Economic Transition Monitor
The path to net-zero

Edition #1: December 2021
From Invesco's Global Market Strategy Office

For professional/qualified/accredited investors only

December 2021
Data as of 10 December 2021 unless stated otherwise

Invesco

Economic Transition Monitor

The path to net-zero

This is the first in what will be a regular monitoring of the path to net-zero. The first edition focuses on the C20 – the 20 largest CO2 emitter countries (see **Figure 1**). These countries accounted for 80% of global CO2 emissions in 2020. Now that COP-26 is behind us, we examine the net-zero targets set by each country (though not all of them have yet established a target). To analyse the likely success in meeting those targets we show recent trends in emissions, emissions per capita and the CO2 intensity of economic activity (net-zero requires the latter two metrics to fall to zero). We also make a distinction between production-based and consumption-based emissions (the former is the way that data is commonly presented but it is unfair to countries that are sources of goods and raw materials that are consumed in other countries). Recent trends are not very encouraging but where there is a will, there is a way. We believe that technology will play a critical role, especially if developing countries are to reach their full potential in a "clean" fashion.

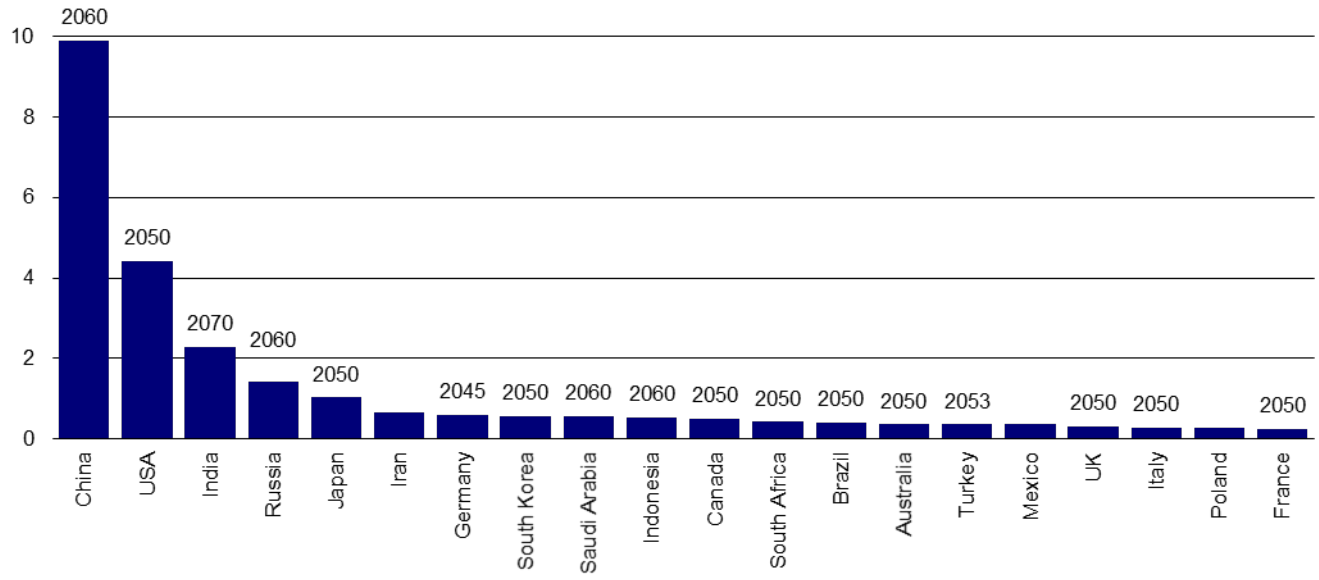
Main conclusions:

- Unfortunately, global emissions continue to rise and we doubt that temperature change can be limited to 1.5 degrees Celsius. The challenge is to limit by how far that target is exceeded
- 17 of the C20 have set net-zero target years (either in law or announced)
- Of the three that have not, Mexico is discussing the topic
- Based on recent trends, only the UK will meet its net-zero target (2050)
- Of the other countries, eight are still seeing a rise in emissions per capita and those trends will eventually need to be reversed if net-zero is to be achieved
- New technologies will be critical in reducing the CO2 intensity of economic activity but will need to be shared with poorer countries if the world is to avoid the worst climate change outcomes
- Governments play a leading role but the private sector will be critical in channelling funds in the right direction

Technology corner:

- In each edition we will focus on some key technological developments
- This time we take some broad-brush strokes
- We highlight carbon capture, carbon removal, carbon storage, alternative energies (hydrogen/ammonia), energy storage (such as pumped storage hydropower) and blockchain for carbon tracking and accounting.

Figure 1 – CO2 emissions by the 20 largest emitters in 2020 (billion tonnes) and net-zero target dates



Notes: The chart shows CO2 emissions in 2020 by the 20 largest emitter countries (the ranking of countries was done using 2019 data to avoid the distortions caused by the pandemic in 2020). The numbers above each bar show the net-zero target year announced by that country (no date suggests that no target has been announced).
Source: BP Statistical Review of World Energy 2021, Energy & Climate Intelligence Unit, Refinitiv Datastream and Invesco

Table of contents

Introduction

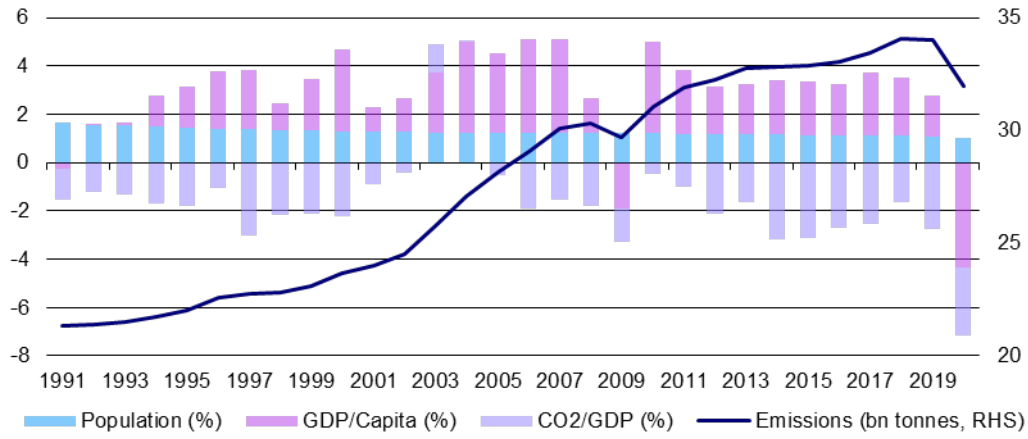
Welcome to the first edition of Invesco's Economic Transition Monitor (ETM), which aims to track global efforts to reach net-zero emissions and thereby limit the extent of climate change. We doubt that temperature change can be limited to 1.5 degrees Celsius, so the task is to limit the extent of the overshoot (see Climate change revisited).

This is very much a first edition and the scope will be expanded over time: first, we cover only the 20 largest CO2 emitter countries in this document (accounting for 80% of global emissions) and this will be increased over time. Second, we limit ourselves to historical data and recent trends but in future iterations we will forecast emissions.

Governments have an important role to play in achieving climate change goals but the private sector's behaviour will be critical. Investors can deploy assets in a way that forces (and profits from) change but can also pressure governments to do the right things. This document is our attempt to hold the feet of governments to the fire by encouraging them to set goals and to then monitor progress towards those goals.

Figure 2 shows the scale of the task. Global CO2 emissions continue to rise (with an interruption in 2020 due to the Covid pandemic) and we seem a long way from the goal of achieving net-zero emissions. For the purposes of this document, we are focusing on CO2 emissions (rather than total greenhouse gas emissions) and we are assuming that achieving net-zero emissions is the same as bringing gross emissions to zero (the difference between net and gross is not enormous and there is not enough historical data on net-emissions to allow sensible comparisons).

Figure 2 – World CO2 emissions and contributions to growth



Notes: annual data from 1991 to 2020. "Emissions" shows global CO2 emissions in billions of metric tonnes. "Population (%)" shows the annual percentage change in global population. "GDP/Capita (%)" shows the annual percentage change in global GDP per capita, where GDP is measured in 2011 prices and converted into US dollars using purchasing power parity (PPP) exchange rates. "CO2/GDP (%)" shows the annual percentage change in global CO2 emissions per US dollar of global GDP (in 2011 prices, using PPP exchange rates). Source: BP Statistical Review of World Energy 2021, IMF, Oxford Economics, World Bank, Refinitiv Datastream and Invesco

Figure 2 also serves to introduce some of the concepts that will feature regularly in this document. Emissions can be thought of as being the product of population, GDP per capita and the CO2 intensity of GDP (CO2 emissions per dollar of GDP). Hence, the growth in global emissions has three components:

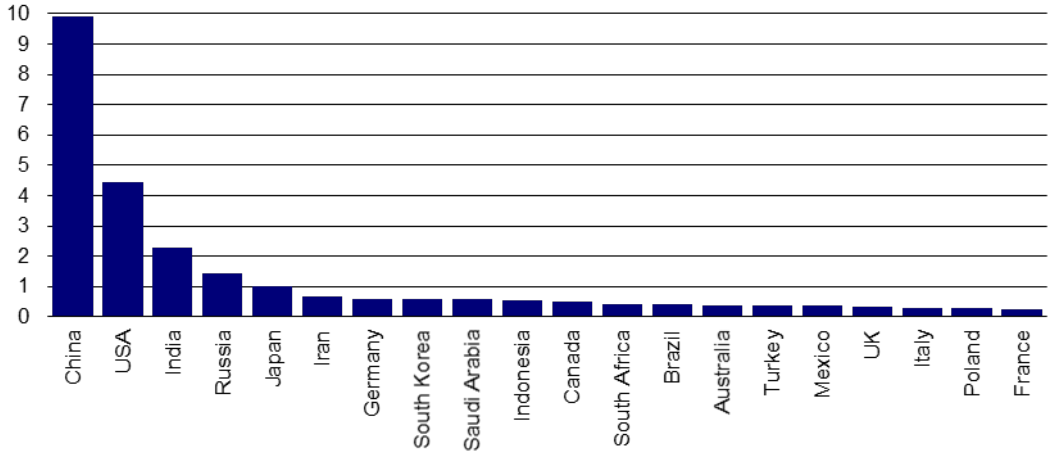
- Population growth – this boosts emissions each year but by a decreasing amount as demographic trends moderate
- GDP/capita growth – this usually adds to emission growth but can detract in recessions (2009 and 2020, for example)
- CO2 intensity of GDP growth – this tends to be negative, which reflects changes in economic structure and technology (clean energy sources, for example)

Hence, the question is whether CO2 intensity can be reduced quickly enough to outweigh growth in population and GDP/capita. This will rely critically upon technology.

Welcome to the C20 group of CO2 emitters

20 countries accounted for 80% of global CO2 emissions in 2020 (see **Figure 3** for the members of what we call the C20 group of countries). These were the 20 largest emitters in 2019 (we chose not to use 2020 as the reference year because of the distortions introduced by the Covid pandemic).

Figure 3 – CO2 emissions in 2020 (billion metric tonnes)



Source: BP Statistical Review of World Energy 2021, Refinitiv Datastream and Invesco

China is by far the largest emitter, which is not surprising given that it has the world's largest population. Other things being equal, the more populous a country, the more emissions it will generate. Of course, other things are not equal and emissions also depend upon GDP per capita (which is an important influence on consumer activity) and the CO2 intensity of economic activity (see **Figure 4**).

Figure 4 -- Explaining CO2 emissions in 2020

	Population (million)	GDP/Capita (US$, 2011 prices)	GDP (US$ bn, 2011 prices)	CO2 intensity of GDP (kg per US$ of GDP)	CO2 emissions (bn tonnes)
China	1418	16226	23010	0.43	9.89
USA	331	60022	19847	0.22	4.43
India	1392	6066	8443	0.27	2.30
Russia	146	26519	3876	0.37	1.43
Japan	125	39864	4998	0.21	1.03
Iran	85	12289	1044	0.62	0.65
Germany	83	51343	4276	0.14	0.60
South Korea	52	42218	2188	0.26	0.58
Saudi Arabia	35	43522	1543	0.37	0.57
Indonesia	272	11499	3130	0.17	0.54
Canada	38	45681	1744	0.30	0.52
South Africa	61	11235	680	0.64	0.43
Brazil	213	14061	2989	0.14	0.42
Australia	26	48635	1251	0.30	0.37
Turkey	85	28292	2394	0.15	0.37
Mexico	129	17882	2306	0.16	0.36
UK	67	41586	2798	0.11	0.32
Italy	60	38974	2322	0.12	0.29
Poland	38	32333	1223	0.23	0.28
France	65	43667	2852	0.09	0.25

Note: ranked by CO2 emissions, which are the product of population, GDP per capita and the CO2 intensity of GDP. Source: BP Statistical Review of World Energy 2021, IMF, World Bank, Refinitiv Datastream and Invesco

Looking at **Figure 4**, the comparison between India and the US is instructive. India has a population that is more than four times that of the US but its GDP per capita is roughly one-tenth as large. Given that the CO2 intensity of the two economies is similar, it is not surprising that India emitted roughly half as much CO2 as the US in 2020.

Of course, as India develops, we expect its GDP per capita to rise relative to that of the US. If India's GDP per capita was already at the US level in 2020, it would have emitted 22.8 bn tonnes of CO2 (if all else were equal), which is 71% of actual global emissions.

This is another illustration of the challenge ahead of us – if populations continue to grow and emerging countries develop (and incomes grow), then we will have to rely heavily on technological innovation to drive down CO2 intensity if global emissions are to fall. Put simply, we cannot allow emerging countries to develop in the same dirty way that the developed world did (and develop they must). We believe this will require not only massive investment in new technologies but that it will also involve a sharing of those technologies and/or provision of financial aid so that all countries can develop in the cleanest possible way.

Most of this document is dedicated to country sections that show three charts that we believe show what progress is being made toward net-zero by each member of the C20 group of countries (which has a large overlap with the G20 group). Those charts are:

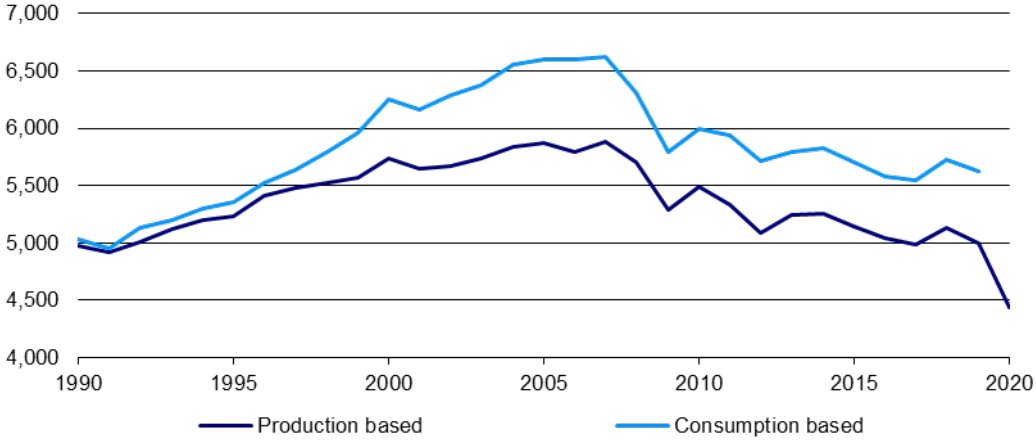
- CO2 emissions since 1990
- CO2 per capita since 1990 (net-zero requires this to fall to zero)
- CO2 intensity of GDP since 1990 (again net-zero requires this to fall to zero)

We also show two measures of CO2 emissions, which is worth a word of explanation:

- Production-based emissions – this is what is emitted by a country as a result of the economic activity within its borders (and is how the data is usually shown).
- Consumption-based emissions – these are the emissions required to produce the goods and services consumed within the economy (they are constructed by allowing for trade flows). It is a measure of emissions due to the lifestyle choices of the population, irrespective of the origin of the goods that are consumed.

This distinction is important when countries outsource energy and heavy manufacturing production to other countries. For example, China's emissions are higher on a production basis than on a consumption basis, while those of the US are higher on a consumption basis (see **Figure 5**). Effectively, China now produces a lot of the goods that the US consumes. Is it fair to blame China for emissions that are due to consumption in the US? We think not and believe it is fairer to compare consumption-based data (we show such rankings in **Figures 6-8**).

Figure 5 – US CO2 emissions from 1990 to 2020 (million metric tonnes per year)



Source: BP Statistical Review of World Energy 2021, Global Carbon Project, Our World in Data, Refinitiv Datastream and Invesco

Technology corner – making the economic transition

While consumers have been barraged with a variety of energy saving tips and suggestions on how to minimize one's climate impact, the reality is that it is technology, not behavioural changes, that are likely to play the leading role in the economic transition to a cleaner and greener future. Many of these technologies have already been developed, and research continues to design more efficient and alternative technologies that have the potential to transform our everyday and industrial lives. Here, we examine a few promising candidates that we view as likely contributors to such change.

Perhaps among the most well-known of emission-reducing technologies, **carbon capture and storage** technologies seek to reduce the emissions intensity of existing CO2-producing fuel sources by filtering greenhouse gases before they have a chance to enter the atmosphere. The potential for wide-scale adoption of this tech suggests that business-as-usual consumption of hydrocarbons would yield significantly less emissions impact, thereby avoiding a dramatic departure away from fossil fuels. While such carbon capture technologies already exist and are used effectively, the primary challenge is a lack of an active market for carbon. Future storage capabilities therefore are important as the amount of carbon captured far exceeds the demands of carbon-users such as the beverage and fertilizer industries.

In a similar approach, **carbon removal** technologies are also under development, which seek to capture carbon already present in the atmosphere and store it for later use or sequestration. However, these technologies suffer from the same issues as carbon capture.

While fossil fuels and renewables dominate today's energy resource makeup, alternative fuels are also a subject of increasing interest. **Hydrogen energy** has long been touted as a viable alternative to fossil fuels due to hydrogen clean burning -- its by-products are primarily water, electricity, and heat. However, costs remain high.

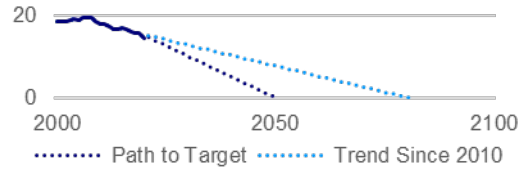
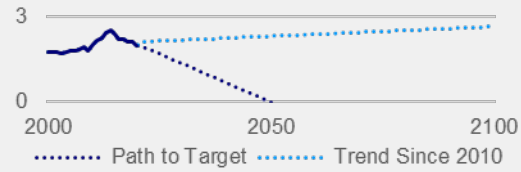
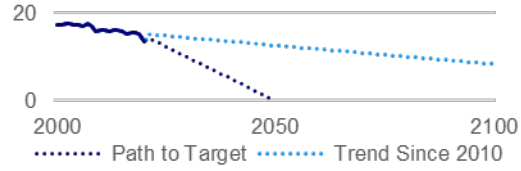
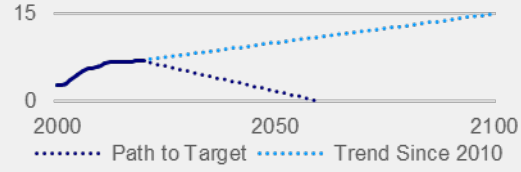
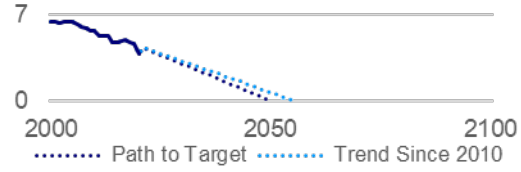
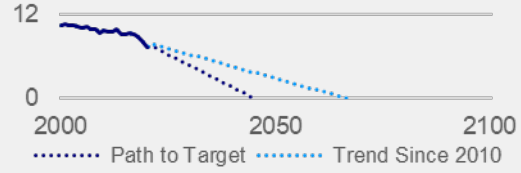
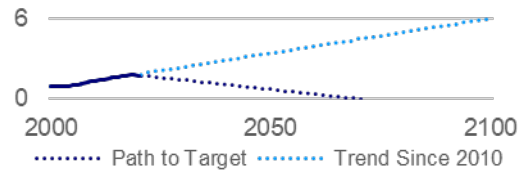
Some recent research has also explored the potential of **ammonia** as an energy resource. Ammonia has a number of benefits over hydrogen and biofuels, especially since it is already produced in large quantities and does not require vast new infrastructure. However, there remain a variety of environmental negatives that would need to be solved in order to it to be considered a green alternative.

Whatever the energy source, **energy storage** remains a key issue in the implementation of many of these technologies. Hydrocarbons have the unique advantage of being easily transported and burned, allowing essentially flexible energy production based on real-time demand. However, many renewables depend on exogenously determined factors, such as the presence of wind, sunlight or water currents, that render them difficult for use in electricity grids. Such alternative energy sources, therefore, depend on energy storage for use in periods where demand is elevated while production is inflexible.

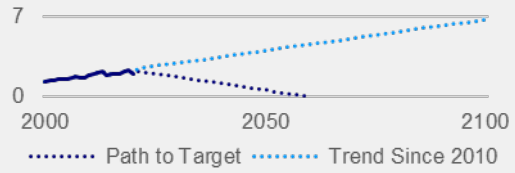
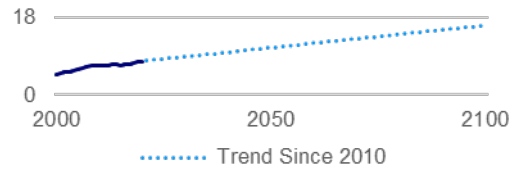
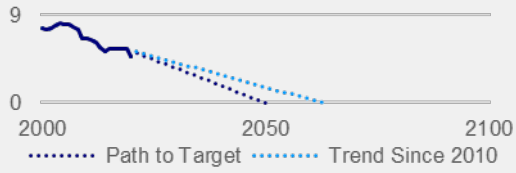
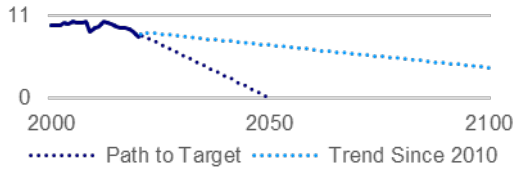
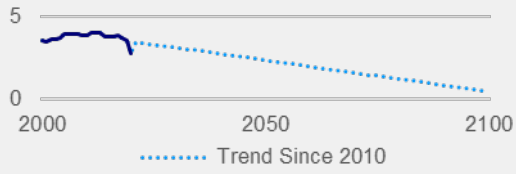
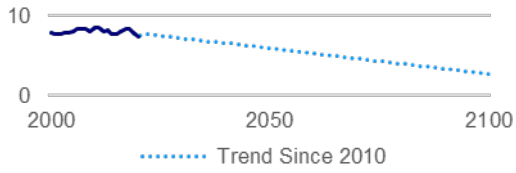
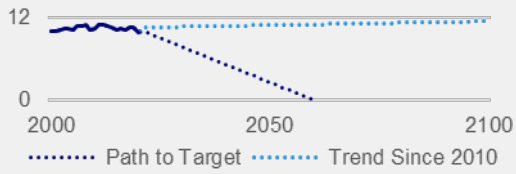
A proven example of such storage technology is **pumped storage hydropower (PSH)**. PSH is a clever spin on hydropower that makes use of periods of relatively low energy demand to pump water uphill from a low-elevation reservoir into an uphill reservoir. In times of higher energy demand, that water is released through a generator to supplement energy needs on the grid. The simplicity of this approach has helped PSH achieve 94% of installed energy storage capacity globally.

These technologies represent a slice of today's scientific efforts to solve industrial and household needs. Still more examples exist, such as taking well-known approaches like carbon taxes and credits and mixing them with emerging technology, as is the case in **blockchain for carbon tracking and accounting**. In future editions, we will explore this and other frontier technologies in greater detail.

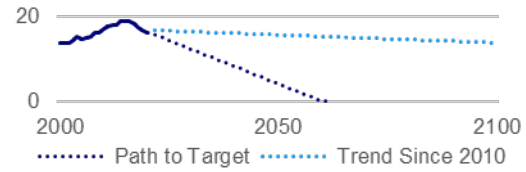
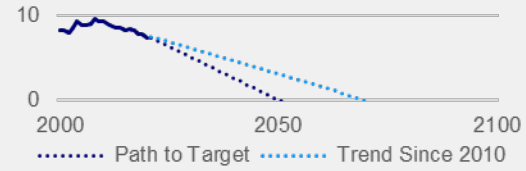
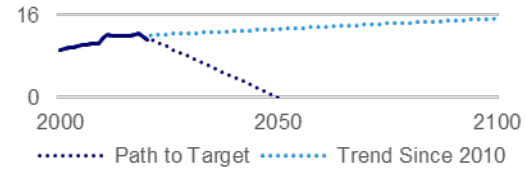
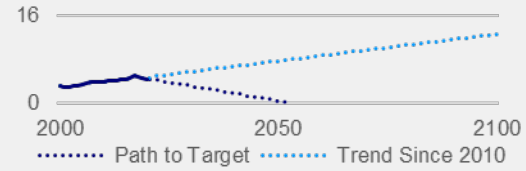
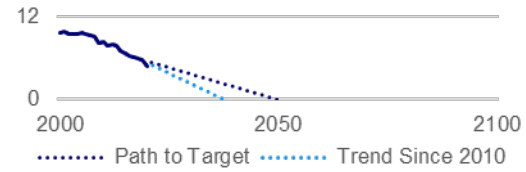
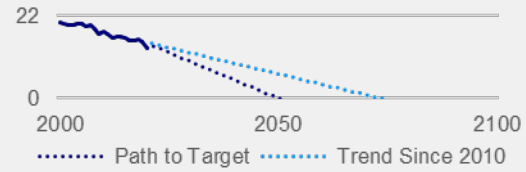
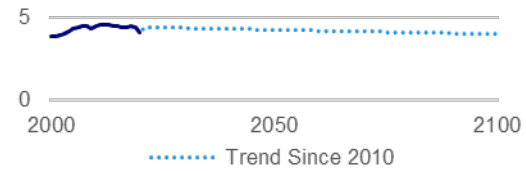
Implementation gaps: who needs to do more?

Path of Per Capita CO2 Emissions (metric tonnes/year)	Net Zero		CO2 Emissions		Population Growth	
	Stated Target	At Current Trend	Share of World (2019)	Per Capita (2019)	Since 2010	Through 2050
Australia 	**2050**	**2080**	1.2%	**3.5** times world average	+1.6%	+0.9%
Brazil 	**2050**	**!** (emissions per capita increased)	1.3%	**0.5** times world average	+0.8%	+0.3%
Canada 	**2050**	**2198**	1.6%	**3.5** times world average	+1.1%	+0.6%
China 	**2060**	**!** (emissions per capita increased)	30.9%	**1.6** times world average	+0.6%	-0.1%
France 	**2050**	**2055**	0.8%	**1.0** times world average	+0.4%	+0.1%
Germany 	**2045**	**2067**	1.9%	**1.9** times world average	+0.4%	-0.1%
India 	**2070**	**!** (emissions per capita increased)	7.2%	**0.4** times world average	+1.1%	+0.6%

Notes: Charts show annual data from 2000 to 2100. All figures after 2020 are projections. Figures are based on production-based CO2 emissions. Figures displayed for "Path to Target", "Trend Since 2010", and population growth figures are annualised rates. Population growth projections are based on the United Nations medium fertility projections.
Sources: BP Statistical Review of World Energy 2021, United Nations, and Invesco.

	Path of Per Capita CO2 Emissions (metric tonnes/year)	Net Zero		CO2 Emissions		Population Growth	
		Stated Target	At Current Trend	Share of World (2019)	Per Capita (2019)	Since 2010	Through 2050
Indonesia		2060	! (emissions per capita increased)	1.7%	**0.5** times world average	+1.3%	+0.7%
Iran		No Target	! (emissions per capita increased)	2.0%	**1.8** times world average	+1.3%	+0.7%
Italy		2050	2063	0.9%	**1.2** times world average	+0.0%	-0.3%
Japan		2050	2168	3.2%	**2.0** times world average	-0.1%	-0.6%
Mexico		No Target	2112	1.1%	**0.8** times world average	+1.2%	+0.6%
Poland		No Target	2142	0.9%	**1.8** times world average	-0.0%	-0.4%
Russia		2060	! (emissions per capita increased)	4.5%	**2.4** times world average	+0.3%	-0.2%

Notes: Charts show annual data from 2000 to 2100. All figures after 2020 are projections. Figures are based on production-based CO2 emissions. Figures displayed for "Path to Target", "Trend Since 2010", and population growth figures are annualised rates. Population growth projections are based on the United Nations medium fertility projections.
Sources: BP Statistical Review of World Energy 2021, United Nations, and Invesco.

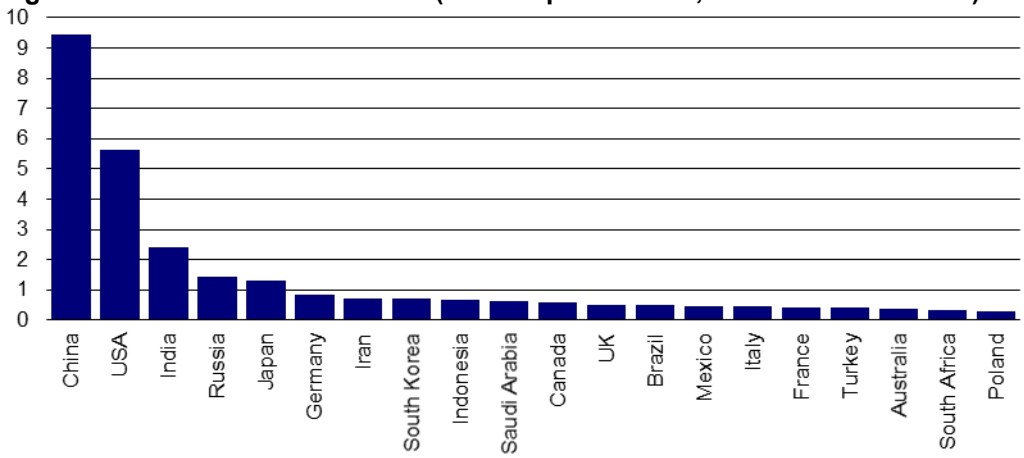
Path of Per Capita CO2 Emissions (metric tonnes/year)	Net Zero		CO2 Emissions		Population Growth	
	Stated Target	At Current Trend	Share of World (2019)	Per Capita (2019)	Since 2010	Through 2050
Saudi Arabia 	**2060**	**2467**	1.8%	**3.8** times world average	+2.4%	+0.9%
South Africa 	**2050**	**2070**	1.4%	**1.8** times world average	+1.5%	+0.8%
South Korea 	**2050**	**!** (emissions per capita increased)	1.8%	**2.7** times world average	+0.5%	-0.3%
Turkey 	**2053**	**!** (emissions per capita increased)	1.2%	**1.0** times world average	+1.3%	+0.5%
United Kingdom 	**2050**	**2037**	1.0%	**1.3** times world average	+0.7%	+0.3%
United States 	**2050**	**2074**	13.9%	**3.4** times world average	+0.7%	+0.5%
World 	-	**2848**	-	-	+1.3%	+0.8%

Notes: Charts show annual data from 2000 to 2100. All figures after 2020 are projections. Figures are based on production-based CO2 emissions. Figures displayed for "Path to Target", "Trend Since 2010", and population growth figures are annualised rates. Population growth projections are based on the United Nations medium fertility projections.
Sources: BP Statistical Review of World Energy 2021, United Nations, and Invesco.

Appendices

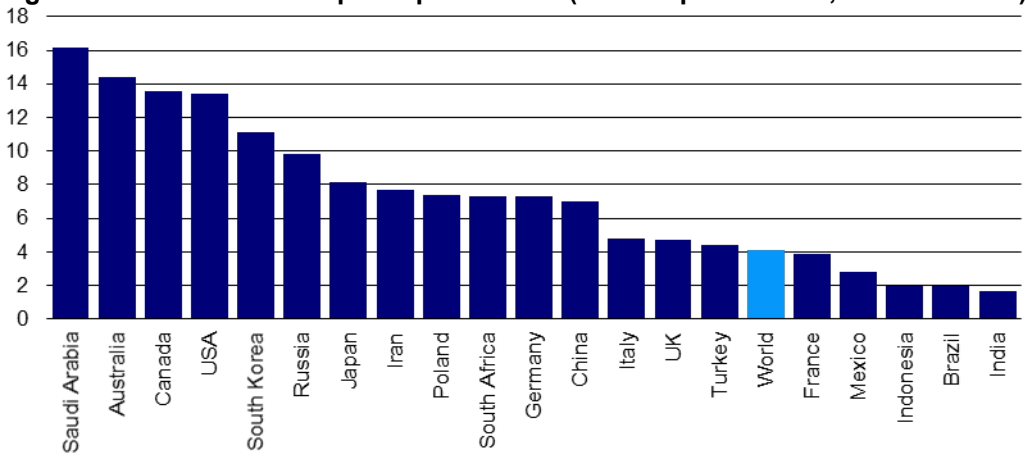
Cross-country comparisons

Figure 6 -- CO2 emissions in 2019 (consumption based, billion metric tonnes)



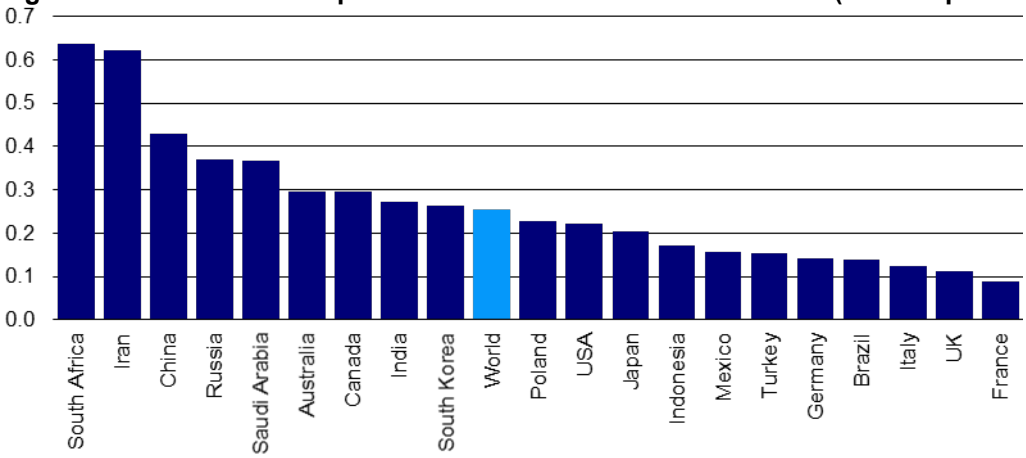
- China is the largest emitter of CO2, followed by the US and India
- The focus is on 2019 data because 2020 comparisons were distorted by the pandemic (and because consumption-based data is not yet available for 2020)

Figure 7 -- CO2 emissions per capita in 2019 (consumption based, metric tonnes)



- Emissions per capita tend to be highest in industrialised or hydrocarbon producing countries
- Emerging economies tend be the lowest per capita emitters because of low incomes but are expected to catch-up

Figure 8 -- CO2 emissions per 2011 PPP US dollar of GDP in 2019 (consumption based, kg)

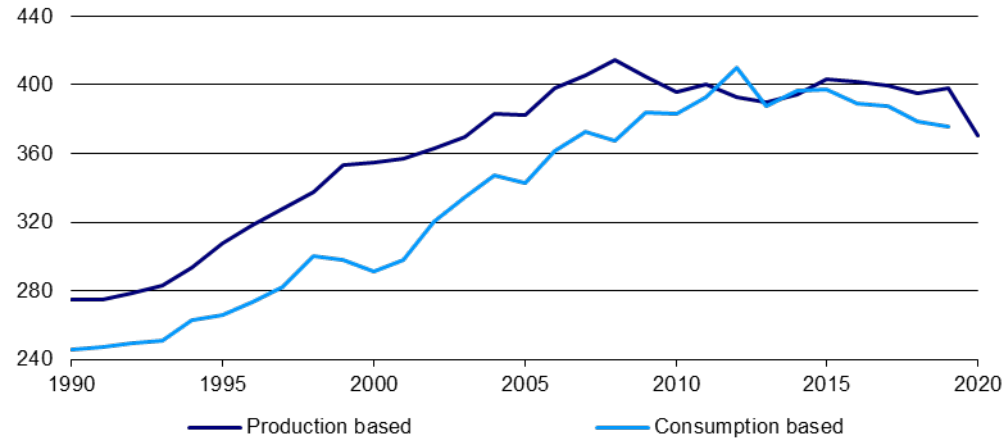


- Emerging and commodity producing countries tend to be the most CO2 intensive
- If net-zero targets are to be reached, CO2 intensity must fall towards zero (the country sections show progress to date)

Notes: Consumption based data allows for the effect of trade: for example if country A produces goods that are exported and consumed in country B, then the associated CO2 is subtracted from country A emissions and added to those of country B (adjustments are performed by the Global Carbon Project). It is a better reflection of lifestyle contributions to emissions. Sources: BP Statistical Review of World Energy 2021, Global Carbon Project, IMF, Oxford Economics, Our World in Data, World Bank, Refinitiv Datastream and Invesco

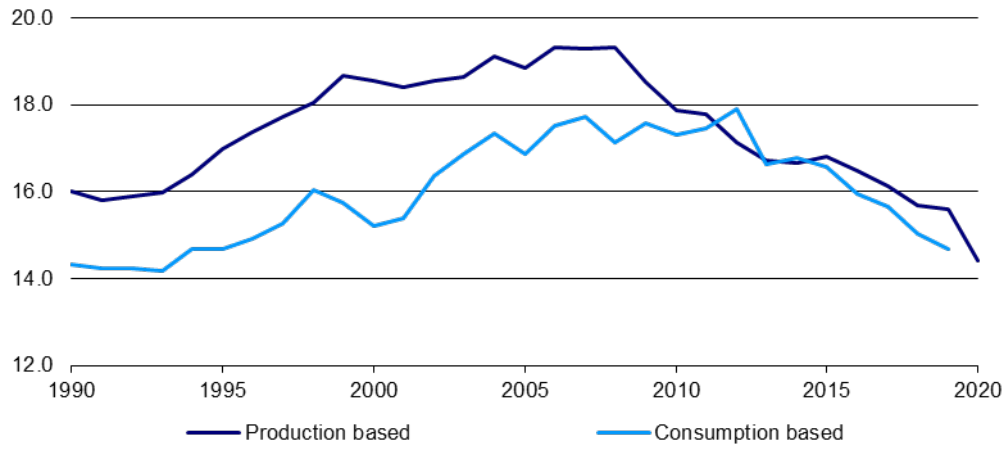
Australia

CO2 emissions (million metric tonnes per year)



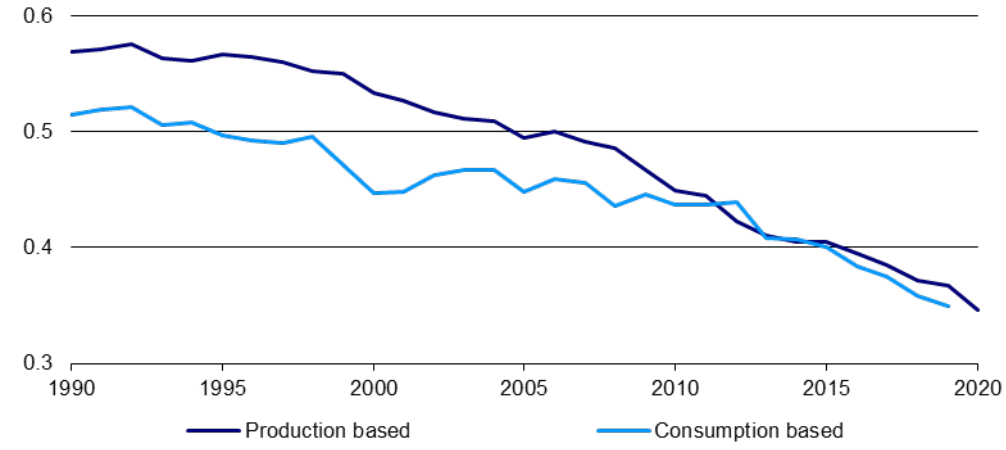
- 14th largest emitter in 2020 (18th largest on a consumption basis in 2019)
- Lower consumption-based emissions suggest some emissions are on behalf of other countries
- Emissions may have been starting to decline before the pandemic

CO2 emissions per capita (metric tonnes per year)



- Australia is the 2nd highest per capita emitter among the C20
- Emissions per capita peaked in 2008, partly due to the effect of the GFC on demand for commodities
- Trend is firmly downward but rate of decline needs to double to meet 2050 net-zero target

CO2 emissions per 2011 PPP US dollar of GDP (kilogramme per year)

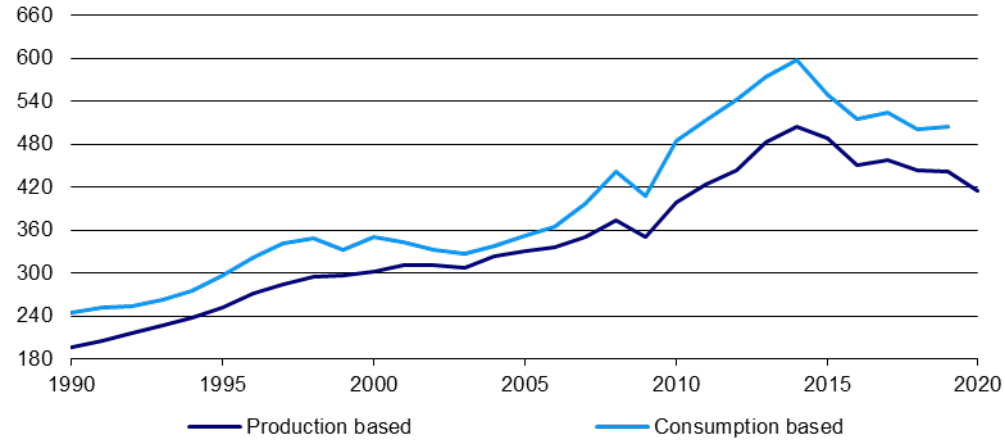


- Australia was the 6th most CO2 intensive economy in 2020
- It ranked 8th in terms of the rate of decline of CO2 intensity (using production-based data in the 10 years to 2020) but needs to double that pace to meet its 2050 net-zero target

Notes: Annual data from 1990 to 2020. Production based CO2 data is the common way to report emissions (it is the CO2 emitted by a country in a given year). Consumption based data allows for trade: for example if country A produces goods that are exported and consumed in country B, then the associated CO2 is subtracted from country A emissions and added to those of country B (adjustments are performed by the Global Carbon Project). It is a better reflection of lifestyle contributions to emissions.
Sources: BP Statistical Review of World Energy 2021, Global Carbon Project, IMF, Oxford Economics, Our World in Data, World Bank, Refinitiv Datastream and Invesco

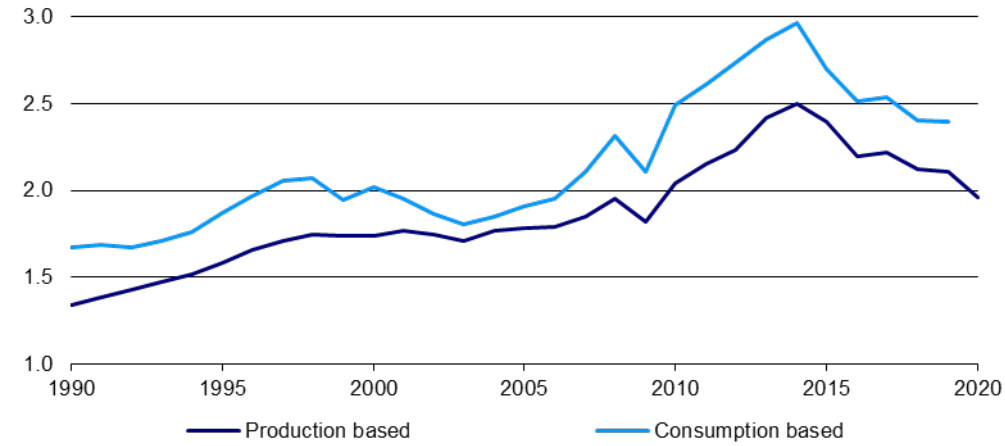
Brazil

CO2 emissions (million metric tonnes per year)



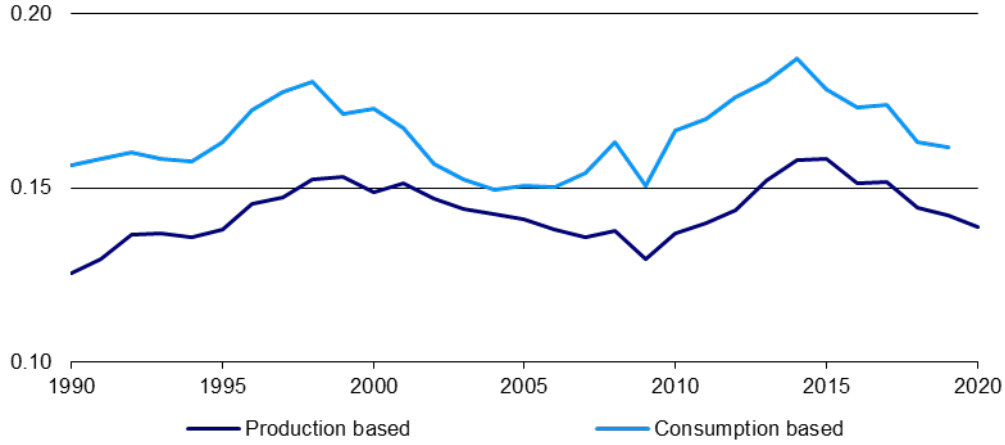
- Brazil is the 13th largest emitter among C20 countries (on both measures)
- Higher consumption-based emissions suggest some emissions are "offshored"
- Emissions peaked in 2014 (sooner than in many emerging markets)

CO2 emissions per capita (metric tonnes per year)



- Brazil is the 2nd lowest per capita emitter among C20 countries
- If the downward trend since 2014 is sustained (not obvious for a developing country), Brazil would easily reach its 2050 net-zero target

CO2 emissions per 2011 PPP US dollar of GDP (kilogramme per year)

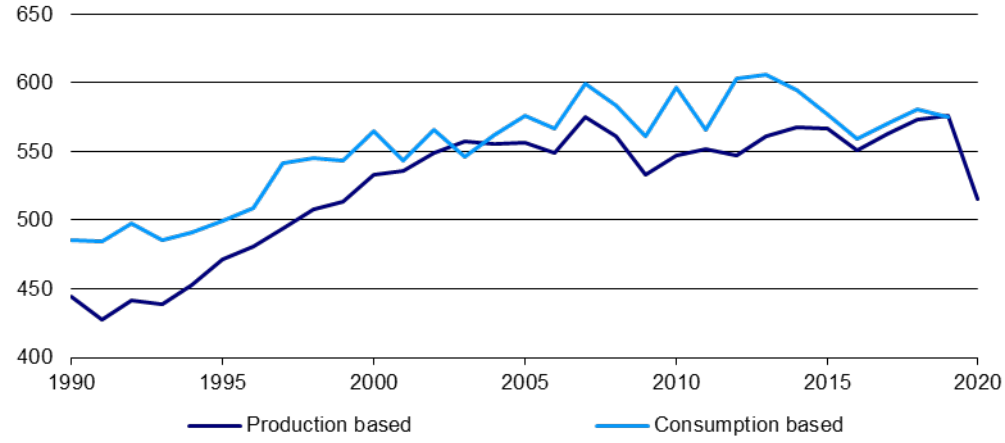


- Brazil is the 4th least CO2 intensive economy (on both measures)
- It ranked 19th in terms of the rate of decline of CO2 intensity (using production-based data in the 10 years to 2020) but the recent trend is better

Notes: Annual data from 1990 to 2020. Production based CO2 data is the common way to report emissions (it is the CO2 emitted by a country in a given year). Consumption based data allows for trade: for example if country A produces goods that are exported and consumed in country B, then the associated CO2 is subtracted from country A emissions and added to those of country B (adjustments are performed by the Global Carbon Project). It is a better reflection of lifestyle contributions to emissions.
Sources: BP Statistical Review of World Energy 2021, Global Carbon Project, IMF, Oxford Economics, Our World in Data, World Bank, Refinitiv Datastream and Invesco

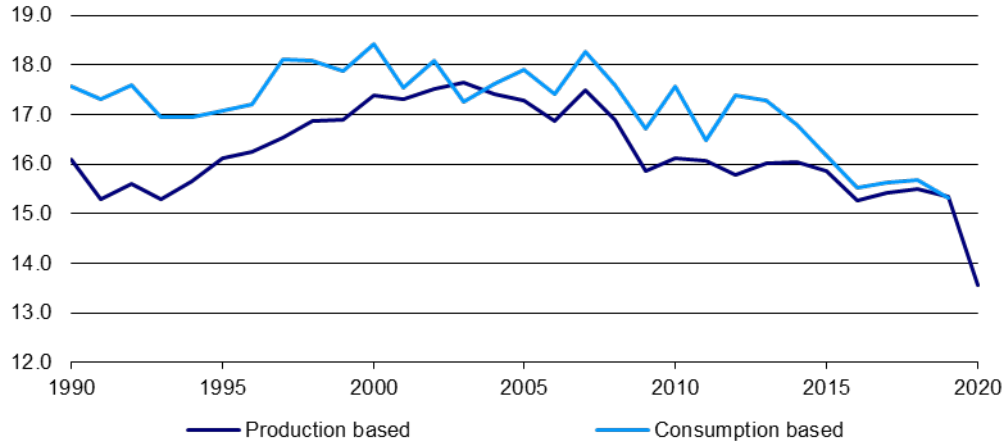
Canada

CO2 emissions (million metric tonnes per year)



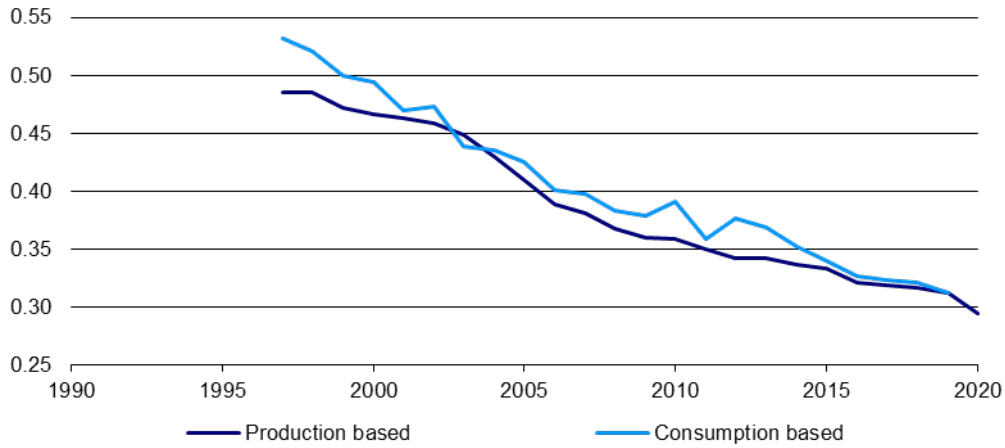
- Canada is the 11th largest emitter among C20 countries (on both measures)
- Higher consumption-based emissions suggest some emissions are "offshored" to other countries (despite being a commodity producer)

CO2 emissions per capita (metric tonnes per year)



- Canada is the 3rd highest per capita emitter among C20 countries (on both measures)
- Emissions per capita peaked around the turn of the century
- Trend is firmly downward but needs to be accelerated if the 2050 net-zero target is to be met

CO2 emissions per 2011 PPP US dollar of GDP (kilogramme per year)

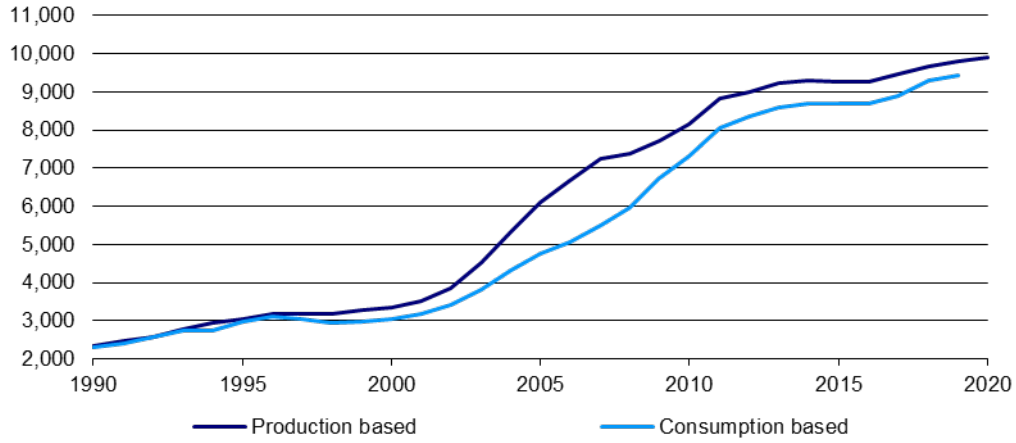


- Canada is the 7th most CO2 intensive economy among the C20
- It ranked 13th in terms of the rate of decline of CO2 intensity (using production-based data in the 10 years to 2020)

Notes: Annual data from 1990 to 2020. Production based CO2 data is the common way to report emissions (it is the CO2 emitted by a country in a given year). Consumption based data allows for trade: for example if country A produces goods that are exported and consumed in country B, then the associated CO2 is subtracted from country A emissions and added to those of country B (adjustments are performed by the Global Carbon Project). It is a better reflection of lifestyle contributions to emissions.
Sources: BP Statistical Review of World Energy 2021, Global Carbon Project, IMF, Oxford Economics, Our World in Data, World Bank, Refinitiv Datastream and Invesco

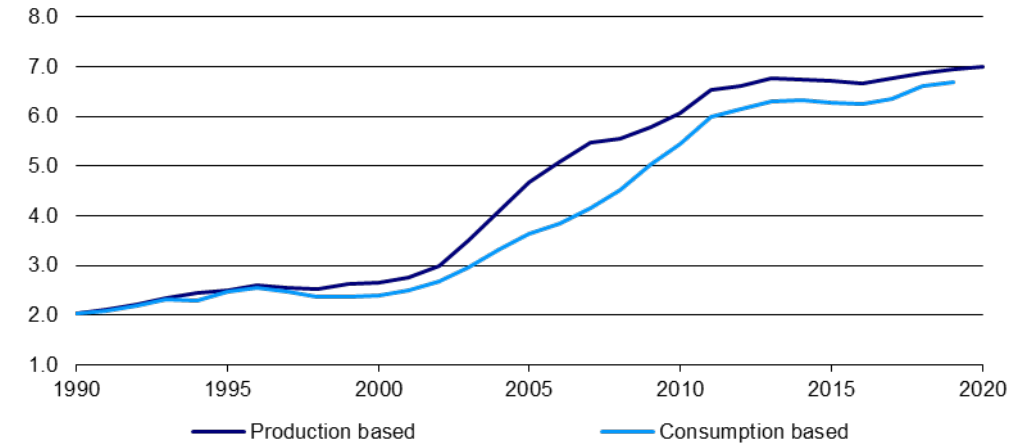
China

CO2 emissions (million metric tonnes per year)



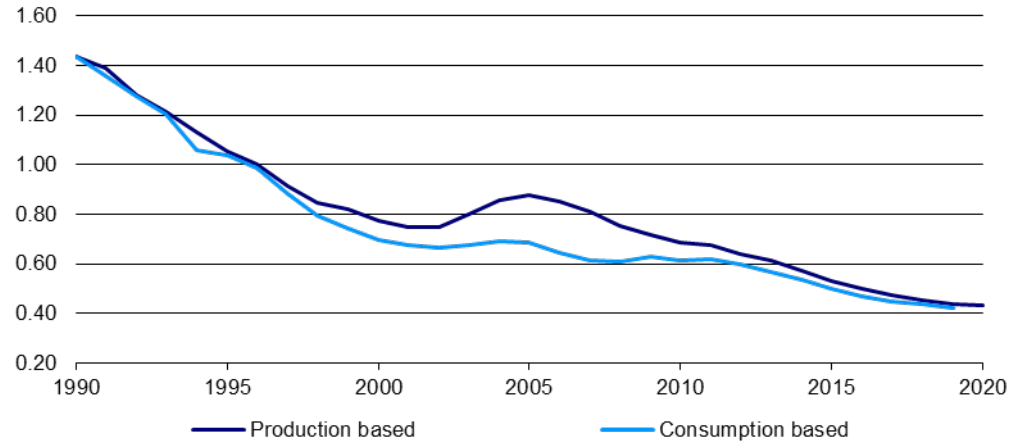
- The largest emitter in 2020 by far (likewise on a consumption basis in 2019)
- Lower consumption-based emissions reflect China's role as the factory of the world

CO2 emissions per capita (metric tonnes per year)



- However, China was only the 12th highest per capita emitter in 2020 among C20 countries (likewise on a consumption basis in 2019)
- Emissions per capita are still rising and this needs to be reversed if the 2060 net-zero target is to be met

CO2 emissions per 2011 PPP US dollar of GDP (kilogramme per year)

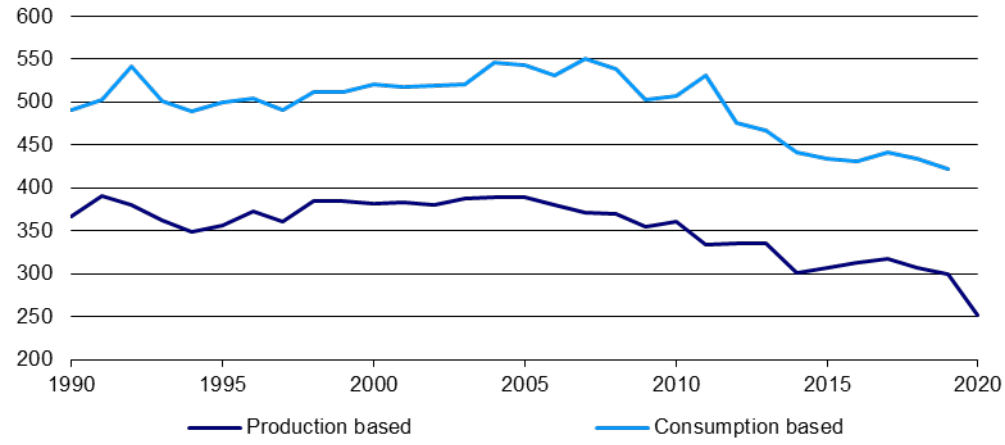


- China was the 3rd most CO2 intensive economy in 2020 (likewise on a consumption basis in 2019)
- This reflects the industrial nature of its development but it had the 2nd fastest rate of decline in CO2 intensity in the last 10 years

Notes: Annual data from 1990 to 2020. Production based CO2 data is the common way to report emissions (it is the CO2 emitted by a country in a given year). Consumption based data allows for trade: for example if country A produces goods that are exported and consumed in country B, then the associated CO2 is subtracted from country A emissions and added to those of country B (adjustments are performed by the Global Carbon Project). It is a better reflection of lifestyle contributions to emissions.
Sources: BP Statistical Review of World Energy 2021, Global Carbon Project, IMF, Oxford Economics, Our World in Data, World Bank, Refinitiv Datastream and Invesco

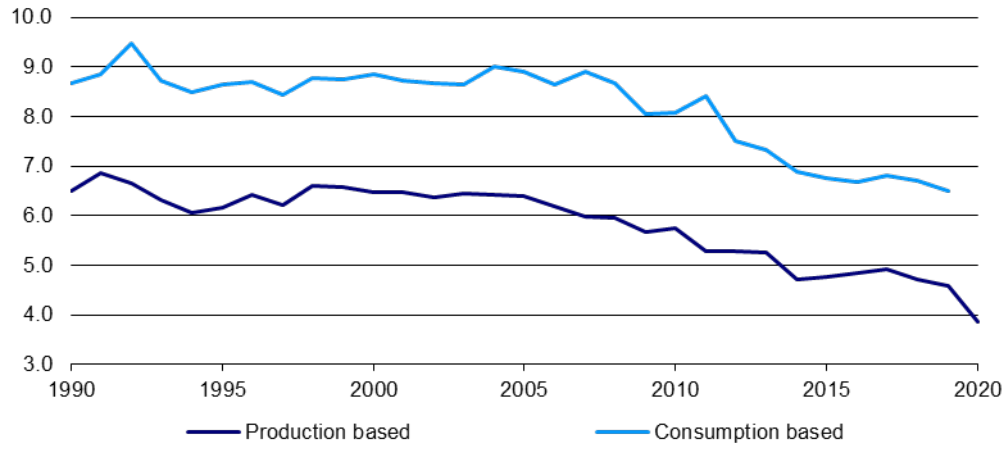
France

CO2 emissions (million metric tonnes per year)



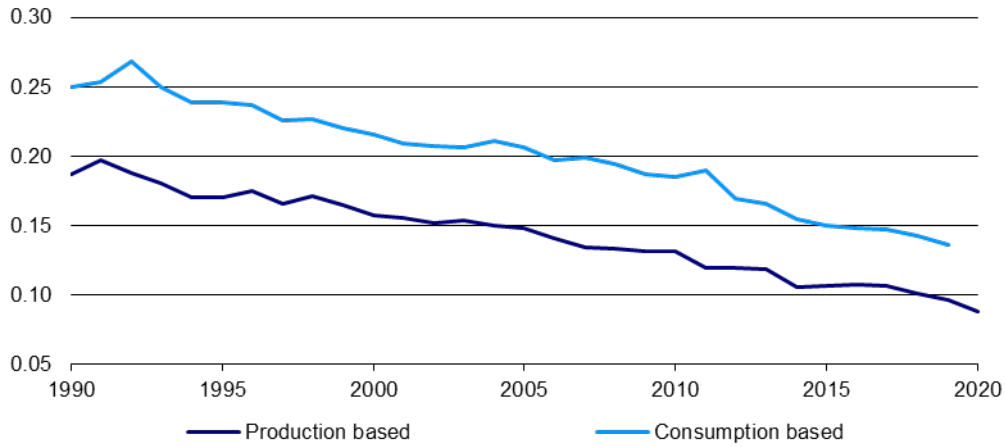
- Among C20 countries, France had the lowest CO2 emissions in 2020 (though it was 16th on a consumption basis in 2019)
- Much higher consumption-based emissions suggest a lot of emissions were offshored to other countries

CO2 emissions per capita (metric tonnes per year)



- On a per capita basis, France is only the 16th highest emitter in the C20
- The focus on nuclear energy is one factor
- Emissions per capita are trending down (a slight acceleration is needed if the 2050 net-zero target is to be met)

CO2 emissions per 2011 PPP US dollar of GDP (kilogramme per year)

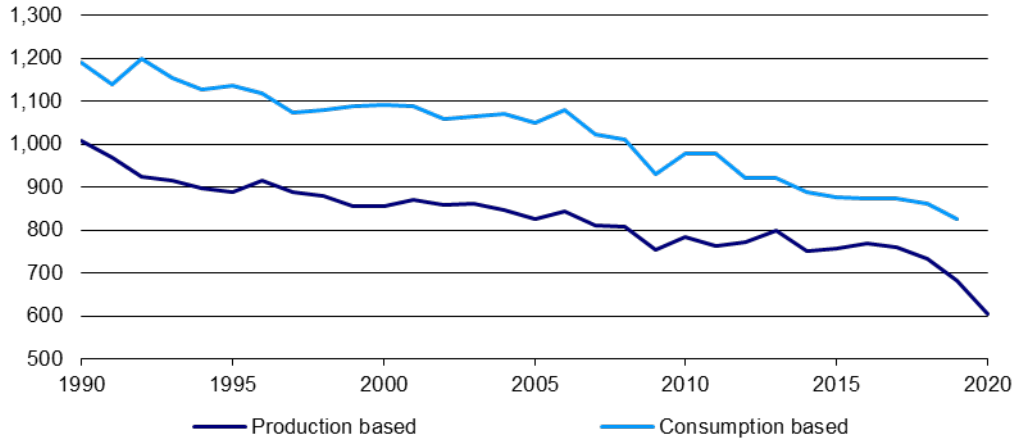


- France has the lowest CO2 intensity of economic activity on both measures
- Again, this is helped by the focus on nuclear
- However, it also had the 4th fastest rate of decline in CO2 intensity in the last 10 years

Notes: Annual data from 1990 to 2020. Production based CO2 data is the common way to report emissions (it is the CO2 emitted by a country in a given year). Consumption based data allows for trade: for example if country A produces goods that are exported and consumed in country B, then the associated CO2 is subtracted from country A emissions and added to those of country B (adjustments are performed by the Global Carbon Project). It is a better reflection of lifestyle contributions to emissions.
Sources: BP Statistical Review of World Energy 2021, Global Carbon Project, IMF, Oxford Economics, Our World in Data, World Bank, Refinitiv Datastream and Invesco

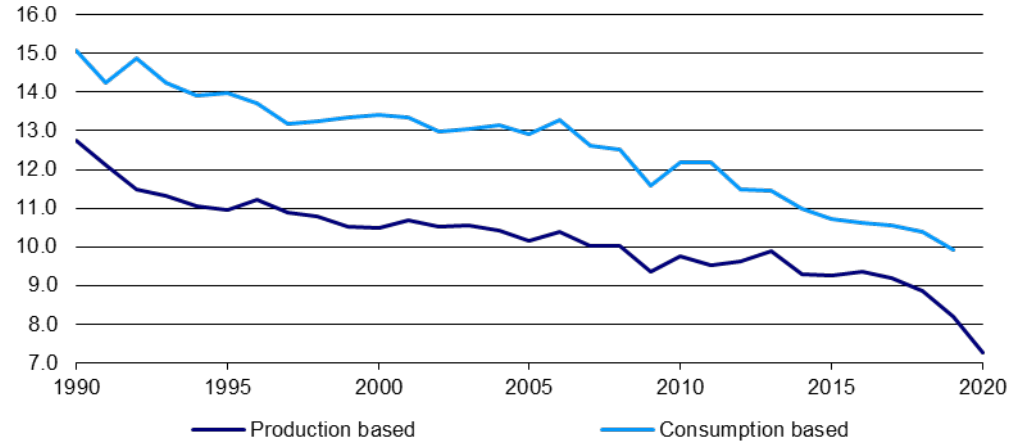
Germany

CO2 emissions (million metric tonnes per year)



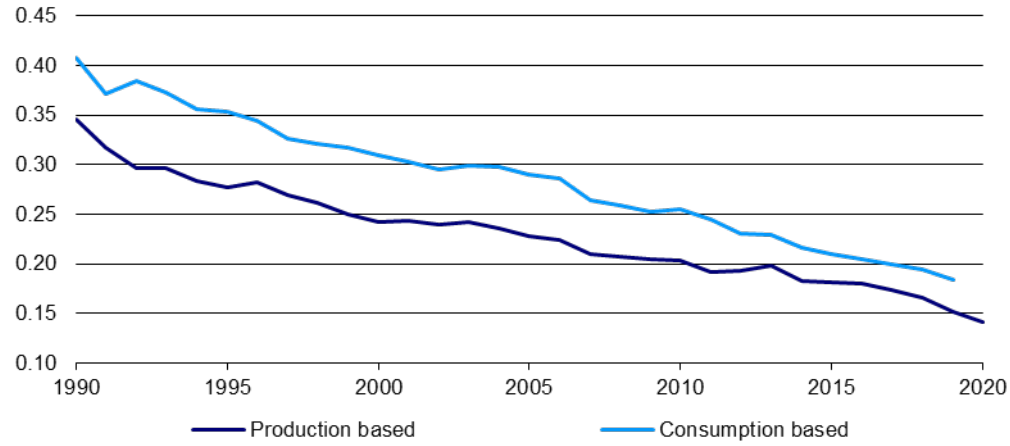
- Among C20 countries, Germany had the 7th highest CO2 emissions in 2020 (6th on a consumption basis in 2019)
- Higher consumption-based emissions suggest some emissions were offshored

CO2 emissions per capita (metric tonnes per year)



- On a per capita emissions basis, Germany ranks 11th among C20 countries (on both measures)
- Emissions per capita have been trending lower since at least 1990 but the rate of decline needs to double if the 2045 net-zero target is to be met

CO2 emissions per 2011 PPP US dollar of GDP (kilogramme per year)

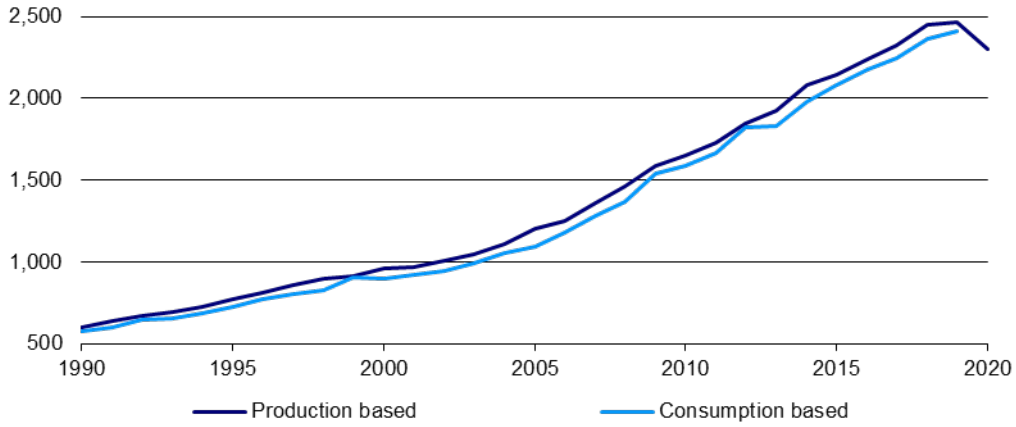


- Germany ranks 16th among C20 countries in terms of the CO2 intensity of its economy (on both measures)
- This is despite its focus on industry and on coal as a source of energy
- It had the 6th fastest rate of decline in CO2 intensity in the last 10 years

Notes: Annual data from 1990 to 2020. Production based CO2 data is the common way to report emissions (it is the CO2 emitted by a country in a given year). Consumption based data allows for trade: for example if country A produces goods that are exported and consumed in country B, then the associated CO2 is subtracted from country A emissions and added to those of country B (adjustments are performed by the Global Carbon Project). It is a better reflection of lifestyle contributions to emissions.
Sources: BP Statistical Review of World Energy 2021, Global Carbon Project, IMF, Oxford Economics, Our World in Data, World Bank, Refinitiv Datastream and Invesco

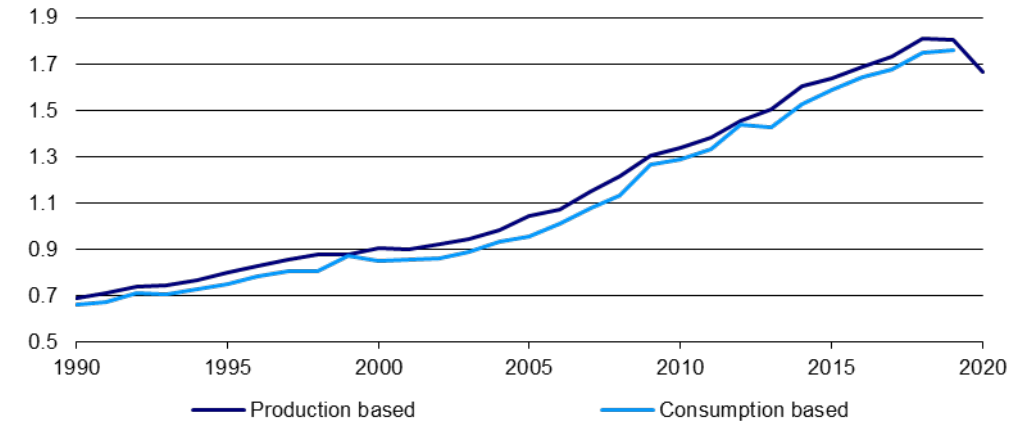
India

CO2 emissions (million metric tonnes per year)



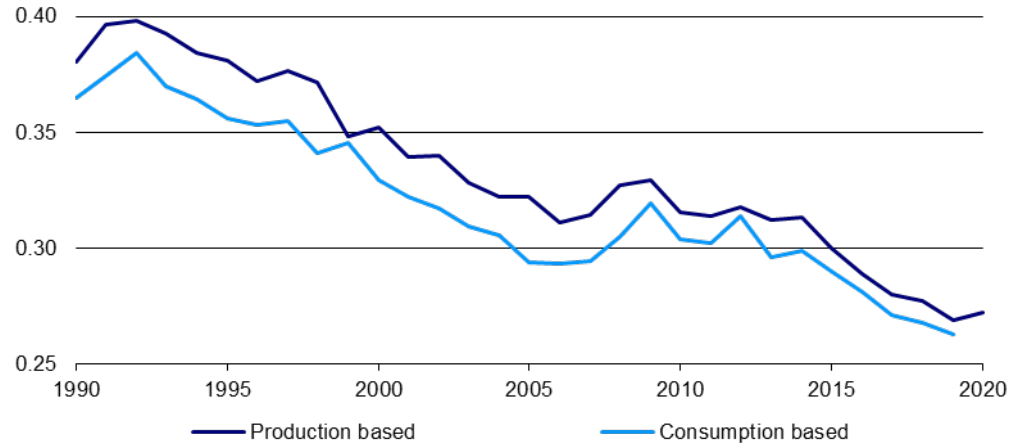
- India's emissions continue to climb, partly due to population growth and partly due to increasing income levels
- Among C20 countries, it has the 3rd highest CO2 emissions (on both measures)

CO2 emissions per capita (metric tonnes per year)



- Its population is second only to that of China but per capita emissions are the lowest among C20 countries
- Emissions per capita continue to trend higher as incomes grow (this needs to reverse if the 2070 net-zero target is to be met)

CO2 emissions per 2011 PPP US dollar of GDP (kilogramme per year)



- India ranks 8th among C20 countries in terms of the CO2 intensity of its economy (on both measures)
- This could worsen as it industrialises (it had only the 17th fastest rate of decline in CO2 intensity in the last 10 years)

Notes: Annual data from 1990 to 2020. Production based CO2 data is the common way to report emissions (it is the CO2 emitted by a country in a given year). Consumption based data allows for trade: for example if country A produces goods that are exported and consumed in country B, then the associated CO2 is subtracted from country A emissions and added to those of country B (adjustments are performed by the Global Carbon Project). It is a better reflection of lifestyle contributions to emissions.
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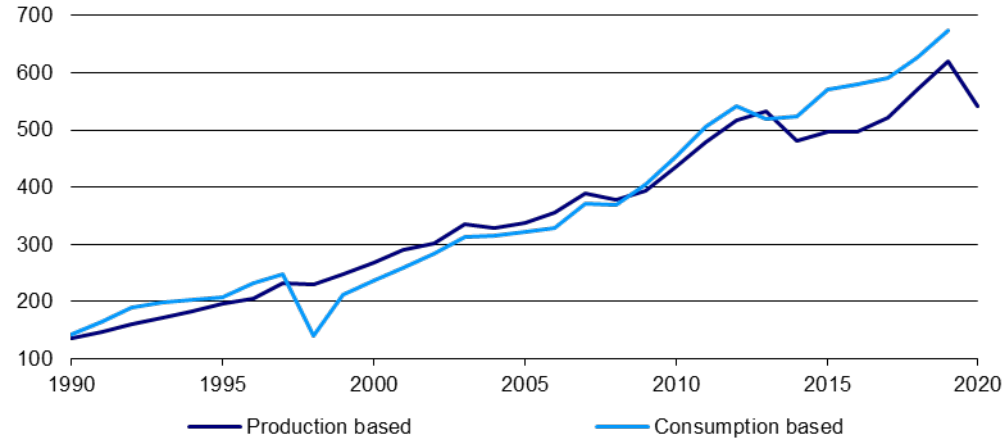
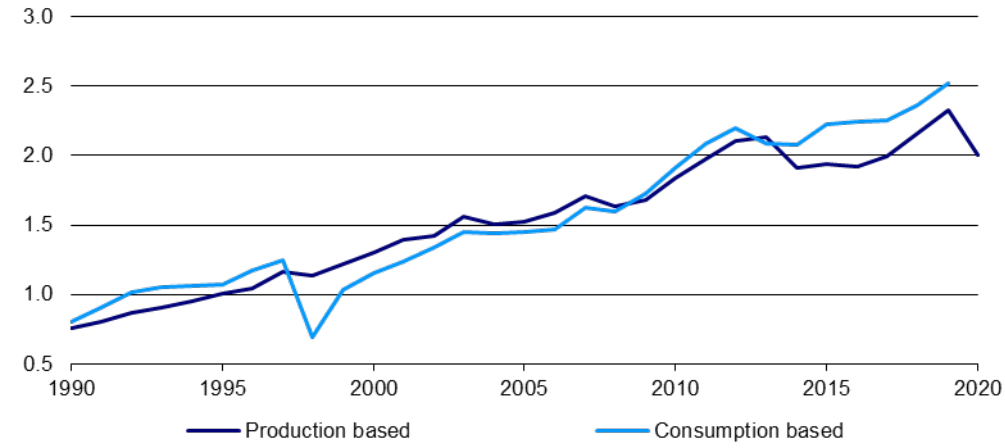
Indonesia

CO2 emissions (million metric tonnes per year)



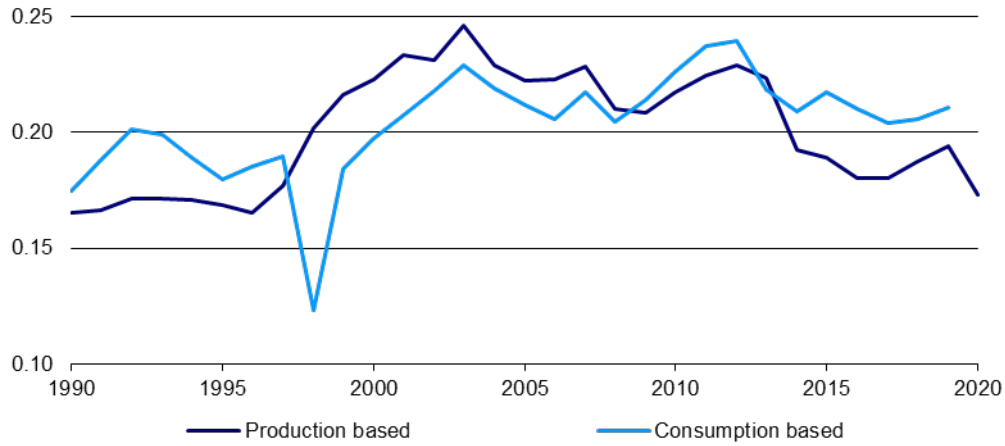
- Though Indonesia has the 4th largest population among C20 countries, it ranked only 10th in terms of CO2 emissions in 2020 (9th on a consumption basis in 2019)
- Emissions continue to rise but some appear to have been offshored in recent years

CO2 emissions per capita (metric tonnes per year)



- Though rising, its emissions per capita are the 3rd lowest among C20 countries
- It needs to reverse that trend to meet the 2060 net-zero target
- The Asian currency crisis impacted the consumption-based measure in the late 1990s

CO2 emissions per 2011 PPP US dollar of GDP (kilogramme per year)



- Indonesia ranks 13th among C20 countries in terms of the CO2 intensity of its economy (on both measures)
- Despite apparent flatness, Indonesia has seen the 11th fastest rate of decline in the last 10 years

Notes: Annual data from 1990 to 2020. Production based CO2 data is the common way to report emissions (it is the CO2 emitted by a country in a given year). Consumption based data allows for trade: for example if country A produces goods that are exported and consumed in country B, then the associated CO2 is subtracted from country A emissions and added to those of country B (adjustments are performed by the Global Carbon Project). It is a better reflection of lifestyle contributions to emissions.
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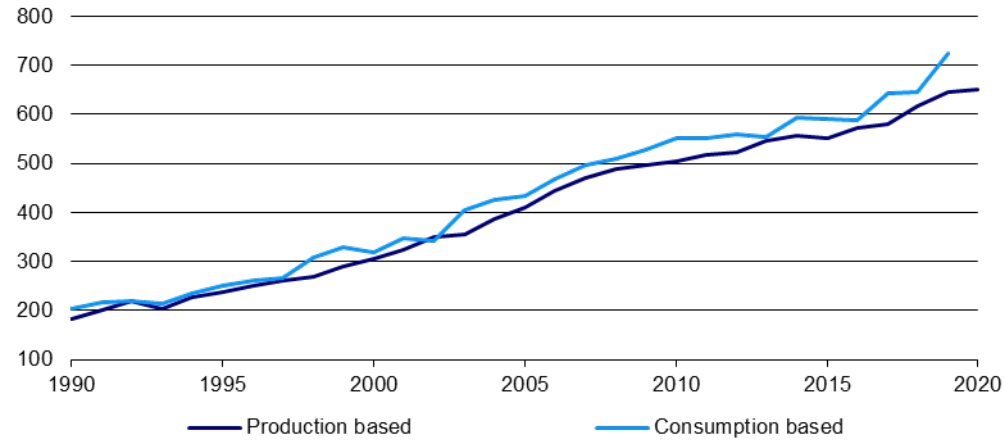
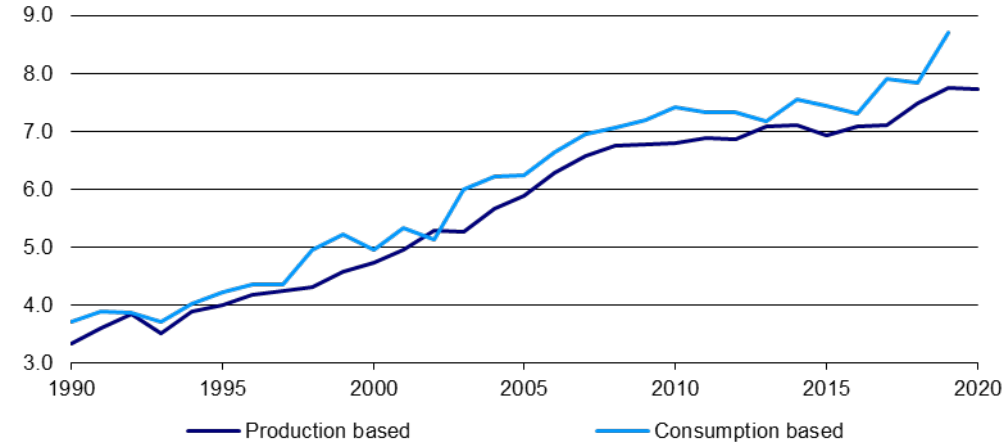
Iran

CO2 emissions (million metric tonnes per year)



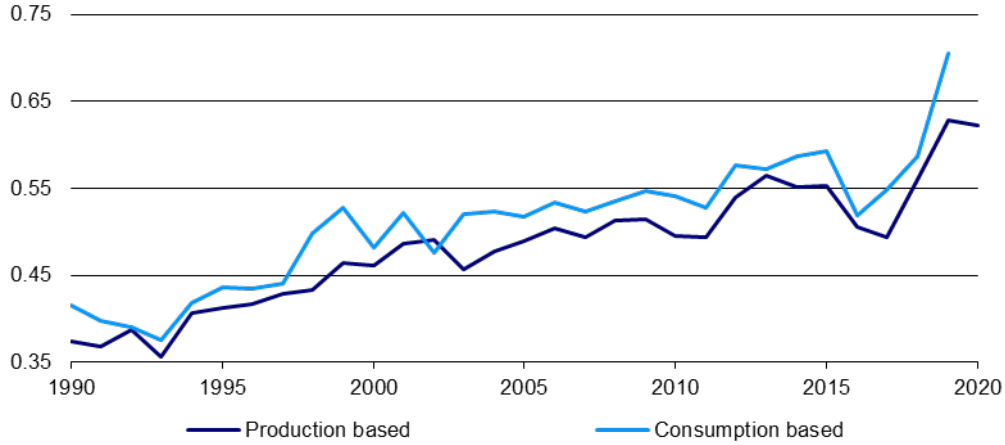
- Despite the effect of sanctions on the economy, Iran's emissions have continued to climb (even in 2020).
- It was the 6th largest emitter among C20 countries in 2020 (7th on a consumption basis in 2019)

CO2 emissions per capita (metric tonnes per year)



- Emissions per capita continue to rise and are now the 8th highest among C20 countries (on both measures)
- Though it is an oil and gas producer, Iran's consumption-based emissions are even higher, suggesting it offshores some emissions

CO2 emissions per 2011 PPP US dollar of GDP (kilogramme per year)



- Iran is one of the few countries that is increasing the CO2 intensity of its economy (it is second only to South Africa in terms of that intensity)
- It has no net-zero target and for now is going in the wrong direction

Notes: Annual data from 1990 to 2020. Production based CO2 data is the common way to report emissions (it is the CO2 emitted by a country in a given year). Consumption based data allows for trade: for example if country A produces goods that are exported and consumed in country B, then the associated CO2 is subtracted from country A emissions and added to those of country B (adjustments are performed by the Global Carbon Project). It is a better reflection of lifestyle contributions to emissions.
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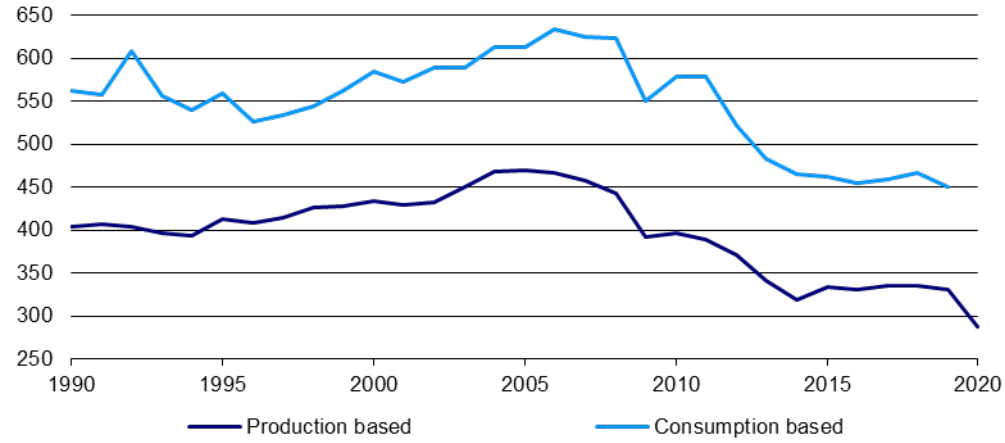
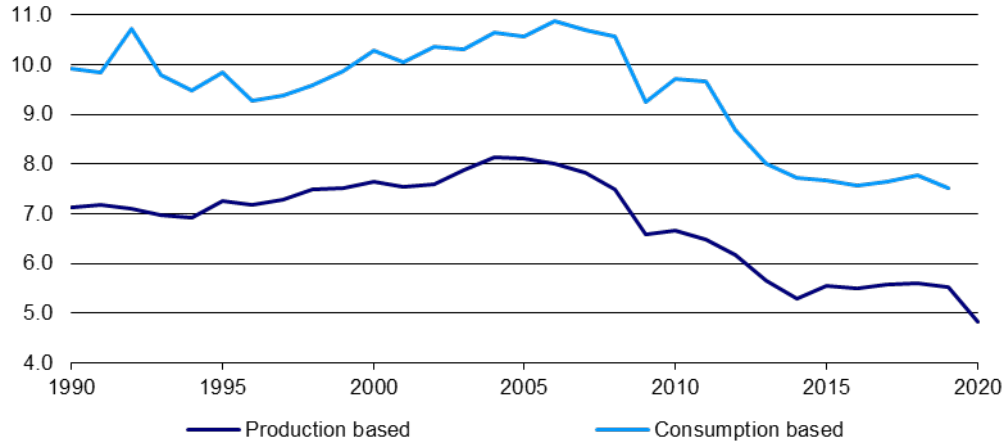
Italy

CO2 emissions (million metric tonnes per year)



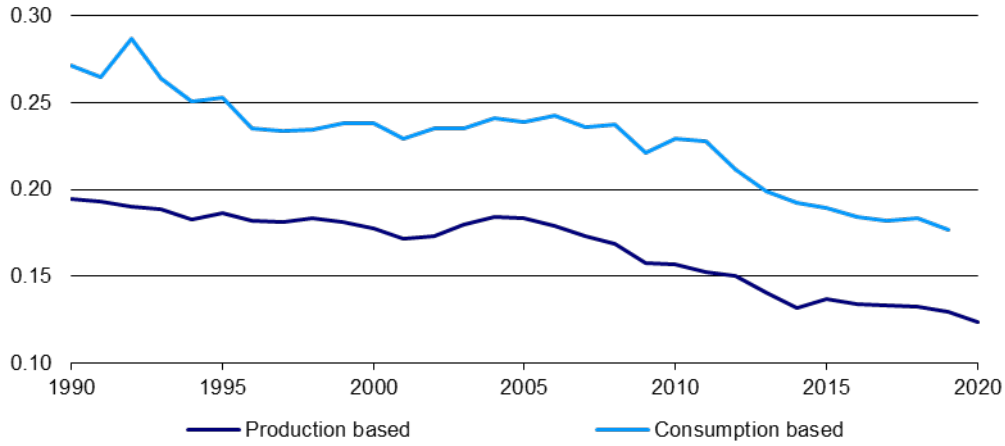
- Italy's emissions have been on a downward path since 2005/6
- Among C20 countries it was the 3rd lowest emitter in 2020 (6th lowest on a consumption basis in 2019)
- It has consistently offshored emissions

CO2 emissions per capita (metric tonnes per year)



- Italy doesn't look so good on a per capita emissions basis (it ranks 13th among C20 on both measures)
- The downtrend may reflect structural changes (as with many other countries) and needs to be accelerated if 2050 net-zero target is to be met

CO2 emissions per 2011 PPP US dollar of GDP (kilogramme per year)

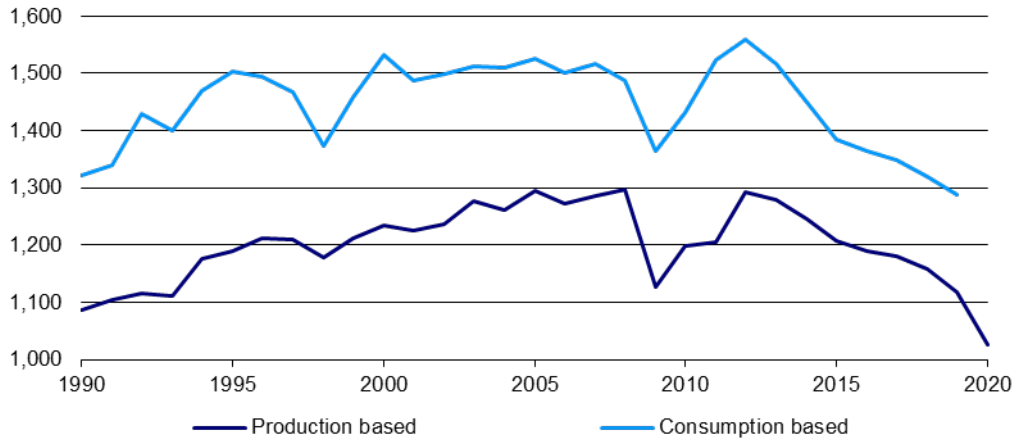


- Italy has the 3rd least CO2 intensive economy among C20 countries
- It is in the middle of the C20 pack when it comes to the 10-year reduction in CO2 intensity and needs to pick up the pace if it is to meet its 2050 net-zero target

Notes: Annual data from 1990 to 2020. Production based CO2 data is the common way to report emissions (it is the CO2 emitted by a country in a given year). Consumption based data allows for trade: for example if country A produces goods that are exported and consumed in country B, then the associated CO2 is subtracted from country A emissions and added to those of country B (adjustments are performed by the Global Carbon Project). It is a better reflection of lifestyle contributions to emissions.
Sources: BP Statistical Review of World Energy 2021, Global Carbon Project, IMF, Oxford Economics, Our World in Data, World Bank, Refinitiv Datastream and Invesco

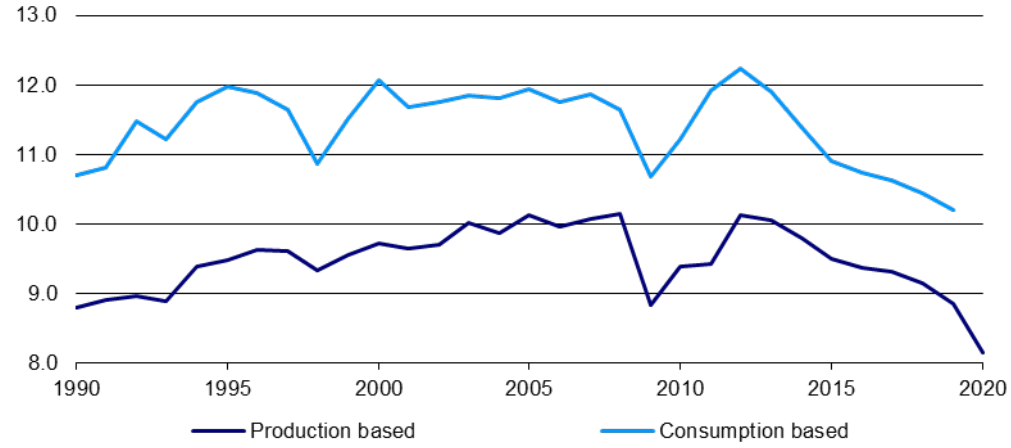
Japan

CO2 emissions (million metric tonnes per year)



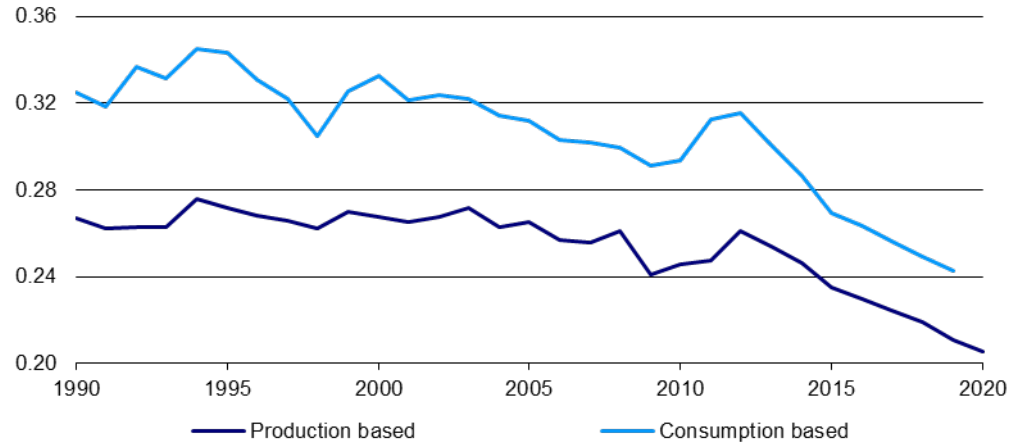
- Japan's CO2 emissions peaked in 2012, the year after the Fukushima nuclear disaster which increased Japan's reliance on fossil fuels
- Among C20 countries it is the 5th highest emitter (on both measures)

CO2 emissions per capita (metric tonnes per year)



- It looks slightly better on a per capita emissions basis (ranking 7th among C20 on both measures)
- Consumption-based emissions exceed production-based measures, suggesting that Japan offshores some of its emissions

CO2 emissions per 2011 PPP US dollar of GDP (kilogramme per year)

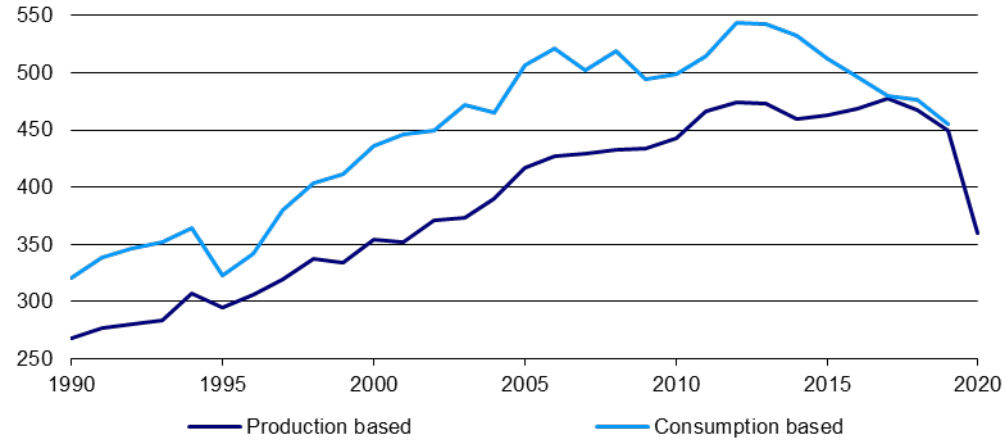


- Japan has the 12th most CO2 intensive economy among C20 countries
- It is in the middle of the C20 pack when it comes to the 10-year reduction in CO2 intensity and needs to radically pick up the pace if it is to meet its 2050 net-zero target

Notes: Annual data from 1990 to 2020. Production based CO2 data is the common way to report emissions (it is the CO2 emitted by a country in a given year). Consumption based data allows for trade: for example if country A produces goods that are exported and consumed in country B, then the associated CO2 is subtracted from country A emissions and added to those of country B (adjustments are performed by the Global Carbon Project). It is a better reflection of lifestyle contributions to emissions.
Sources: BP Statistical Review of World Energy 2021, Global Carbon Project, IMF, Oxford Economics, Our World in Data, World Bank, Refinitiv Datastream and Invesco

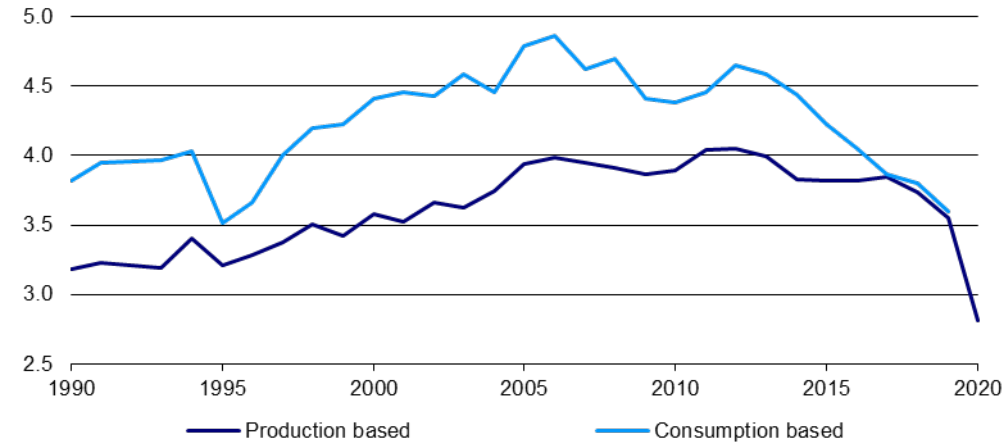
Mexico

CO2 emissions (million metric tonnes per year)



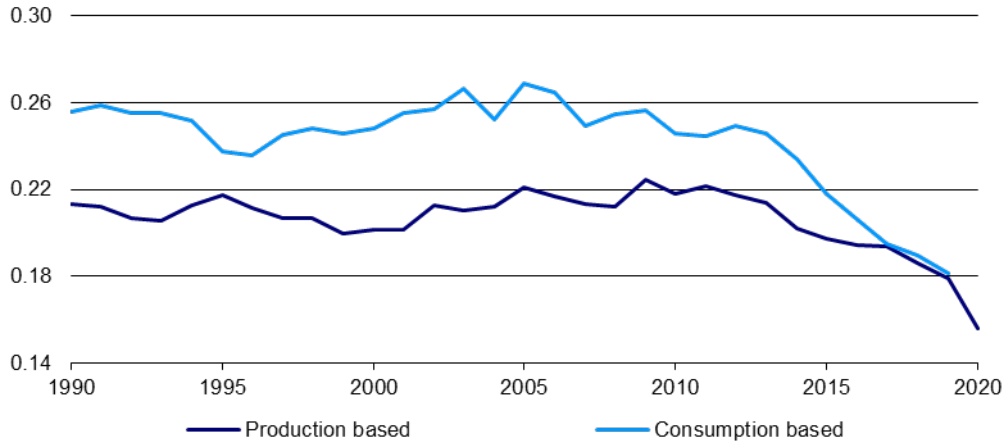
- Unlike many other emerging economies, Mexico has seen a reduction in CO2 emissions in recent years
- Among C20 countries it was the 5th lowest emitter in 2020 (6th lowest on consumption-based data in 2019)

CO2 emissions per capita (metric tonnes per year)



- Given that its per capita emissions are relatively low (4th lowest among C20 on both measures), it is impressive that this measure has fallen in the last decade
- It appears to be no longer offshoring its emissions

CO2 emissions per 2011 PPP US dollar of GDP (kilogramme per year)



- Mexico has the 7th least CO2 intensive economy among C20 countries
- It ranks 7th in terms of the 10-year reduction in CO2 intensity (it has no net-zero target but at this rate will be far from achieving net-zero in 2050)

Notes: Annual data from 1990 to 2020. Production based CO2 data is the common way to report emissions (it is the CO2 emitted by a country in a given year). Consumption based data allows for trade: for example if country A produces goods that are exported and consumed in country B, then the associated CO2 is subtracted from country A emissions and added to those of country B (adjustments are performed by the Global Carbon Project). It is a better reflection of lifestyle contributions to emissions.
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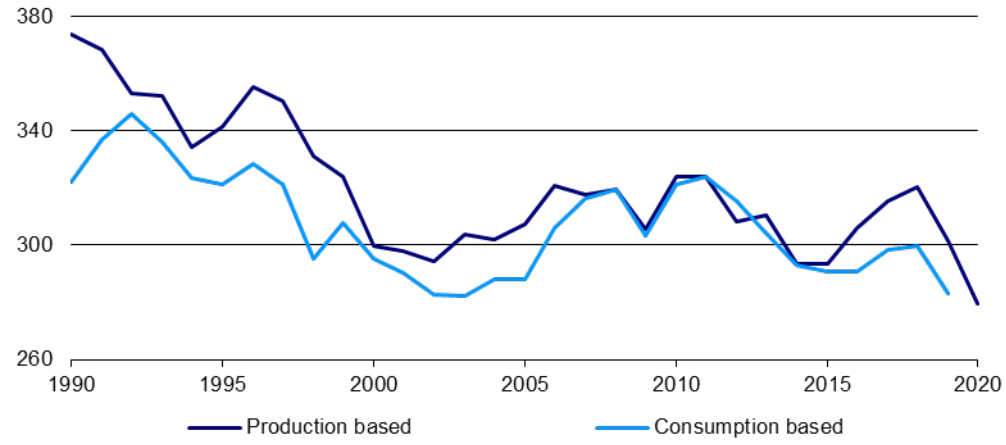
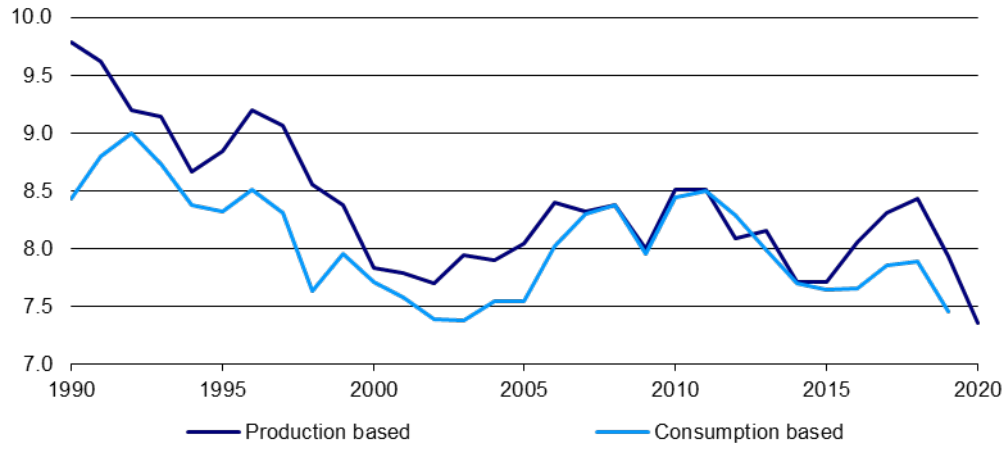
Poland

CO2 emissions (million metric tonnes per year)



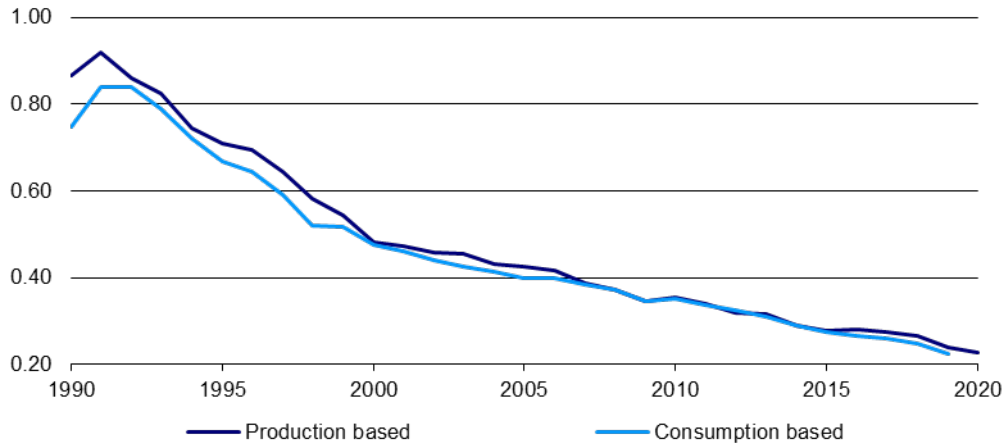
- Poland's emissions declined in the 1990s (post-Soviet economic transition) but have since stabilised
- Among C20 countries it was the 2nd lowest emitter in 2020 (lowest on consumption-based data in 2019)

CO2 emissions per capita (metric tonnes per year)



- This is due to Poland having the 3rd smallest population (it has the 9th highest per capita emissions on both measures)
- The divergence between the two measures suggests Poland is used as a production site for other countries

CO2 emissions per 2011 PPP US dollar of GDP (kilogramme per year)



- Poland's economy is consistently becoming less CO2 intensive (it ranks 10th among C20 countries in terms of intensity)
- It has the 3rd fastest decline in CO2 intensity over the last 10 years (it has no net-zero target)

Notes: Annual data from 1990 to 2020. Production based CO2 data is the common way to report emissions (it is the CO2 emitted by a country in a given year). Consumption based data allows for trade: for example if country A produces goods that are exported and consumed in country B, then the associated CO2 is subtracted from country A emissions and added to those of country B (adjustments are performed by the Global Carbon Project). It is a better reflection of lifestyle contributions to emissions.
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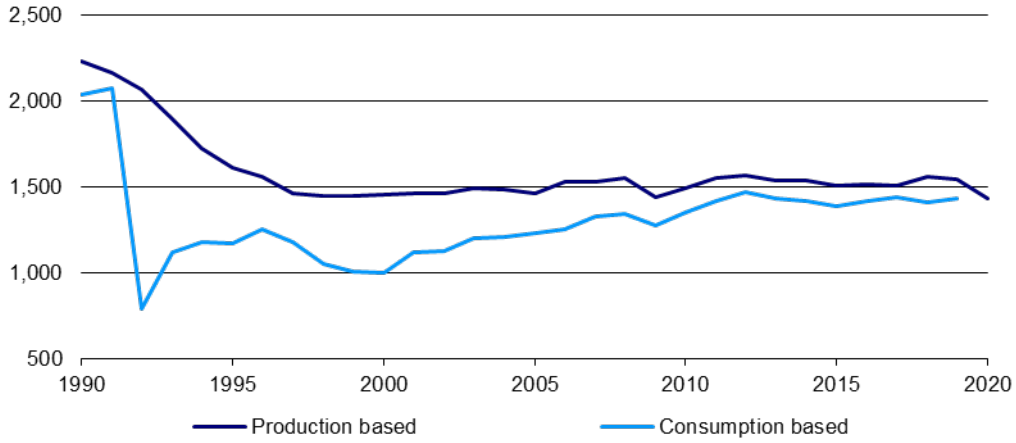
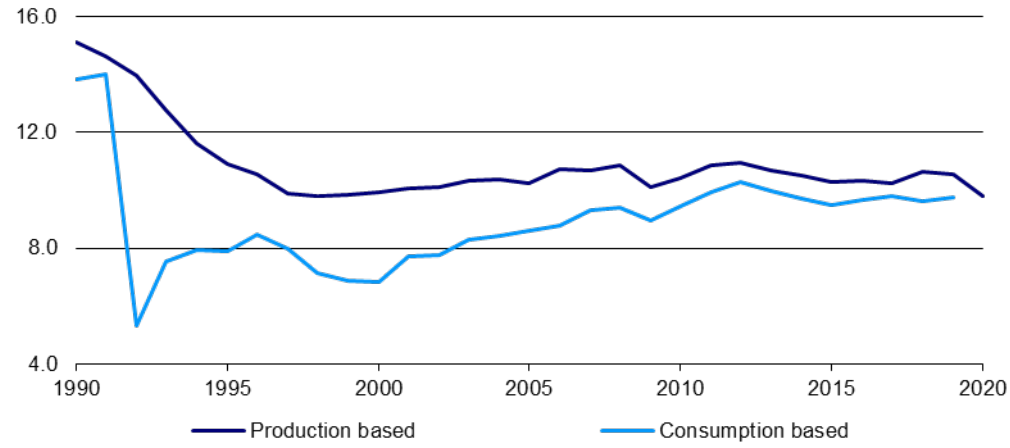
Russia

CO2 emissions (million metric tonnes per year)



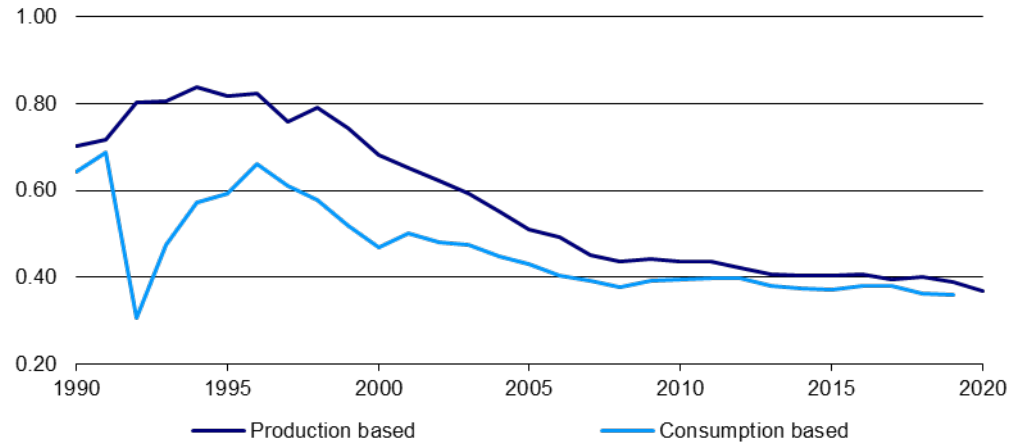
- Russia's economy shrank in the post-Soviet era, which explains the decline in CO2 in the early 1990s (trade volatility may have impacted the consumption-based measure)
- It is now the 4th highest emitter among C20 countries (on both measures)

CO2 emissions per capita (metric tonnes per year)



- On a per capita basis, it drops to 6th (on both measures)
- The divergence between the two measures may be due to being an energy exporter
- Per capita emissions have flattened but need to fall if the 2060 net-zero target is to be met

CO2 emissions per 2011 PPP US dollar of GDP (kilogramme per year)



- Russia is the 4th most CO2 intensive country among the C20 (commodity rich economies top the rankings)
- Intensity has declined in the last 10 years but too slowly (it ranks 15th in terms of the speed of decline)

Notes: Annual data from 1990 to 2020. Production based CO2 data is the common way to report emissions (it is the CO2 emitted by a country in a given year). Consumption based data allows for trade: for example if country A produces goods that are exported and consumed in country B, then the associated CO2 is subtracted from country A emissions and added to those of country B (adjustments are performed by the Global Carbon Project). It is a better reflection of lifestyle contributions to emissions.
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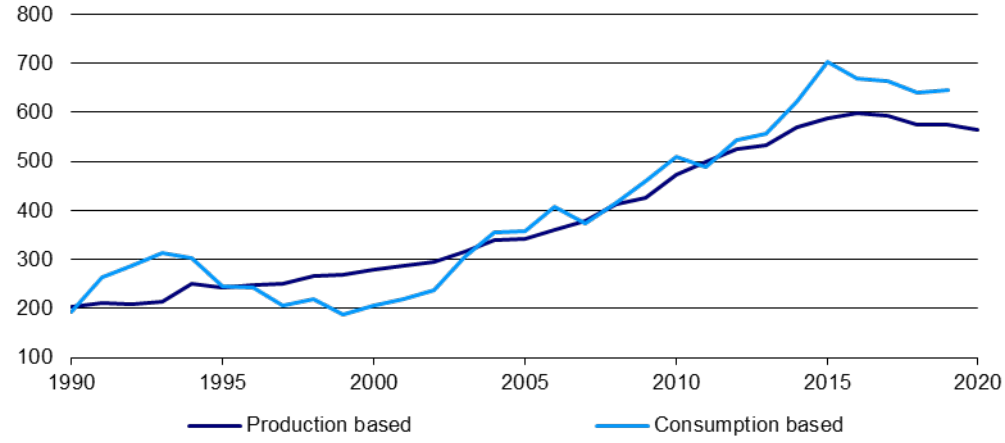
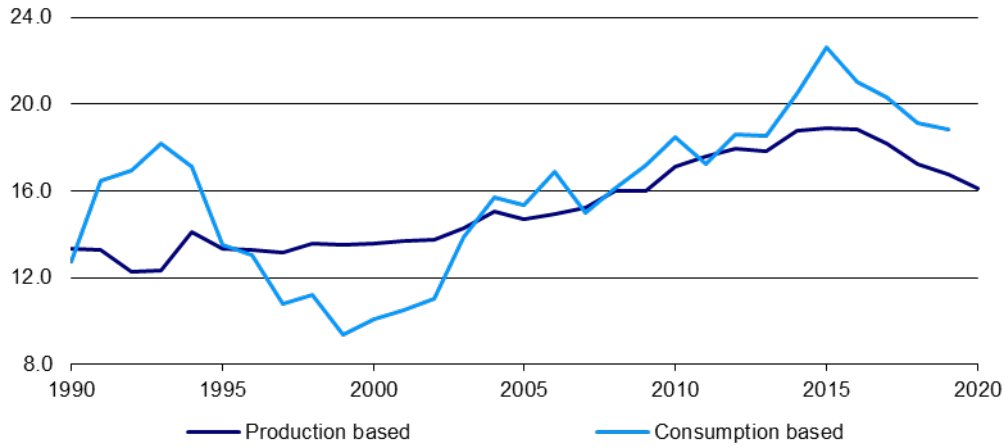
Saudi Arabia

CO2 emissions (million metric tonnes per year)



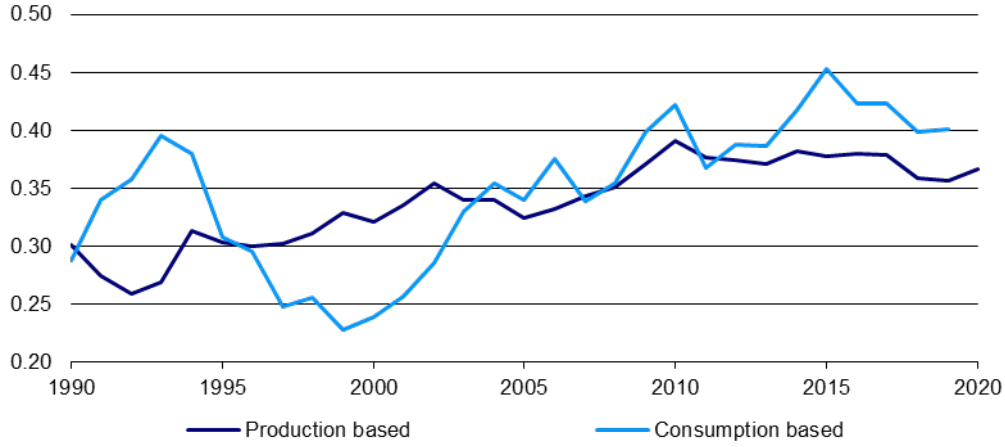
- Saudi Arabia is a big exporter of oil and gas, which could explain the large CO2 emissions (it ranks 9th among C20 countries)
- However, its emissions are now higher on a consumption basis, suggesting its own lifestyle choices are the problem

CO2 emissions per capita (metric tonnes per year)



- Per capita emissions have only recently turned down and that trend needs to accelerate if it is to meet its 2060 net-zero target
- Saudi Arabia has the highest per capita emissions among all C20 countries

CO2 emissions per 2011 PPP US dollar of GDP (kilogramme per year)



- It is the 5th most CO2 intensive country among the C20 (commodity rich economies top the rankings)
- Intensity has only recently peaked and the decline over the last 10 years is much too slow (it ranks 18th in terms of the speed of decline)

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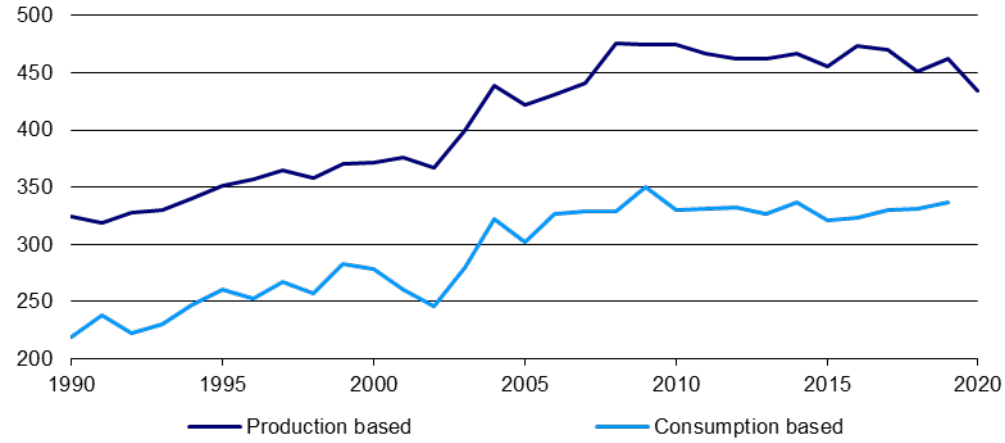
Sources: BP Statistical Review of World Energy 2021, Global Carbon Project, IMF, Oxford Economics, Our World in Data, World Bank, Refinitiv Datastream and Invesco

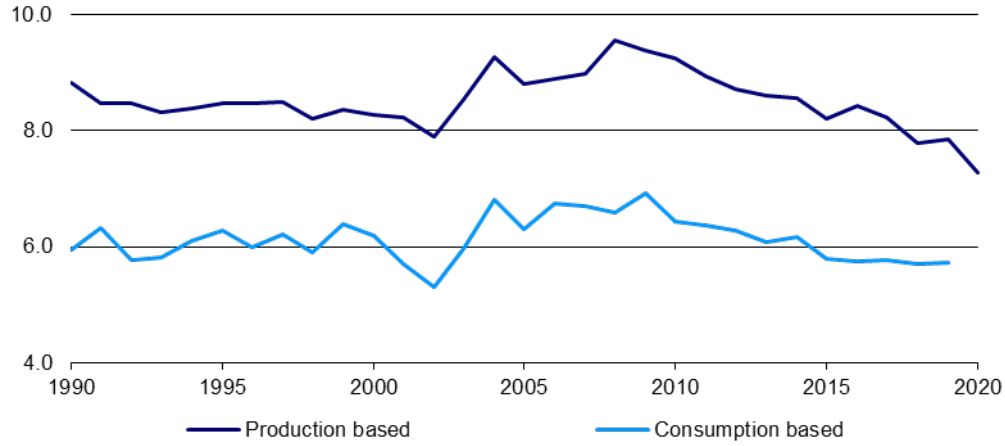
South Africa

CO2 emissions (million metric tonnes per year)



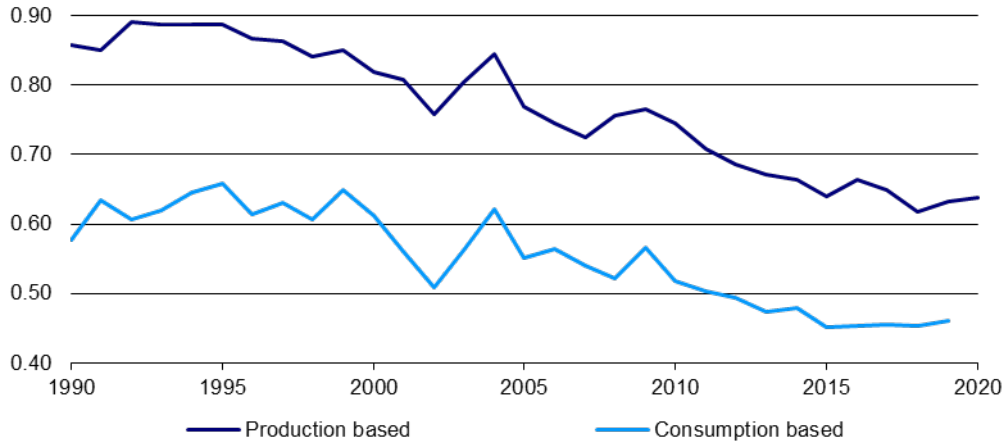
- South Africa's emissions have flattened since the GFC (it now ranks 12th among the C20)
- They are much lower on a consumption basis (rank #19), suggesting a lot is on behalf of other countries (mining activities)

CO2 emissions per capita (metric tonnes per year)



- Per capita emissions have trended down since the GFC but the pace of decline needs to double to meet the 2050 net-zero target
- South Africa ranks 10th among C20 countries when it comes to CO2 per capita (on both measures)

CO2 emissions per 2011 PPP US dollar of GDP (kilogramme per year)



- South Africa's is the most CO2 intensive C20 economy (commodity rich economies top the rankings)
- Intensity was gradually falling (until recently) but the decline over the last 10 years is much too slow (it ranks 16th in terms of the speed of decline)

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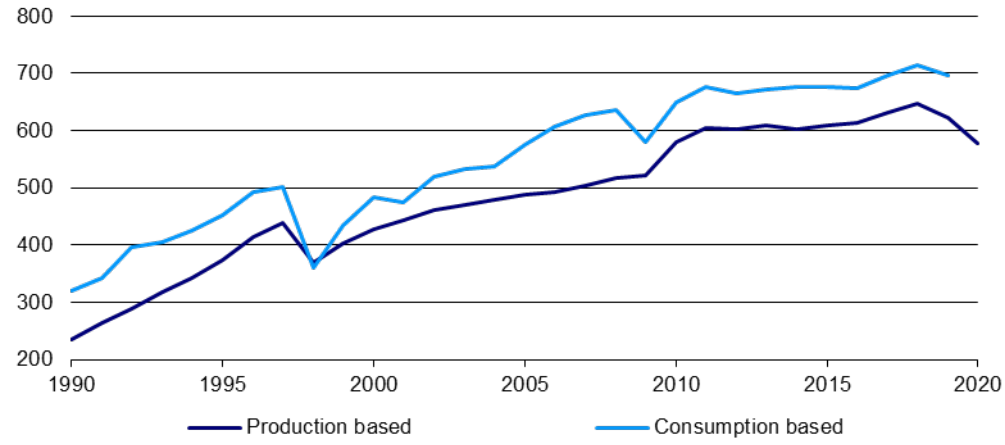
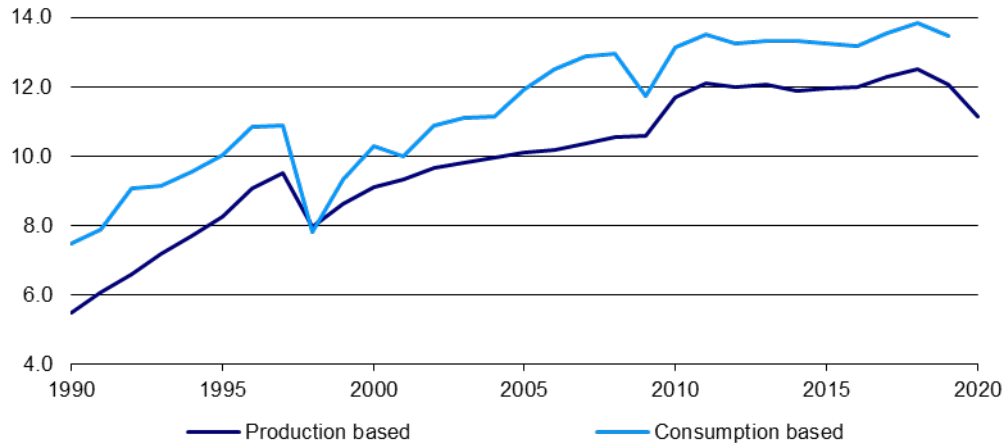
South Korea

CO2 emissions (million metric tonnes per year)



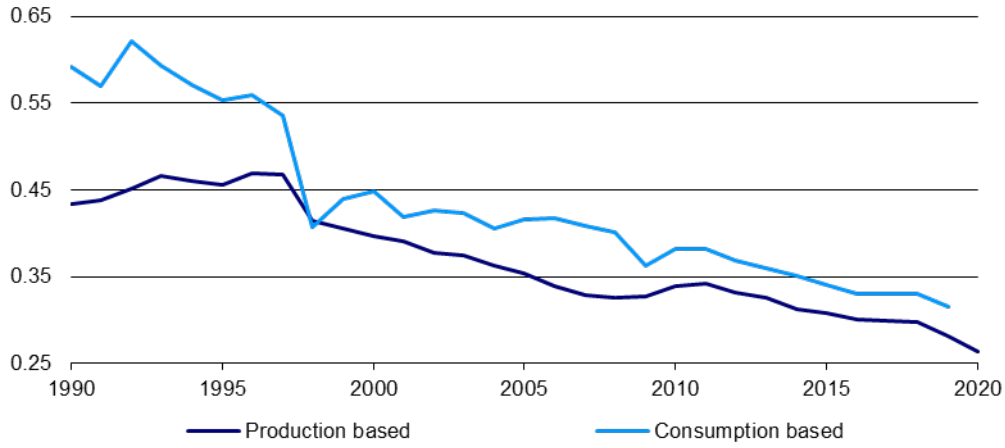
- South Korea's emissions were trending upward until recently and may still be doing so (it now ranks 8th among the C20)
- That they are higher on a consumption basis, suggests offshoring (goods are imported from other countries)

CO2 emissions per capita (metric tonnes per year)



- Per capita emissions have continued to increase and that trend needs to reverse if the 2050 net-zero target is to be met
- South Korea has the 5th highest per capita emissions among C20 countries (on both measures)

CO2 emissions per 2011 PPP US dollar of GDP (kilogramme per year)



- South Korea is the 9th most CO2 intensive C20 economy
- Intensity has been gradually falling (the decline over the last 10 years is the 9th fastest among the C20)
- The late 1990s volatility in the consumption-based measure was caused by the Asian crisis

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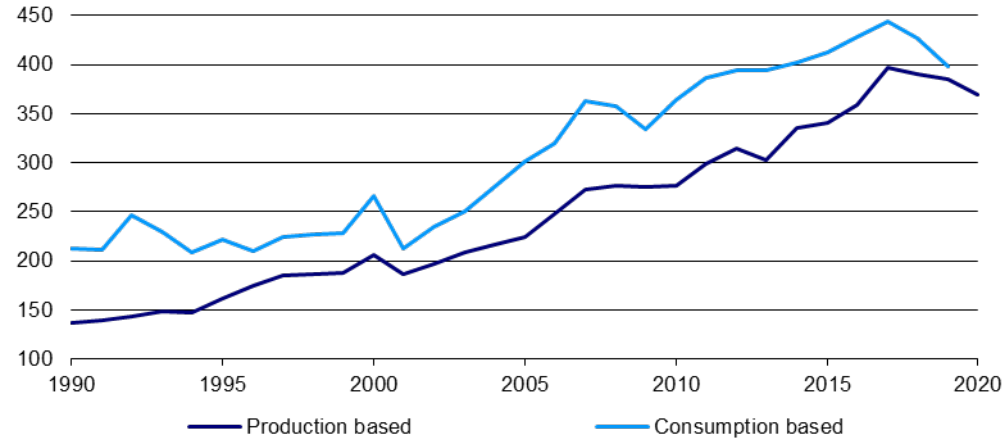
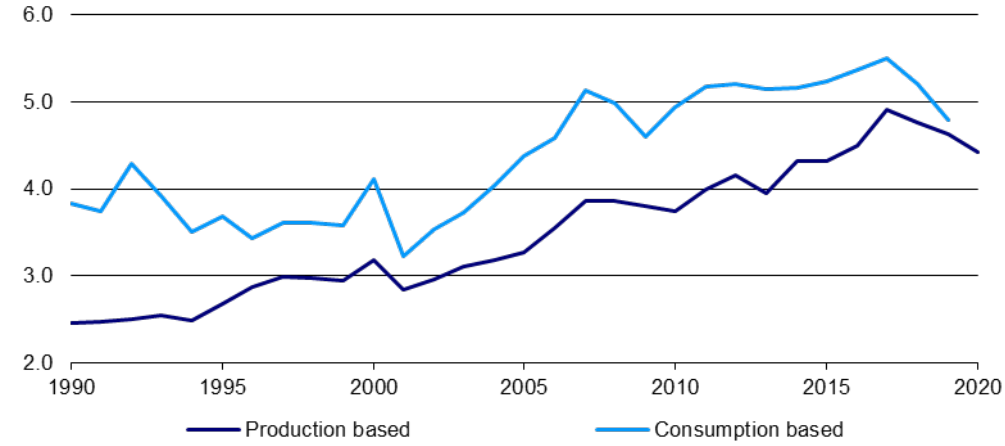
Turkey

CO2 emissions (million metric tonnes per year)



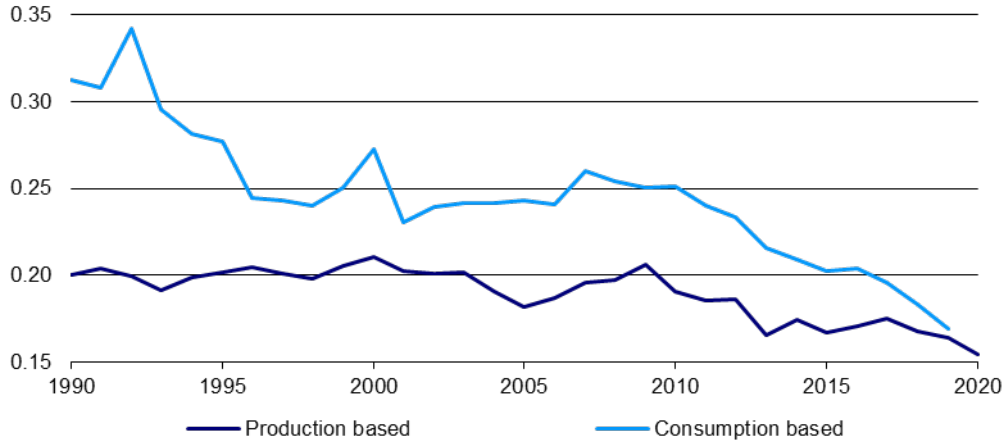
- Turkey's emissions have been trending upward but a weak economy has helped flatten the curve in recent years
- It now ranks 15th among C20 countries (or 17th on a consumption basis)

CO2 emissions per capita (metric tonnes per year)



- Per capita emissions have continued to increase and that trend needs to reverse if the 2053 net-zero target is to be met
- Turkey has the 15th highest per capita emissions among C20 countries (on both measures)

CO2 emissions per 2011 PPP US dollar of GDP (kilogramme per year)



- Turkey is the 15th most CO2 intensive C20 economy
- Intensity has been gradually falling (the decline over the last 10 years is the 12th fastest among the C20)
- The recent dip in the consumption measure may be due to the effect of currency weakness

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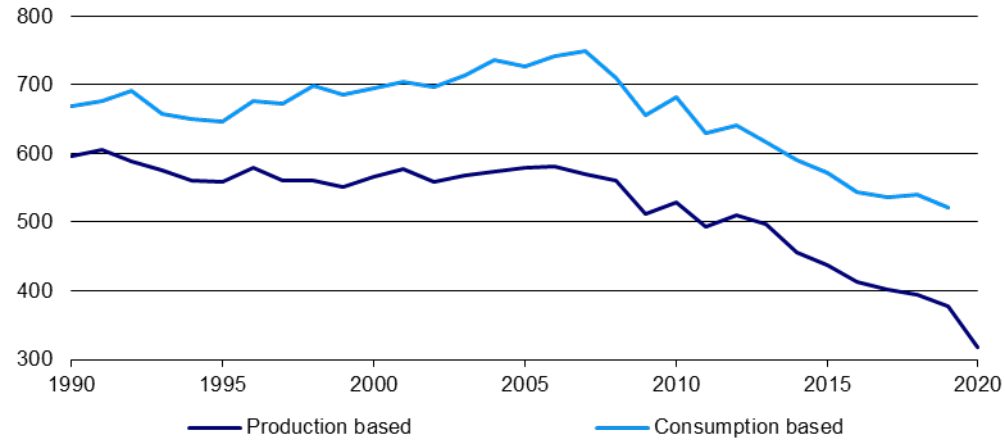
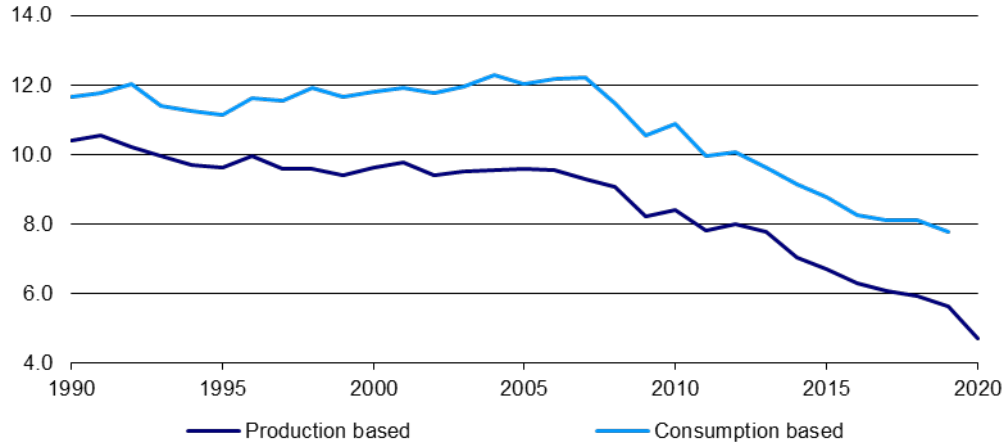
United Kingdom

CO2 emissions (million metric tonnes per year)



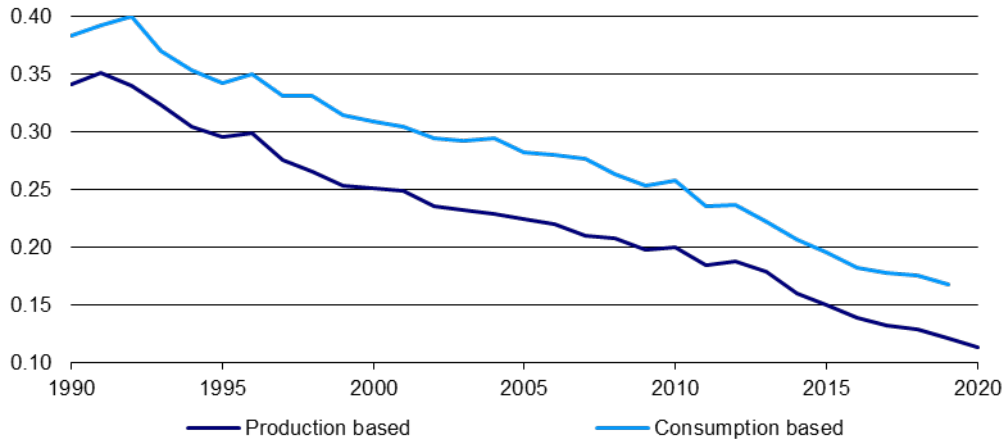
- UK emissions have been falling since 2006/7 (due to the move away from coal-fired electricity generation)
- It now ranks 17th (or 12th on a consumption basis – the UK has offshored an increasing share of its emissions)

CO2 emissions per capita (metric tonnes per year)



- Per capita emissions have been falling since 2006/7 (the UK ranks 14th among C20 countries)
- The UK is the only country that is on target to meet its (2050) net-zero target (based on the evidence of the last 10 years)

CO2 emissions per 2011 PPP US dollar of GDP (kilogramme per year)



- The UK is the 2nd least CO2 intensive C20 economy (helped by its focus on service industries)
- Intensity has been gradually falling (the decline over the last 10 years is the fastest among the C20)

Notes: Annual data from 1990 to 2020. Production based CO2 data is the common way to report emissions (it is the CO2 emitted by a country in a given year). Consumption based data allows for trade: for example if country A produces goods that are exported and consumed in country B, then the associated CO2 is subtracted from country A emissions and added to those of country B (adjustments are performed by the Global Carbon Project). It is a better reflection of lifestyle contributions to emissions.
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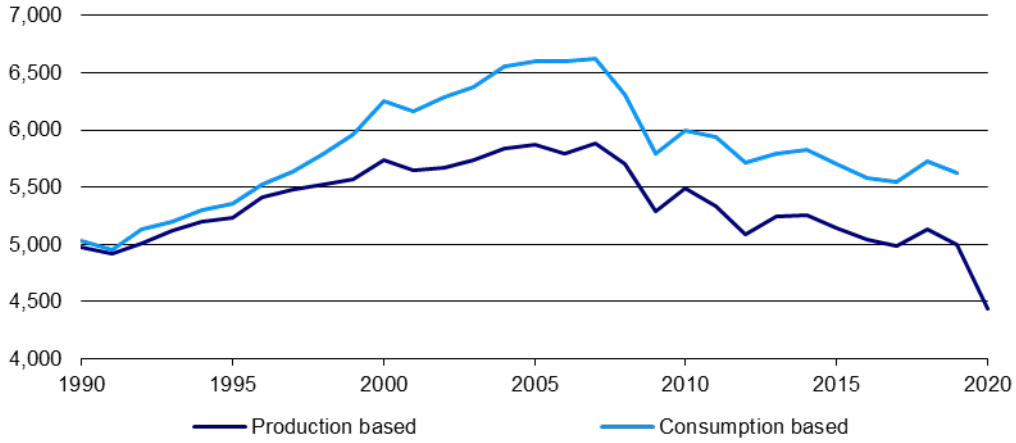
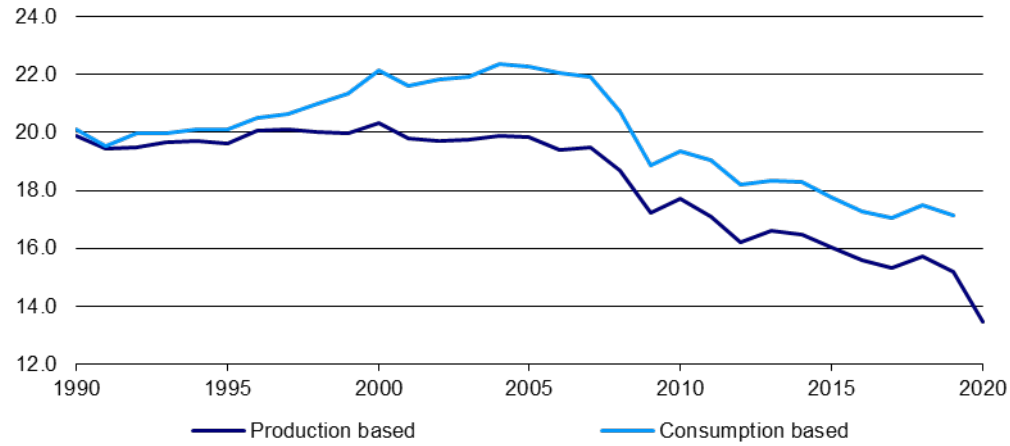
United States of America

CO2 emissions (million metric tonnes per year)



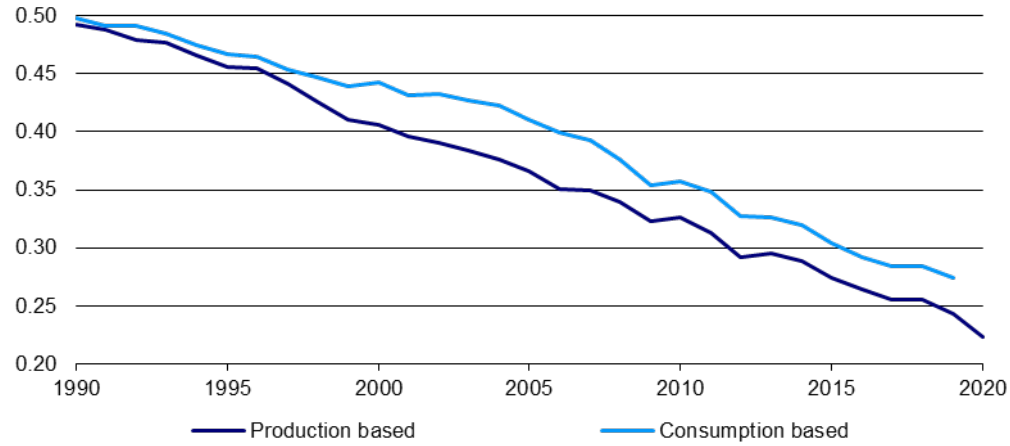
- US emissions have been falling since 2007 but it is still the world's 2nd largest emitter (on both measures)
- The widening gap between consumption and production-based measures since 1990 suggests increasing offshoring of industry

CO2 emissions per capita (metric tonnes per year)



- Per capita emissions have been falling since the early 2000s but the US still ranks 4th among C20 countries
- The US needs to double the pace of decline seen in the last 10 years if it is to meet its 2050 net-zero target

CO2 emissions per 2011 PPP US dollar of GDP (kilogramme per year)



- The US is the 11th most CO2 intensive C20 economy
- Intensity has been gradually falling and the decline over the last 10 years is the 5th fastest among the C20

Notes: Annual data from 1990 to 2020. Production based CO2 data is the common way to report emissions (it is the CO2 emitted by a country in a given year). Consumption based data allows for trade: for example if country A produces goods that are exported and consumed in country B, then the associated CO2 is subtracted from country A emissions and added to those of country B (adjustments are performed by the Global Carbon Project). It is a better reflection of lifestyle contributions to emissions.
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