driving the private sector's adoption of internal carbon pricing:

1. Achieve emissions reduction targets. Businesses are also setting their own emissions reduction targets in response to growing pressure from governments and the potential risks of climate change on their operations. For example, Shell aims to halve its carbon footprint by 2050, while Microsoft has pledged to reduce its operational carbon emissions by 75 percent against the 2013 baseline by 2030.[55] In Singapore, DBS Bank has committed to powering all local operations with renewable energy by 2030, and Singtel has pledged to cut its absolute

[54] CDP (2017), Putting a price on carbon - Integrating climate risk into business planning. Available at: https://www.actu-environnement.com/media/pdf/news-29828-prix-carbone-entreprises-cdp.pdf

[55] Sources include: Microsoft (2017), "Microsoft pledges to cut carbon emissions by 75 percent by 2030". Available at: https://blogs.microsoft.com/on-the-issues/2017/11/14/microsoft-pledges-cut-carbon-emissions-75-percent-2030/
DBS (2017), *RE100 Commitment*. Available at: https://www.dbs.com/sustainability/responsible-business-practices/managing-our-environmental-footprint/re100-commitment/default.page

greenhouse gas emissions across its Singapore and Australia operations by 42 percent from its 2016 base-year by 2030.[56]

Globally, almost half of the companies which have committed to limiting global warming to 2 degrees Celsius and switching to renewable energy have either adopted or plan to adopt an internal carbon price by 2018.[57]

2. Hedge against carbon regulations. Companies may choose to implement an internal carbon price to prepare for future regulations or to respond to existing regulations. This is particularly true for businesses facing higher regulatory risks related to carbon emissions such as those in the oil and gas, and minerals sectors.

3. Build resilient supply chains. The physical impacts of climate change can affect the availability of critical raw materials used in a company's supply chains. Climate change can also result in higher prices of its key inputs, including energy and water. Incorporating a carbon price into business planning and operations is one way to account for and address these risks.

4. Increase competitiveness. Internal carbon pricing could direct resources to low-carbon and energy-efficient projects. This helps the company improve its operational efficiency and reduce costs. It will also spur innovations and create opportunities to increase the company's competitiveness in low-carbon areas.

5. Demonstrate leadership in sustainability issues. Consumers are increasingly paying attention to sustainability practices of corporates. According to a global consumer survey conducted by Nielsen, more than 80 percent of the respondents felt strongly that companies should implement programmes to improve the environment while 30 percent would be willing to pay a premium for products made with sustainable materials.[58] The highly visible carbon price can communicate to consumers about the company's efforts to protect the environment.

Besides consumers, investors and shareholders are also placing added emphasis on sustainability issues. For example, BlackRock has supported a shareholder resolution

[56] Sources include: Singtel (2017), *Singtel Group Sustainability Report*. Available at: *https://www.singtel.com/content/dam/singtel/about-us/sustainability/reports/singtel-sustainability-report-2017.pdf*
DBS (2017), *RE100 Commitment*. Available at: https://www.dbs.com/sustainability/responsible-business-practices/managing-our-environmental-footprint/re100-commitment/default.page
[57] Center for Climate and Energy Solutions (2017), *The Business of Pricing Carbon: How Companies are Pricing Carbon to Mitigate Risks and Prepare for a Low-Carbon Future*. Available at: https://www.c2es.org/site/assets/uploads/2017/09/business-pricing-carbon.pdf
[58] Nielsen (2018), "Sustainable shoppers buy the change they wish to see in the world". Available at: https://www.nielsen.com/us/en/insights/reports/2018/the-education-of-the-sustainable-mindset.html

requesting ExxonMobil to report the impacts of its climate change policies to achieve the 2 degree Celsius warming target.[59]

There are four different ways for companies to implement internal carbon pricing – (i) a shadow price, (ii) an internal carbon fee, (iii) an implicit price and or (iv) an internal cap-and-trade programme. Shadow pricing and internal carbon fee are the most common approaches.[60]

Shadow price

A shadow price is a notional value attached to carbon emissions to assess the risks of business investments. In particular, a pre-determined carbon price will be incorporated into the calculation of the internal rate of return (IRR) of each investment. This helps companies prioritise low-carbon projects under anticipated government policies that may increase emissions-related costs.

Shadow pricing is usually favoured at the start of an internal carbon pricing journey. This is because it helps businesses select investments that would yield a high rate of return in a carbon-constrained environment. Companies also use shadow pricing as a proxy for future carbon regulations. By setting an internal carbon price higher than the current levels regulated by governments, companies can better future-proof their operations against potential increases in carbon prices.

While shadow pricing is easy to implement, its impacts on reducing carbon emissions could be limited, with some companies indicating that using a shadow price may be insufficient to materially drive the company's long-term strategy and shifting investments to low-carbon options. Determining the right shadow price to be used in the calculation of investment returns is also challenging, where the lack of long-term regulatory certainty (a particularly pertinent problem in developing markets) makes it difficult for companies to obtain an effective price range.

Mining multinational BHP has a shadow price of US$24-80 per tCO_2e since 2004 to guide decisions to improve energy efficiency and diversify its assets for a carbon-constrained future.[61] This has contributed to the company's reduction in emissions by 13 percent between

[59] Harvard Business Review (2018), "Does Wall Street Finally Care About Sustainability?". Available at: https://hbr.org/2018/01/does-wall-street-finally-care-about-sustainability
[60] WSP (2017), *Carbon pricing Seven things to consider when establishing a carbon pricing program*. Available at: https://www.wsp.com/en-US
[61] Center for Climate and Energy Solutions (2017). "Companies set their own price on carbon". Available at: https://www.c2es.org/2017/09/companies-set-their-own-price-on-carbon/

2015 and 2016. In Singapore, Sembcorp uses this mechanism in project appraisals and portfolio stress tests as part of its risk management process.[62]

Internal carbon fee

This is an internally pre-determined fee that companies voluntarily impose on their operations, adding a cost related to greenhouse gas emissions to their total operating costs. The fee is applied to individual business units on different activities (such as energy consumption, waste generation or air travel), which leads to actual internal transfers of funds within the company. The money collected can be used to fund the company's emissions reduction projects or Corporate Social Responsibility (CSR) activities.[63]

Placing an explicit dollar value on carbon emissions helps to communicate the company's concerns related to climate change across its operations. There are also longer-term benefits associated with implementing an internal carbon fee. With the fee directly impacting the profits of each business unit within the company, this may directly link the financial incentives (through variable compensation) of business units to achieving carbon reduction targets. Over time, this can create a shift in the company's culture towards one that places higher value on the environment.[64]

Several challenges have emerged regarding the implementation of an internal carbon fee. Companies have indicated concerns on how to get internal stakeholders to accept such an approach and how such a programme can be developed and administered.[65] A carbon fee may be viewed as placing an excessive cost on the business and considered punitive by business units that generate higher emissions in the company. Furthermore, it may be less feasible in certain sectors such as electricity given the need to minimise costs for the benefits of consumers.

[62] Sembcorp (2018), Climate Change Strategy. Available at: http://www.sembcorp.com/en/media/514242/sembcorp-climate-change-strategy.pdf
[63] Institute for Climate Economics (2016), Internal carbon pricing - A growing corporate practice. Available at: https://www.i4ce.org/wp-core/wp-content/uploads/2016/09/internal-carbon-pricing-november-2016-ENG.pdf
[64] Center for Climate and Energy Solutions (2017), *The Business of Pricing Carbon: How Companies are Pricing Carbon to Mitigate Risks and Prepare for a Low-Carbon Future*. Available at: https://www.c2es.org/site/assets/uploads/2017/09/business-pricing-carbon.pdf
[65] Center for Climate and Energy Solutions (2017), *The Business of Pricing Carbon: How Companies are Pricing Carbon to Mitigate Risks and Prepare for a Low-Carbon Future*. Available at: https://www.c2es.org/site/assets/uploads/2017/09/business-pricing-carbon.pdf

Box 4: Microsoft's internal carbon fee programme

Since 2012, a carbon fee has been applied to Microsoft's business groups based on the emissions associated with their electricity consumption as well as employee air travel. Between 2012 and 2016, the fee (which ranged from US$5 to US$10 per tonne) was universally applied across 12 business units in more than 100 countries.

Early engagements of relevant stakeholders, including the senior management, and the environmental sustainability and finance divisions have helped gathered internal buy-in. A cross-departmental group consisting of representatives from both the environmental sustainability team and the finance team was formed to take the responsibility of administering the fee.

The funds collected have been used to invest in various projects to reduce carbon emissions. Since the start of the programme, more than US$2 million has been invested in 60 projects across 23 countries.[66]

Implicit price

A company's implicit carbon price is calculated based on how much it spends to reduce emissions and/or to comply with government regulations. It could be the amount a company spends on renewable energy purchases or compliance with fuel standards. For instance, some companies incorporate maximum emission standards on fleet vehicles into their procurement policies, which may lead to an increase in expenditure on this item. The additional cost is taken to be the implicit carbon price.

Unlike a shadow price or an internal carbon fee, an implicit price is calculated retrospectively and is not used to assess the implications of future carbon constraints. Instead, an implicit price helps a company understand its carbon footprint and identify ways to minimise costs associated with carbon emissions. Some companies use implicit prices as benchmarks before formally launching other carbon pricing approaches. For example, Unilever used an implicit carbon price of US$10 per tonne of emissions, calculated by dividing the cost of generating or purchasing renewable energy by the number of tonnes saved.[67]

[66] Center for Climate and Energy Solutions (2017), *The Business of Pricing Carbon: How Companies are Pricing Carbon to Mitigate Risks and Prepare for a Low-Carbon Future*. Available at: https://www.c2es.org/site/assets/uploads/2017/09/business-pricing-carbon.pdf
[67] Center for Climate and Energy Solutions (2017), *The Business of Pricing Carbon: How Companies are Pricing Carbon to Mitigate Risks and Prepare for a Low-Carbon Future*. Available at: https://www.c2es.org/site/assets/uploads/2017/09/business-pricing-carbon.pdf

Internal cap-and-trade

Similar to cap-and-trade systems established by governments, companies may choose to implement their internal cap-and-trade programmes. In this approach, companies set an upper limit on total emissions from all business units and create an allowance for each tonne of carbon emitted. Different business units can then buy or sell allowances from each other.

This mechanism is particularly useful for conglomerates with diverse operations as it gives carbon-intensive units more flexibility while reducing emissions company-wide. However, internal cap-and-trade is uncommon due to its complex structure and high development and implementation costs. Shell piloted STEPs (Shell Tradable Emissions Permit System) in 2000 to help meet its greenhouse gas reduction targets and prepare for the EU's cap-and-trade programme that started in 2005.[68]

It is important to note that the four internal carbon pricing approaches described above are not mutually exclusive. Companies can use a combination of these mechanisms to meet their emissions targets. The choice of internal carbon pricing approaches depends on the goals and operational needs of each company. For example, Disney uses a shadow price to complement its internal carbon fee in driving investments in low carbon technologies.[69]

4. There are several best practices in implementing carbon pricing.

Carbon pricing implementation can be facilitated through the following best practices:

1. Adopt phased approaches to allow for policy refinements. A phased approach to carbon pricing may be used to provide policy stability and certainty for the compliance period, such that major refinements to the scheme is done between phases. For instance, California's cap-and-trade programme started with a two-phase compliance period – from 2013 to 2014, and from 2015 to 2017. This allowed companies time to prepare for an expansion of the coverage (from 35 to 85 percent of the state's total emissions) and gradual decreases in the emissions limit. When the first two phases ended in 2017, the government approved an extension of the programme until 2030 and incorporated new design elements such as a price ceiling and additional assistance to the industrial sector.[70]

[68] Center for Climate and Energy Solutions (2017), *The Business of Pricing Carbon: How Companies are Pricing Carbon to Mitigate Risks and Prepare for a Low-Carbon Future*. Available at: https://www.c2es.org/site/assets/uploads/2017/09/business-pricing-carbon.pdf
[69] Center for Climate and Energy Solutions (2017), *The Business of Pricing Carbon: How Companies are Pricing Carbon to Mitigate Risks and Prepare for a Low-Carbon Future*. Available at: https://www.c2es.org/site/assets/uploads/2017/09/business-pricing-carbon.pdf
[70] Center for Climate and Energy Solutions (2017), *Summary of California's extension of its cap-and-trade program.* Available at: https://www.c2es.org/site/assets/uploads/2017/09/summary-californias-extension-its-cap-trade-program.pdf

Similarly, in Singapore, the government has adopted a phased approach by setting a transitionary carbon tax of S$5/tCO$_2$e (with the intention to increase it to between S$10 and S$15 per tCO2e by 2030) which allows firms to adapt and react to the tax, including affording them sufficient time to invest and reap the benefits of new energy-efficient technologies.

2. Ensure more efficient revenue recycling. In some cases, governments have earmarked the revenues generated through carbon pricing schemes to promote low-carbon innovations. Quebec and California use revenue raised from their cap-and-trade programmes to fund low-carbon technologies.[71] In the EU, the Innovation Fund created by revenue from the sale of emissions allowances will invest in carbon capture and storage technologies as well as renewable energy.[72] Governments may also provide consumer rebates to alleviate the burden of the carbon price. For example, in Manitoba, Canada, households will receive a rebate of C$336 (US$250) on their tax return in 2019 to offset the cost incurred (estimated at C$232, or US$173) due to the carbon tax.

3. Enhance public communication. Effective communication about carbon pricing is integral to gaining public acceptance. To assist governments in communicating their carbon pricing schemes to the public, the Partnership for Market Readiness (PMR) together with the Carbon Pricing Leadership Coalition (CPLC)[73] published the "Guide to Communicating Carbon Pricing" which includes key communication principles as well as a step-by-step guide to develop an effective carbon pricing communication campaign.[74]

The guide highlights the importance of explaining how carbon pricing policies benefit different audiences with respect to their motivations, values, and concerns. Besides the broad impacts of carbon pricing on climate change, benefits that are of immediate concerns to the public such as reduced air pollution and job creation in clean energy industries could be emphasised.

4. Increase collaboration between governments. The implementation of carbon pricing schemes may be supported by increased collaboration between different countries. The World Bank launched the Partnership for Market Readiness, which aims to help countries prepare and implement climate change mitigation measures including carbon-pricing policies by leveraging partners' experiences to share knowledge and best practices.[75] Furthermore,

[71] Carbon Pricing Leadership Coalition (2016), *What Are the Options for Using Carbon Pricing Revenues?.* Available at: http://pubdocs.worldbank.org/en/668851474296920877/CPLC-Use-of-Revenues-Executive-Brief-09-2016.pdf
[72] International Carbon Action Partnership (2019), *EU Emissions Trading System (EU ETS).* Available at: https://icapcarbonaction.com/en/?option=com_etsmap&task=export&format=pdf&layout=list&systems[]=43
[73] The Carbon Pricing Leadership Coalition *brings together leaders from government, private* sector, academia, and civil society to expand the use of carbon pricing policies. For more information, see: https://www.carbonpricingleadership.org/#
[74] For more information, please refer to Partnership for Market Readiness, Carbon Pricing Leadership Coalition (2018), Guide to communicating carbon pricing. Available at: https://openknowledge.worldbank.org/bitstream/handle/10986/30921/132534-WP-WBFINALonline.pdf
[75] For more information, please refer to Partnership for Market Readiness. Available at: https://www.thepmr.org/

governments can work together to develop linked carbon pricing initiatives. An example would be the scheduled linking of the EU and Swiss emissions trading systems by 2020.[76] Members of the Pacific Alliance are also exploring the possibility of having a regional market with aligned carbon pricing policies across Chile, Colombia, Mexico, and Peru.[77]

5. Leverage existing resources. Companies may also make use of existing resources to guide their implementation of internal carbon pricing schemes. Together with Ecofys (an international energy and sustainability consultancy) and the Generation Foundation (the advocacy arm of the sustainable investment firm Generation Investment Management), CDP (formerly the Carbon Disclosure Project) published a practical "how-to" guide to introduce best practice approaches to internal carbon pricing globally.[78] The guide prescribes the following design dimensions in an internal carbon pricing programme:

- **"Height", which refers to the price per unit of greenhouse gas emitted.** The price level should be able to bring about changes in business decisions in line with the objectives of the internal carbon pricing programme.

- **"Width", which refers to the coverage of the internal carbon pricing programme**. All emissions hotspots in the entire value chain that can be influenced should be covered by the programme.

- **"Depth", which refers to the degree of influence on decisions made by the company and its partners.** Companies are recommended to make their internal carbon pricing programmes increasingly influential to create a substantial impact on the decision-making process internally and with their partners.

- **"Time", which refers to an ongoing evaluation of the programme execution and impact.** Companies should regularly assess the "height", "width" and "depth" of their internal carbon pricing programmes to ensure that carbon pricing is embedded in their business strategy and the company is moving towards a low-carbon direction.

[76] Sources include: International Carbon Action Partnership (2019), *Swiss ETS.* Available at: https://icapcarbonaction.com/en/?option=com_etsmap&task=export&format=pdf&layout=list&systems[]=64
International Carbon Action Partnership (2019), *Canada - Québec Cap-and-Trade System*. Available at: https://icapcarbonaction.com/en/?option=com_etsmap&task=export&format=pdf&layout=list&systems%5B%5D=73
[77] The World Bank (2017), "The Pacific Alliance and climate change". Available at: http://blogs.worldbank.org/climatechange/pacific-alliance-and-climate-change
[78] For more information, please refer to Ecofys, The Generation Foundation and CDP (2017), *How-to guide to corporate internal carbon pricing - Four dimensions to best practice approaches*. Available at: https://www.cdp.net/en/reports/archive?page=4&per_page=20&sort_by=published_at&sort_dir=desc

The Singapore Chapter of the CPLC was launched in November 2018 to help companies adopt internal carbon pricing mechanisms by encouraging collaboration and knowledge sharing, as well as through technical support. It also facilitates discussions between the private and public sectors to promote investments in low-carbon innovations in Singapore and the region.[79]

5. Despite progress, governments and businesses must significantly raise their ambition levels on carbon pricing to tackle climate change more effectively.

In summary, while carbon pricing efforts are promising, they cover only 20 percent of global greenhouse gas emissions.[80] This implies that actual reduction is likely to be much lower, as the effectiveness of pricing mechanisms will depend on factors such as the carbon price levels and the responsiveness of emitting entities to the pricing signals.

80 percent of global greenhouse gas emissions are still not covered by current carbon pricing initiatives

Carbon emissions remain largely under-priced. An OECD analysis of 42 countries representing 80 percent of global emissions has an overall pricing gap of 76.5 percent in 2018. While the gap has narrowed (83 percent in 2012 and 79.5 percent in 2015), carbon prices may only meet climate costs by 2095 at the current rate of progress.[81] This implies that countries have room to increase price levels further to optimise their mitigation package, particularly as policies such as regulations and mandates could have higher implicit costs than a low, explicit carbon price.

To achieve the targets outlined in the Paris Agreement, prices need to reach an estimated range of US$40-80 per tCO_2e by 2020, and US$50-100 per tCO_2e by 2030.[82] However, it is also important to emphasise that it could be misleading to compare headline carbon prices across countries as a measure of policy progress towards reducing carbon emissions. A country with a lower carbon tax that has no ambiguous exemptions (that could maintain a transparent, fair and consistent price signal) could be more effective than one with a high

[79] Carbon Pricing Leadership Coalition (2018), "CPLC and Global Compact Network Singapore Launch CPLC Singapore". Available at: https://www.carbonpricingleadership.org/news/2018/11/18/carbon-pricing-leadership-coalition-cplc-launches-first-official-chapter-in-singapore
[80] World Bank Group (2018), *State and Trends of Carbon Pricing 2018*. Available at: https://openknowledge.worldbank.org/bitstream/handle/10986/29687/9781464812927.pdf
[81] OECD (2018), *Effective Carbon Rates*. Available at: http://www.oecd.org/tax/tax-policy/effective-carbon-rates-2018-brochure.pdf
[82] High-Level Commission on Carbon Prices (2017), *Report of the High-Level Commission on Carbon Prices*. Available at: https://openknowledge.worldbank.org/bitstream/handle/10986/29687/9781464812927.pdf

carbon price but has generous exemptions or free allowances to particular trade-exposed sectors.

Carbon pricing also needs to be complemented by other measures to effectively tackle climate change, including:

- **Carbon offsets.** Carbon offsets may be incorporated into carbon pricing programmes to reduce compliance costs. Companies can buy carbon offsets that fund emission reduction projects in other countries as an alternative to more expensive emissions reductions in their own countries. For instance, the EU's cap-and-trade programme allows companies to use carbon offsets from the Clean Development Mechanism which invests in low-carbon projects in developing countries to meet their compliance requirements.[83]

- **Energy efficiency standards**. Governments and businesses could set efficiency standards for vehicles and buildings to promote energy efficiency. The EU has introduced a code of conduct outlining best practices that companies have to adopt in order to improve the energy efficiency of their data centres.[84] In Singapore, the Energy Market Authority (EMA) has also launched the Energy Efficiency Grant to co-fund up to 50 percent of energy efficiency improvement projects by power generation companies.[85]

- **Fiscal instruments.** Governments may provide tax exemptions or tax breaks for energy efficiency improvements. Several countries in Europe impose a fee on energy inefficient vehicles but offer a rebate on energy efficient ones to encourage the use of more energy efficient alternatives.[86]

- **Renewable portfolio requirements**. This may entail requiring power providers to have a minimum share of clean energy in their output mix. This has been applied in Germany, Chile and a number of states in the United States.[87]

[83] European Commission, "Use of international credits". Available at: https://ec.europa.eu/clima/policies/ets/credits_en#tab-0-0
[84] European Commission (2018), *2018 Best Practice Guidelines for the EU Code of Conduct on Data Centre Energy Efficiency: Version 9.1.0*. Available at: https://ec.europa.eu/jrc/en/publication/2018-best-practice-guidelines-eu-code-conduct-data-centre-energy-efficiency-version-910
[85] For more information, please refer to Energy Market Authority, "Energy Efficiency for Power Generation". Available at: https://www.ema.gov.sg/Energy_Efficiency%20for%20Power%20Generation.aspx
[86] Carbon Pricing Leadership Coalition, "What is Carbon Pricing?". Available at: https://www.carbonpricingleadership.org/what
[87] Carbon Pricing Leadership Coalition, "What is Carbon Pricing?". Available at: https://www.carbonpricingleadership.org/what

- **Trade policies**. Governments can support clean energy industries by reducing tariffs on green goods such as solar panels and wind turbines, enabling better access to global renewable energy technologies.

- **Carbon capture, storage and utilisation (CCSU)**. CCUS technologies play a vital role in meeting the goals of the Paris Agreement. In fact, CCSU is considered one of the only technology solutions that can significantly reduce emissions from coal and gas power generation and deliver the deep emissions reductions needed across key industrial processes such as steel, cement and chemicals manufacturing.[88] However, the cost of carbon capture is a major obstacle to large scale adoption currently. Recent estimates reveal that the cost of carbon capture has fallen to between US$94 and US$232 per tonne of carbon, down significantly from US$1,000 per tonne previously.[89] Over time, more investments from governments and businesses may further reduce the cost of such technology, increasing the viability of large scale adoption.

[88] International Energy Agency (2018), "Carbon capture, utilisation and storage". Available at: https://www.iea.org/topics/carbon-capture-and-storage/
[89] MIT Technology Review (2018), "Maybe we can afford to suck CO_2 out of the sky after all". Available at: https://www.technologyreview.com/s/611369/maybe-we-can-afford-to-suck-cosub2sub-out-of-the-sky-after-all/