Mitigating Carbon Emissions for Malaysia's Iron and Steel Sector

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Globally, our NDCs up to 2030 are inadequate to stay on a 1.5°C pathway

Projected global emissions in 2030 based on NDCs (min-max)	50-57	47-55
Gap between NDCs and 2°C pathway (min-max)	10-16	6-14

Gap between NDCs and 1.5°C pathway (min-max)	19-26	16-23

Note: NDCs as announced prior to COP 26

Source: IPCC (2022), Summary for policymakers: Climate change 2022: Mitigation of climate change

Malaysia's NDC by 2030 will not decrease net emission and commit to peak emissions

GDP at 2010 prices	MYR bil	659.6	1,677.5	1017.9	154.3%

Carbon intensity	kg CO_2e/MYR	0.427	0.235	-0.168	-45.0%*
Gross GHG emissions	bil kg CO_2e	281.8	394.2	112.4	39.9%

* Malaysia's NDC target is to reduce carbon intensity by 45% by 2030 from a 2005 base

The race to net zero CO by 2050

p50 [p5–p95] [a]			GHG emissions ($GtCO_2$-eq yr^{-1}) [g]			GHG emissions reductions from 2019 (%) [h]			Emissions milestones [i,j]			
Category [b,c,d] [# pathways]	Category/subset label	WGI SSP & WGIII IPs/IMPs alignment [e,f]	2030	2040	2050	2030	2040	2050	Peak CO_2 emissions (% peak before 2100)	Peak GHG emissions (% peak before 2100)	Net zero CO_2 (% net zero pathways)	Net zero GHGs (% net zero pathways) [k,l]
Modelled global emissions pathways categorised by projected global warming levels (GWL). Detailed likelihood definitions are provided in SPM Box1. The five illustrative scenarios (SSPx-yy) considered by AR6 WGI and the Illustrative (Mitigation) Pathways assessed in WGIII are aligned with the temperature categories and are indicated in a separate column. Global emission pathways contain regionally differentiated information. This assessment focuses on their global characteristics.			Projected median annual GHG emissions in the year across the scenarios, with the 5th–95th percentile in brackets. Modelled GHG emissions in 2019: 55 [53–58] $GtCO_2$-eq.			Projected median GHG emissions reductions of pathways in the year across the scenarios compared to modelled 2019, with the 5th–95th percentile in brackets. Negative numbers indicate increase in emissions compared to 2019.			Median 5-year intervals at which projected CO_2 & GHG emissions peak, with the 5th–95th percentile interval in square brackets. Percentage of peaking pathways is denoted in round brackets. Three dots (…) denotes emissions peak in 2100 or beyond for that percentile.		Median 5-year intervals at which projected CO_2 & GHG emissions of pathways in this category reach net zero, with the 5th–95th percentile interval in square brackets. Percentage of net zero pathways is denoted in round brackets. Three dots (…) denotes net zero not reached for that percentile.	
C1 [97]	limit warming to 1.5°C (>50%) with no or limited overshoot		31 [21–36]	17 [6–23]	9 [1–15]	43 [34–60]	69 [58–90]	84 [73–98]	2020–2025 (100%) [2020–2025]		2050–2055 (100%) [2035–2070]	2095–2100 (52%) [2050–…]
C1a [50]	… with net zero GHGs	SSP1–1.9, SP LD	33 [22–37]	18 [6–24]	8 [0–15]	41 [31–59]	66 [58–89]	85 [72–100]				2070–2075 (100%) [2050–2090]
C1b [47]	… without net zero GHGs	Ren	29 [21–36]	16 [7–21]	9 [4–13]	48 [35–61]	70 [62–87]	84 [76–93]				…–… [0%] […–…]

Source: IPCC (2022), Summary for

policymakers: Climate change 2022: Mitigation of climate change

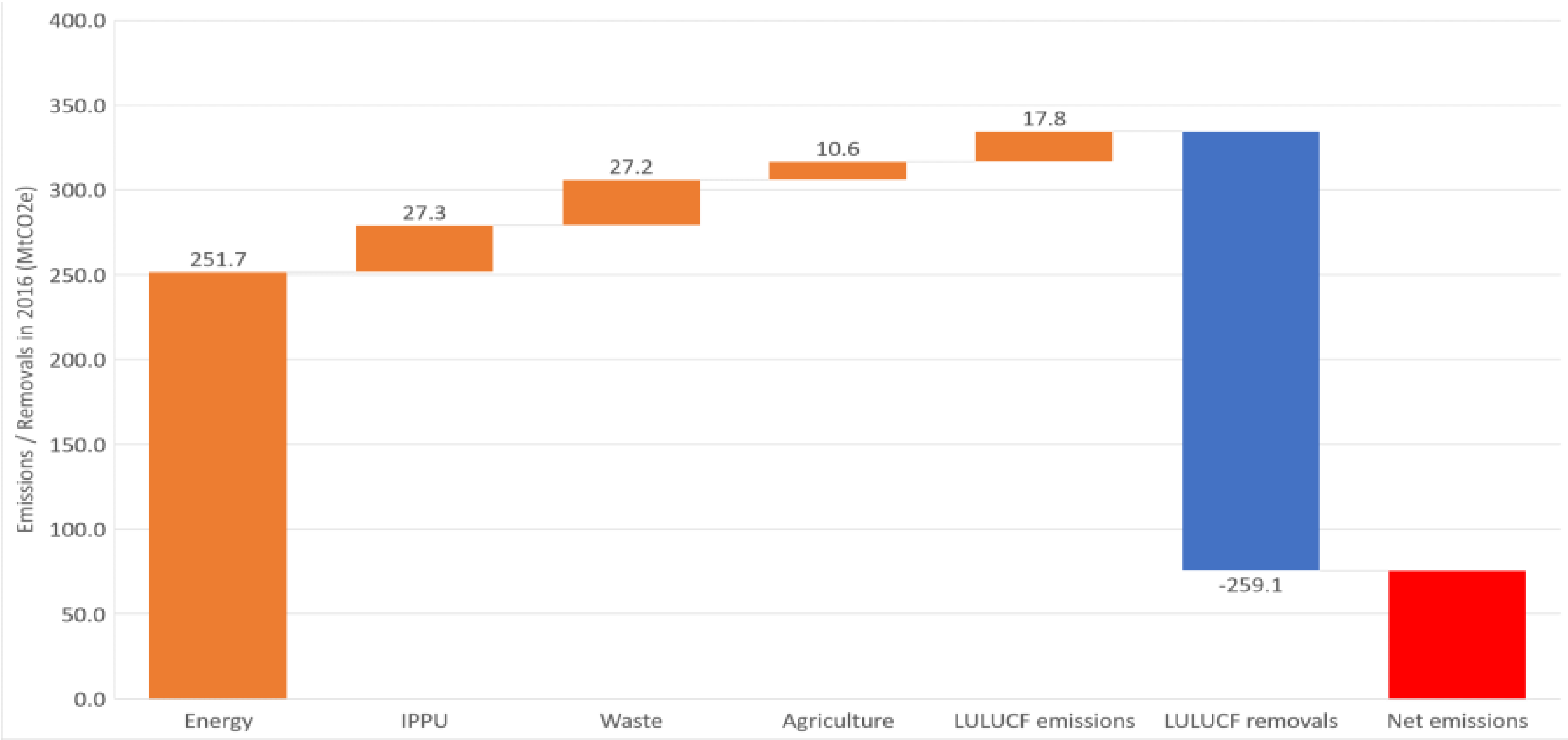
We need more countries to commit to net zero by or before 2050

Before 2050	Finland (2035) Austria (2040) Iceland (2040)		
	Germany (2045)	Sweden (2045)	
By 2050	Argentina	Australia	Brazil
	Canada	**Japan**	South Africa
	South Korea	United Kingdom	**United States**
	European Union		
	Cambodia	Vietnam	Singapore
After 2050	Indonesia (2060)	**China (2060)**	**India (2070)**
	Russia (2060)	Saudi Arabia (2060)	Turkey (2053)

	Thailand (2065)		
Ambiguous	Malaysia (≥2050)		
Yet to announce	Mexico	Philippines	

Source: Climate change intelligence unit, Al Jazzera, Authors' analysis

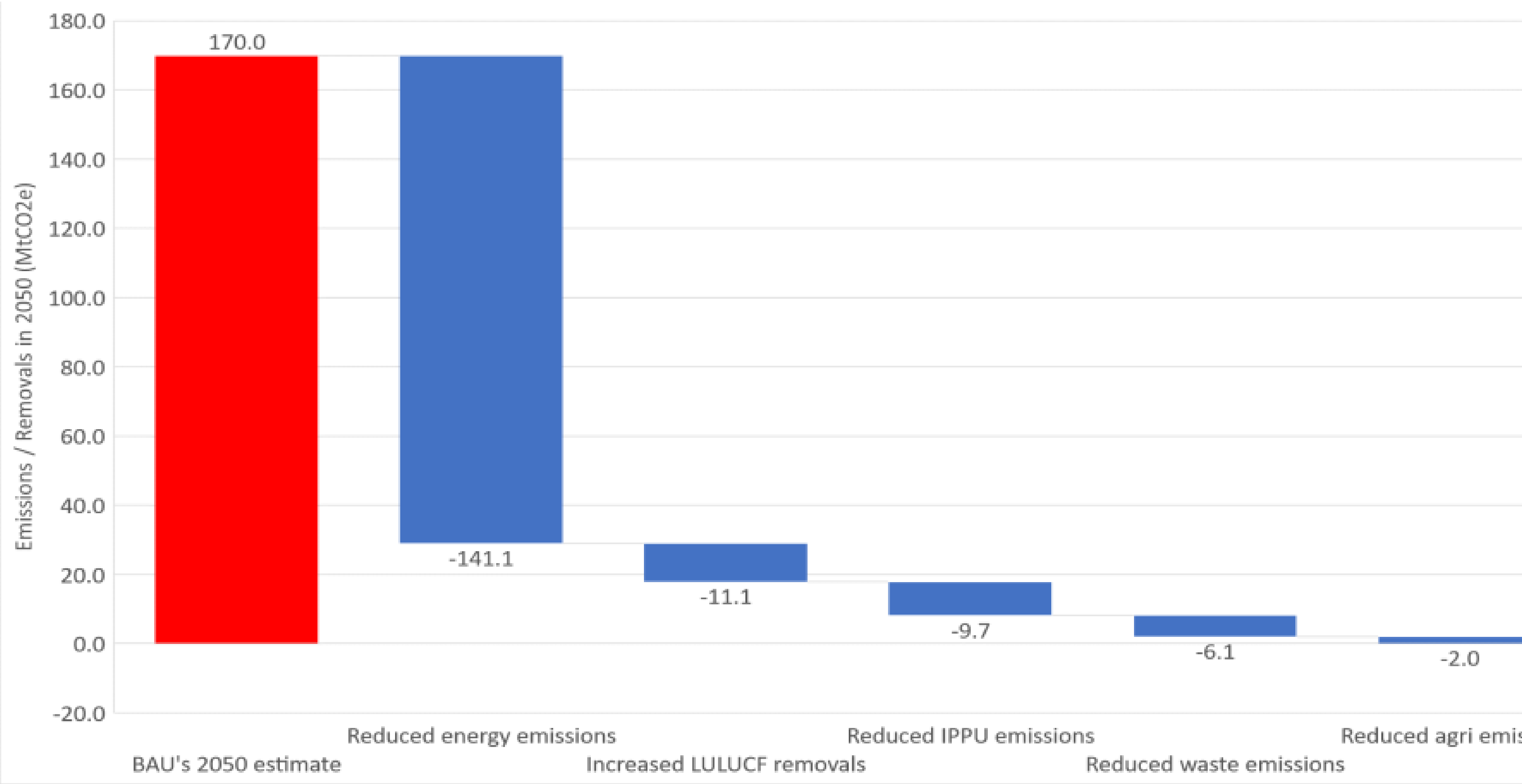
Malaysia's GHG inventory in 2016


Emissions / Removals in 2016 (MtCO2e)
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
251.7
27.3
27.2
10.6
17.8
-259.1
Energy
IPPU
Waste
Agriculture
LULUCF emissions
LULUCF removals
Net emissions

75.5Note: IPPU: Industrial process and product use; LULUCF: Land use, land use change and forestry

Source: Third Biennial Report

BCG-WWF’s net zero by 2050 is largely driven by reduced energy emissions


Emissions / Removals in 2050 (MtCO2e)
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
-20.0
170.0
-141.1
-11.1
-9.7
-6.1
-2.0
BAU's 2050 estimate
Reduced energy emissions
Increased LULUCF removals
Reduced IPPU emissions
Reduced waste emissions

Source: BCG-WWF: Net zero pathways for Malaysia (2021), Authors' analysis

BCG-WWF's levers to achieve net zero by 2050 are commercially viable (NPV>0)

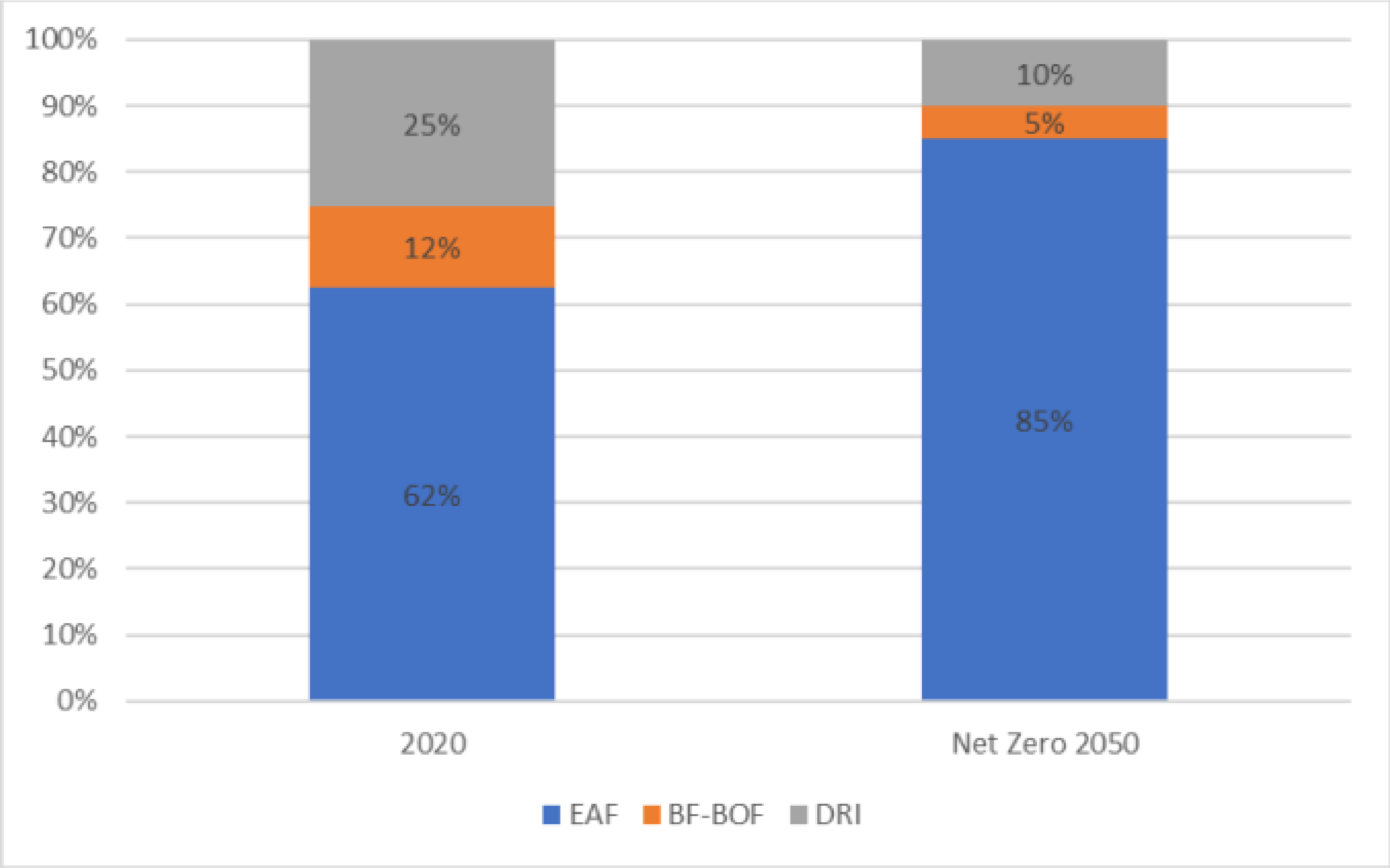
Energy *(-104.0 MtCO2e)*	***Electricity generation*** – Improve energy efficiency, zero coal power plants, 61% of capacity from renewable energy (solar, hydro, biomass), 39% from more efficient combine cycle gas turbine (CCGT) plants ***Transport*** – 100% electric vehicles, 60% public transport share, biofuel and hydrogen for heavy transport ***Oil and gas*** – reduce fugitive emission intensity
AFOLU – LULUCF *(-11.1 MtCO2e)*	Strengthen post-felling silviculture, zero deforestation for cropland expansion, reforestation of degraded forest, rehabilitation of drained organic soil
IPPU *(-9.7 MtCO2e)*	Reduce clinker to cement ratio to from 89% to 50%, increase use of recycled material and inert anodes for aluminum production, **increase share of Electric Arc Furnace to recycle steel to from 62% to 85%, use blue or green hydrogen for existing direct reduced iron plants**

Waste *(-6.1 MtCO2e)*	Increase biogas plants, increase recycling, reduce food waste, increase waste to energy plar
AFOLU – Agriculture *(-2.0 MtCO2e)*	Reduce fertilizer usage through increased precision and control, employ alternate wetting and drying techniques in rice plantations, improve feed to cattle to reduce enteric fermentation

- BCG-WWF is of the view that without CCUS, existing commercially viable technology options bring Malaysia very close to net zero by 2050. With CCUS, for sure Malaysia can achieve net zero by 2050. However, improvements in other technologies may exempt the need for CCUS

Source: BCG-WWF: Net zero pathways for Malaysia (2021), Authors' analysis

BCG-WWF forecast Malaysia's EAF share of capacity to increase to 85%



Source: BCG-WWF: Net zero pathways for Malaysia (2021)

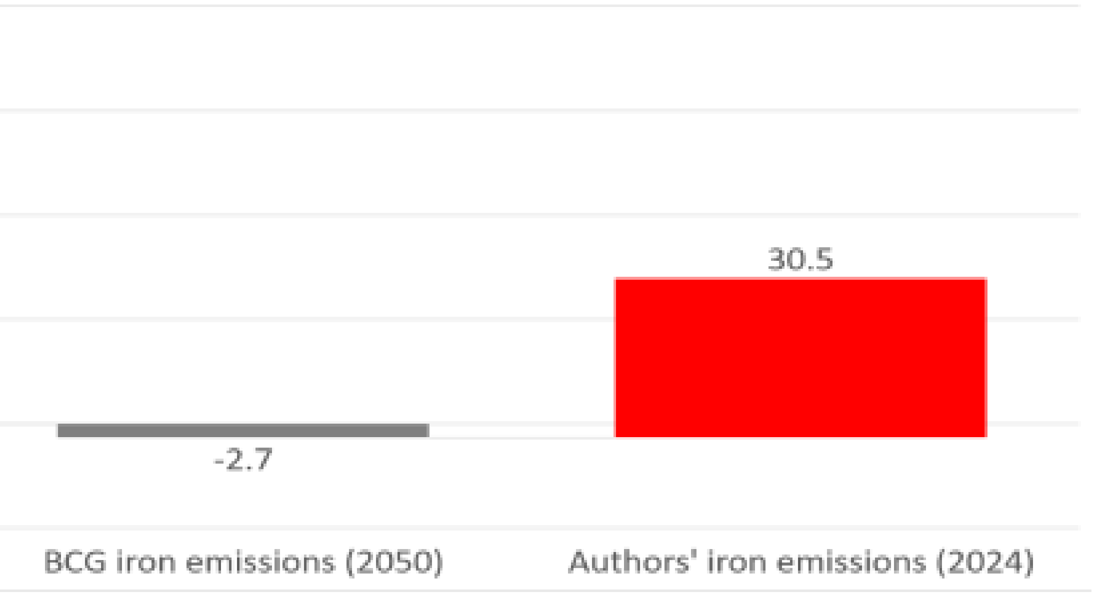
hare of EAF to reach 85% by 2050 may not be realistic

REP: Reference production scenario SAP:
Structure adjustment production scenario

Source: Zhang, A Bottom-up Energy Efficiency Improvement Roadmap for China's Iron and Steel Industry up to 2050 (2016)

- Scrap metal will be limited in availability in developing countries (Battle, 2014)

Despite assuming no growth after 2024, our iron estimates lead to 27.9 MtCO2e more



37% of Malaysia's 2016 net emissions

27.9

Note: BCG’s iron emissions (2050) = iron emissions (2016) grown linearly at 2.2%p.a. from 2020 to 2050

Source: BCG-WWF: Net zero pathways for Malaysia (2021), Authors’ analysis

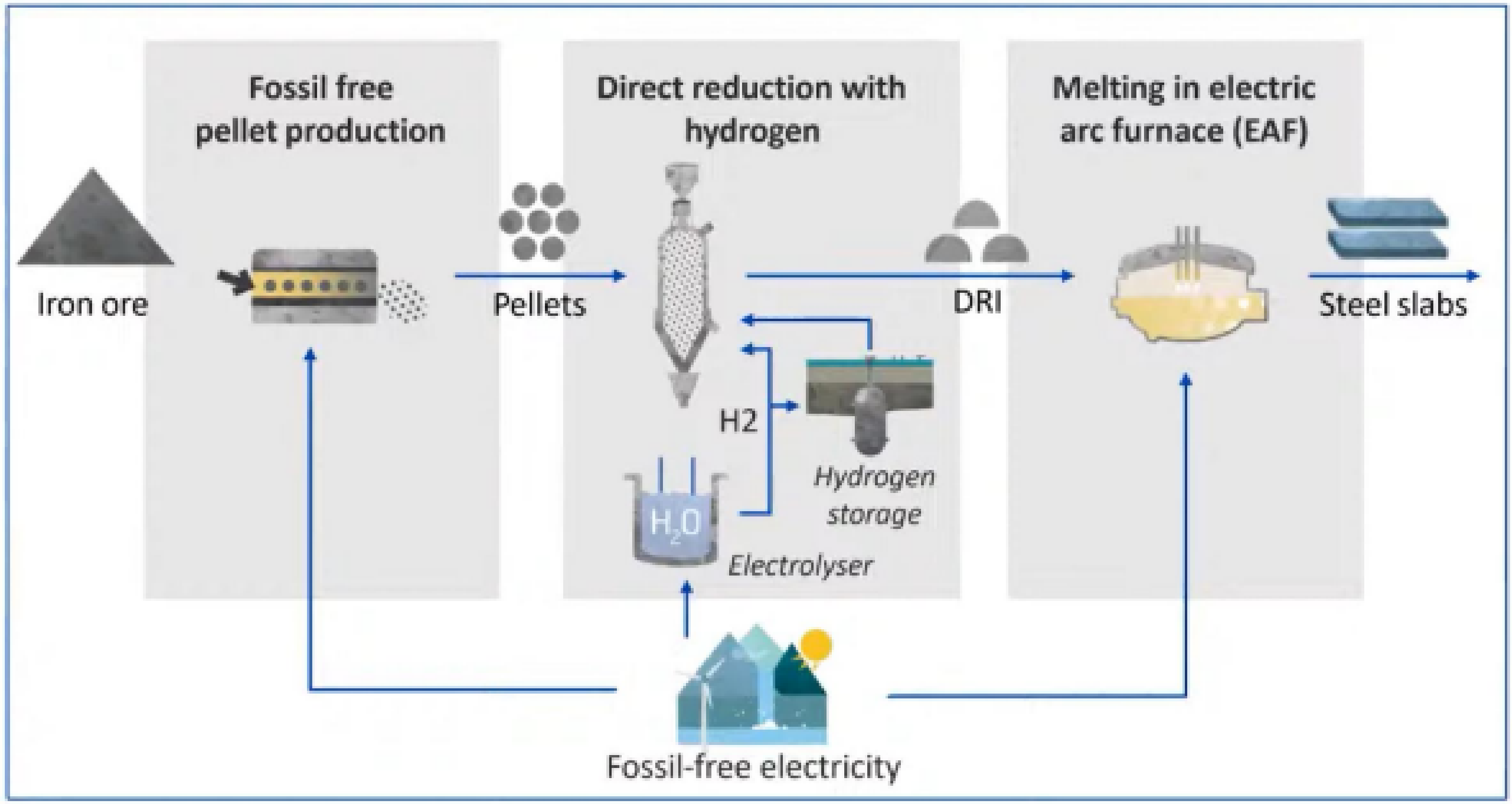
Base case of Malaysian iron production

Iron products (Hot briquetted iron/Direct reduced iron)	Antara (Sold to Esteel in 2020), Labuan	DRI		888	75%	80%	0.7	467	497
	Lion DRI (Sold to Lion Industries in 2021), Banting*	DRI		1,540	0%	0%	0.7	0	0
	Perwaja, Kemaman*	DRI		1,500	0%	0%	0.7	0	0

Iron products (pig iron, hot metal, blast furnace)	Ann Joo, Penang	BF		500	43%	80%	1.46	439	818
	Eastern, Kemaman	BF		700	43%	80%	1.46	314	584
Authors' estimate Total AGF				**4,428**				**1,221**	**1,899**
BUR 3 Total BUR3								**1,385**	**-**
Additional installations since 2016	Alliance, Kuantan (2017)	BF	Announced by firm	Built 3,500 in 2017 Additional 6,500 by ?	-	80%	1.46	-	11,68
	Eastern, Kemaman	BF	Announced by firm	Additional 2,000 by 2023	-	80%	1.46	-	2,336
	Lion Industries, Banting	BF	Announced by firm	2,500 by ?	-	80%	1.46	-	2,920
	Wen An, Bintulu	BF	In Construction	10,000 by 2024	-	80%	1.46	-	11,68
	Total additional								**28,61**
Total									**30,51**

Not accounted for in BCG's Net Zero Pathway Report (2021), which took BUR3 figures, then grew emissions at 2.2%p.a. → 2,660 ('000tCO2e)

HYBRIT fossil free steel could be commerciable by 2026



- Demonstration plant is being constructed in Gällivare, Sweden by a consortium of SSAB, LKAB, and

Vattenfall and is expected to be completed in 2025 and be commerciable by 2026 • Steel produced will be 20% to 30% more expensive, and there may be a challenge to acquire adequate green hydrogen

Source: HYBRIT consortium, Axelson (2018)

Malaysia needs a phased approach to decarbonise the iron and steel sector

Short run (before 2030)	• Immediately **stop issuing new blast furnace (lock-in period of 17 years)** licenses • Reduce demand requirements through **improved steel manufacturing yields, extending building lifetime and vehicle lightweighting** • If demand requires, **roll-out new electric arc furnaces which recy scrap metal** which is supply constrained

Long run (2030 and beyond)	• Adopt near zero technology at scale as soon as commercially available:
	• **HYBRIT at scale**
	  • Need green / blue hydrogen
	  • Need renewable energy for heating and machine movement
	Hisarna at scale, a novel low emissions blast furnace-basic oxygen green hydrogen is not available

Observations

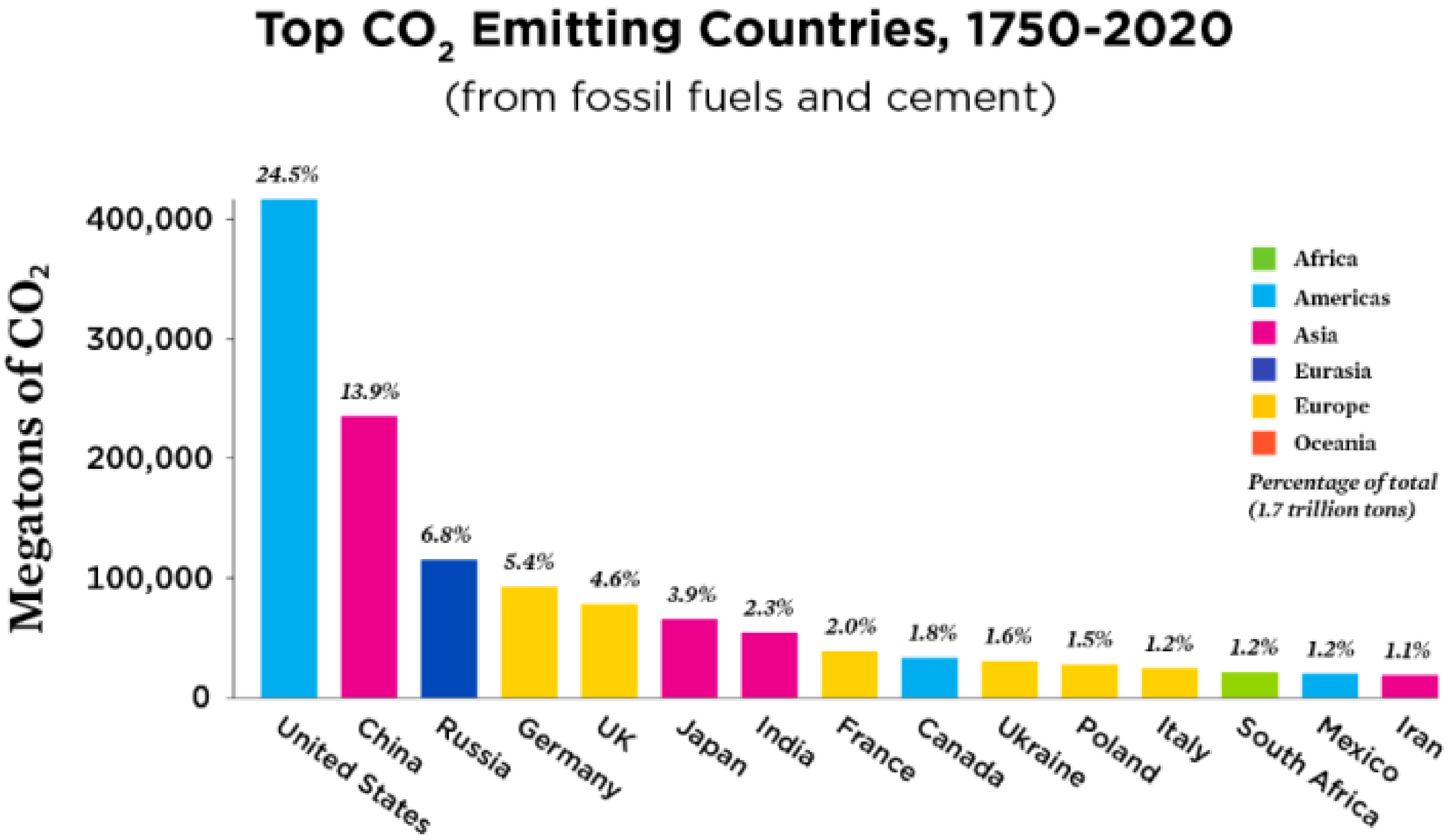
• To be consistent with the 1.5°C pathway which requires global CO_2 emissions to reduce by 43% by 2030 and joint but differentiated responsibilities principle, developed countries need to reduce emissions by more than 43%, and **developing countries like Malaysia should commit to peak emissions by 2030.**

• Policymakers need to be aware that some industries have **large lumpy capital investments and demand beyond the local market (e.g. iron and steel)**. Furthermore, large capital investments result in **long lock-in periods**. For such industries, estimation of the current carbon emissions should be based on expectation views, not historical views.

- As Malaysia is a technology adopter not a technology innovator, it requires technology transfer from developed countries. Malaysia must therefore specify its technology needs in its “nationally determined contributions” (NDC) to press for activation of the Technology Mechanism in the Paris Climate Treaty, to facilitate **technology development and technology transfer** to implement technology in-pursuit of the long-term vision of the Paris Agreement.
- Review of recent achievement reports by the Technology Mechanism (i.e. “Technology and Nationally Determined Contributions: Stimulating the Update of Technologies in Support of Nationally Determined Contribution Implementation” and “Joint annual report of the Technology Executive Committee and the Climate Technology Center and Network for 2021”) provide no evidence that any achievements have been made for the iron and steel for both developed and developing countries.

- Near zero emission technologies are more costly than carbon intensive technologies (e.g. HYBRIT steel is expected to cost 20%-30% more than blast furnace steel), developing countries will need the **concessionary finance** promised in the Paris Climate Treaty to fund installation of the new green technologies at scale.
- 2017-2018 period developed countries contributed USD25 billion on “grant-equivalent basis”

Common but differentiated responsibilities


Top CO_2 Emitting Countries, 1750-2020
(from fossil fuels and cement)
Megatons of CO_2
400,000
300,000
200,000
100,000
0
24.5%
13.9%
6.8%
5.4%
4.6%
3.9%
2.3%
2.0%
1.8%
1.6%
1.5%
1.2%
1.2%
1.2%
1.1%
United States
China
Russia
Germany
UK
Japan
India
France
Canada
Ukraine
Poland
Italy
South Africa
Mexico
Iran
Africa
Americas
Asia
Eurasia
Europe
Oceania
Percentage of total
(1.7 trillion tons)

Source: Union of Concerned Scientists (2021)