



# BHP

## Operational decarbonisation

21 June 2023

Merredin Solar Farm, Western Australia

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## Forward-looking statements

This presentation contains forward-looking statements, which may include, without limitation, statements regarding: (i) our strategy, our values and how we define success; (ii) our commitment to generating social value; (iii) our commitments under sustainability frameworks, standards and initiatives; (iv) our expectations, commitments and objectives with respect to sustainability, decarbonisation, natural resource management, climate change and portfolio resilience and timelines and plans to seek to achieve or implement such objectives, including our strategies, goals, targets, milestones and metrics to seek to reduce or support the reduction of greenhouse gas emissions, and related perceived costs, benefits and opportunities for BHP; (v) the assumptions, beliefs and conclusions in our climate change related statements and strategies, for example, in respect of future temperatures, energy consumption and greenhouse gas emissions, and climate-related impacts; (vi) trends in commodity prices and currency exchange rates; (vii) demand for commodities and our expectations of a competitive advantage for our business or certain products; (viii) reserves and resources and production forecasts; (ix) expectations, plans, strategies and objectives of management; (x) climate scenarios; (xi) assumed long-term scenarios; (xii) potential global responses to climate change; (xiii) the potential effect of possible future events on the value of the BHP portfolio; (xiv) approval of certain projects and consummation of certain transactions; (xv) closure or divestment of certain assets, operations or facilities (including associated costs); (xvi) anticipated production or construction commencement dates; (xvii) capital costs and scheduling; (xviii) operating costs and supply (including shortages) of materials and skilled employees; (xix) anticipated productive lives of projects, mines and facilities; (xx) provisions and contingent liabilities; and (xxi) tax and regulatory developments.

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For example, our future revenues from our assets, projects or mines which may be described in this presentation will be based, in part, upon the market price of the minerals or metals produced, which may vary significantly from current levels. These variations, if materially adverse, may affect the timing or the feasibility of the development of a particular project, the expansion of certain facilities or mines, or the continuation of existing assets.

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Numbers presented may not add up precisely to the totals provided due to rounding.

Due to the inherent uncertainty and limitations in measuring greenhouse gas (GHG) emissions and operational energy consumption under the calculation methodologies used in the preparation of such data, all GHG emissions and operational energy consumption data or references to GHG emissions and operational energy consumption volumes (including ratios or percentages) in this presentation are estimates. Emissions calculation and reporting methodologies may change or be progressively refined over time resulting in the need to restate previously reported data.

There may also be differences in the manner that third parties calculate or report GHG emissions or operational energy consumption data compared to BHP, which means that third-party data may not be comparable to our data. For information on how we calculate our GHG emissions and operational energy consumption data, see our Methodology tab in our ESG Standards and Databook (for the applicable year), available at [bhp.com](https://www.bhp.com).

Unless expressly stated, information and data in this presentation does not reflect BHP's acquisition of OZ Minerals Limited on 2 May 2023.

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In this presentation, the terms 'BHP', the 'Company', the 'Group', 'BHP Group', 'our business', 'organisation', 'we', 'us' and 'our' refer to BHP Group Limited and, except where the context otherwise requires, our subsidiaries. Refer to note 28 'Subsidiaries' of the Financial Statements in BHP's Annual Report for the year ended 30 June 2022 for a list of our significant subsidiaries. Those terms do not include non-operated assets. Notwithstanding that this presentation may include production, financial and other information from non-operated assets, non-operated assets are not included in the Group and, as a result, statements regarding our operations, assets and values apply only to our operated assets unless otherwise stated.

# BHP

## Operational decarbonisation Overview

**Dr. Graham Winkelman**

Head of Carbon Management, Sustainability & Climate Change



# Our focus on operational decarbonisation

Working with global partners and other stakeholders in the value chain

On track to reduce our operational emissions by at least 30% by FY30 from FY20 levels

We have an aspirational goal to achieve net zero operational emissions by 2050

## To succeed:

- technology must advance quickly from where it is now
- we must collaborate with our vendors and industry
- we must effectively integrate decarbonisation into all aspects of our business

The pathway to **net zero will be non-linear** as we grow the business

Working hard to find the **most capital efficient carbon abatement solutions**

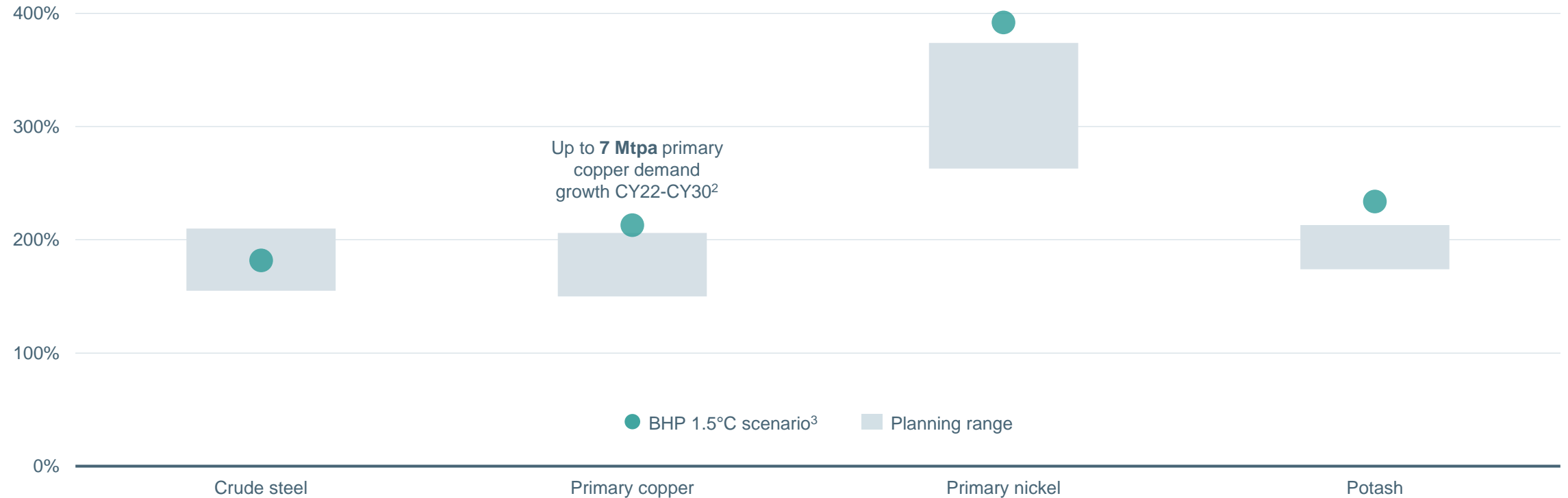


# Enabling the world's response to climate change

Metals and minerals are essential for the world to develop and achieve its decarbonisation ambitions

## Large cumulative demand increases across commodities<sup>1</sup>

(%, next 30 years compared to the last 30 years)



Source: BHP analysis; Vivid Economics.

1. Demand for crude steel does not infer equal demand for steel making raw materials.

2. Would require up to 10 Mtpa global mine capacity addition post depletion and grade decline.

3. BHP's 1.5°C scenario requires steep global annual emissions reduction, sustained for decades, to stay within a 1.5°C carbon budget. 1.5°C is above pre-industrial levels. For more information about the assumptions, outputs and limitations of our 1.5°C scenario refer to the BHP Climate Change Report 2020 available at [bhp.com](https://www.bhp.com). Signposts do not yet indicate the appropriate measures are in place to drive decarbonisation at the pace or scale required for us to assess achieving the aims of the Paris Agreement (including our 1.5°C scenario) as the most likely future outcome.

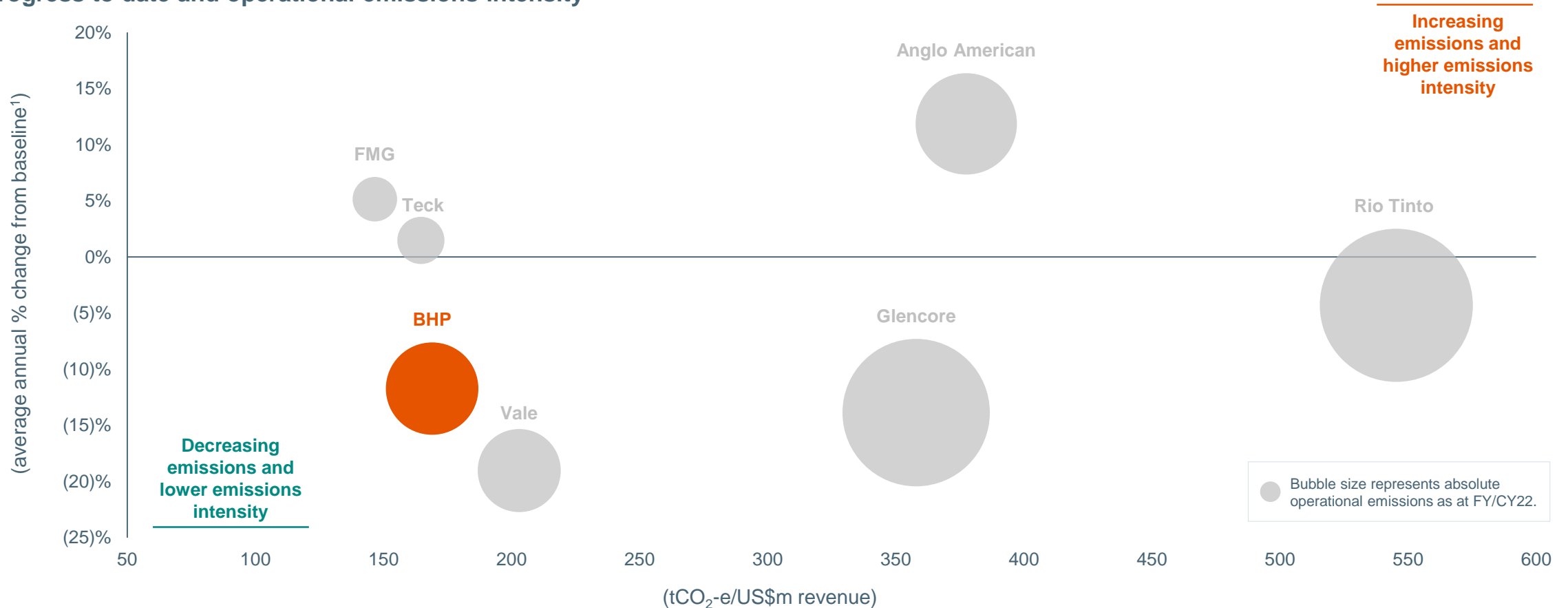
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# Good progress versus our competitors

Early action places BHP amongst the lowest absolute operational emissions relative to other major miners

## Progress to date and operational emissions intensity



Note: Average % change from baseline represents average annual decline of individual companies' emissions from baseline year to FY/CY22. Companies may have inherently different decarbonisation pathways, and timelines for those pathways, due to factors such as the composition of their business, the location of their operations, their mining methods, and their growth plans. BHP's business activity is expected to grow to FY30, which under the current circumstances would lead to some growth in operational emissions.

1. Baseline years: Anglo American – 2016, BHP – 2020, FMG – 2020, Glencore – 2019, Rio Tinto – 2018, Teck – 2020, Vale – 2017.

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# BHP is delivering on operational decarbonisation

We are working towards decarbonising our operations while supplying the minerals the world needs to deliver the energy transition



## Focus

Our FY30 target and 2050 goal set the direction to guide and challenge the business and provide clarity to suppliers, shareholders, and customers



## Action

We are actively working to develop and implement commercially feasible decarbonisation solutions



## Integration

Decarbonisation is factored into every business plan and portfolio management decision as we seek to ensure growth is compatible with a net zero world



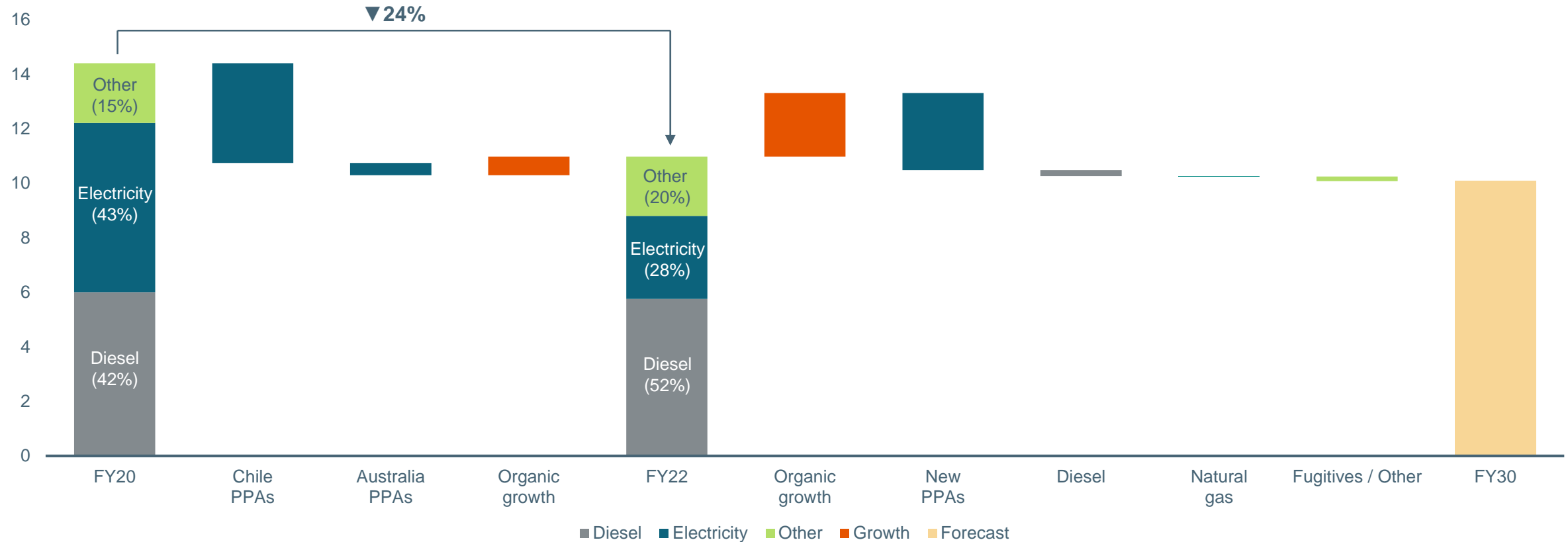
## Our Purpose

To bring people and resources together to build a better world

# Positive steps taken towards our FY30 target

BHP is firmly focused on reducing operational emissions and has made good progress to date

## Operational GHG emissions (Mt CO<sub>2</sub>-e)



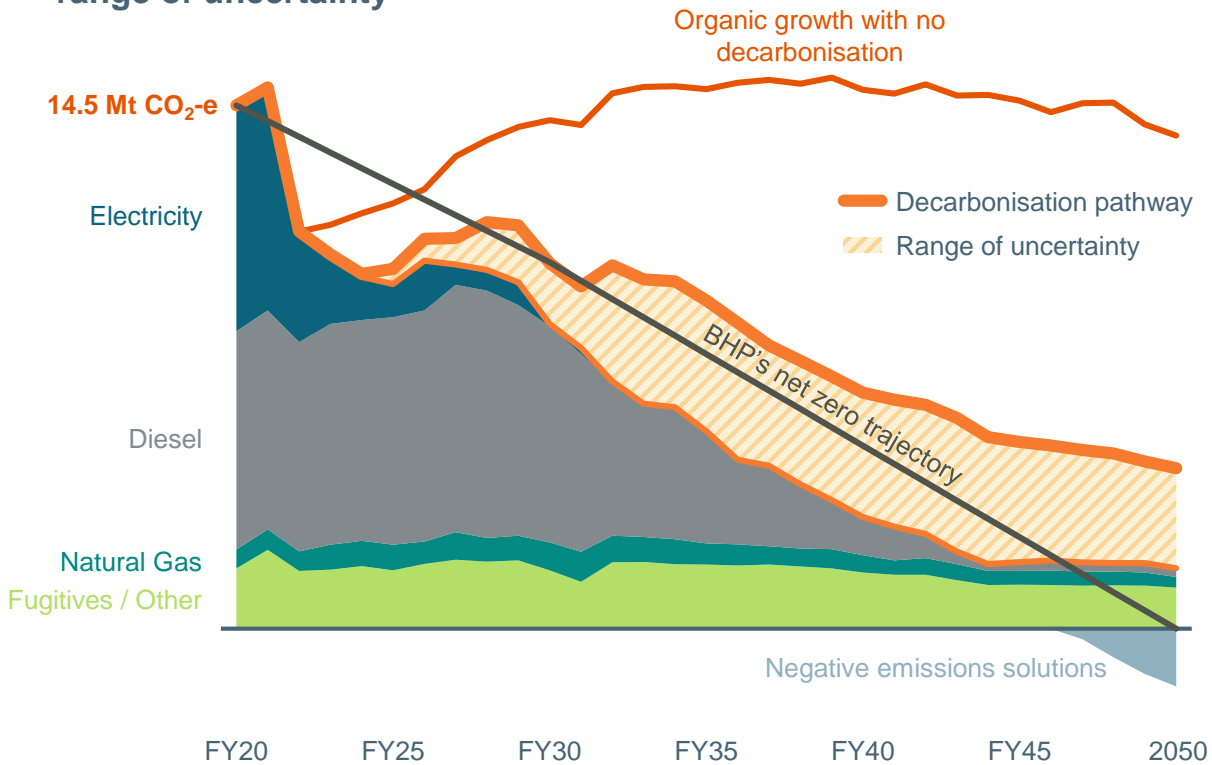
Note: Based on latest annual business plans. Excludes OZ Minerals assets and plans. FY20 GHG emissions data has been adjusted for divestments and methodology changes. PPA – Power Purchase Agreement. Organic growth represents increase in emissions associated with our operations. New PPA refers to emissions reductions from renewable PPAs already entered and/or intended to be signed with reductions occurring post FY22 and before FY30. Emissions calculation methodology changes may affect the information presented in this chart.



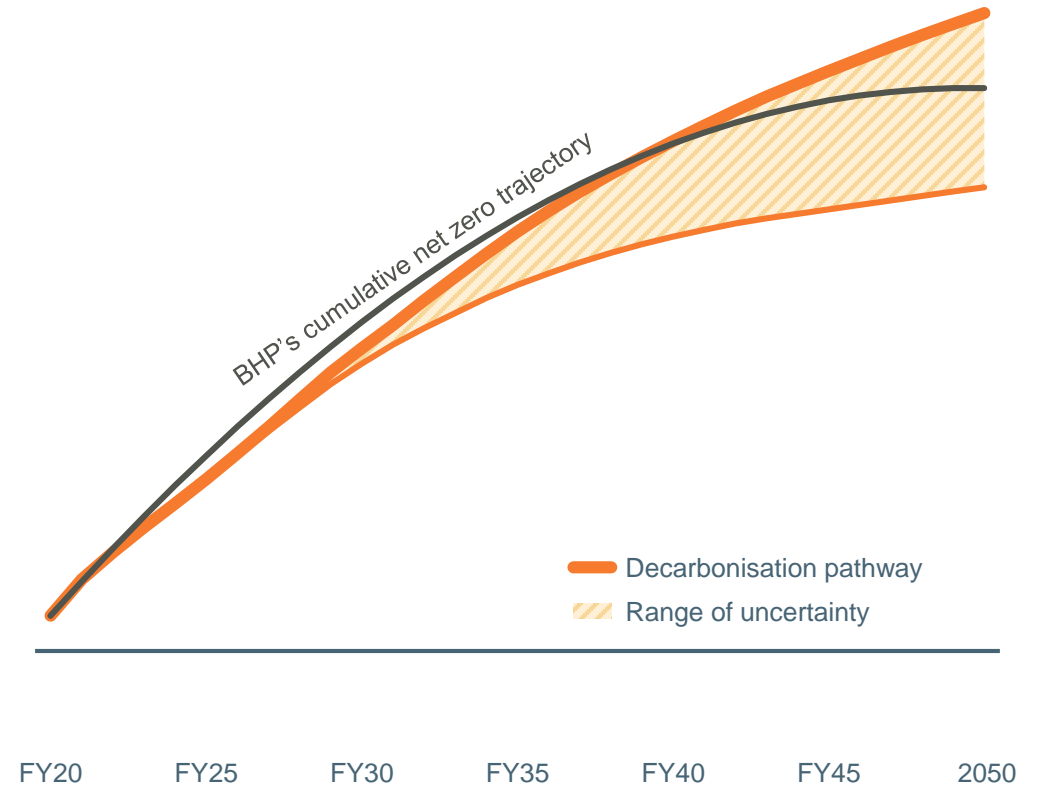
# BHP's operational decarbonisation trajectory

Decarbonisation will be non-linear and will require significant effort to overcome emissions growth and technology challenges

BHP's net zero trajectory: significant early action with future range of uncertainty



BHP's net zero cumulative emissions trajectory



Note: Future GHG emissions estimates are based on latest annual business plans. Excludes OZ Minerals assets and plans. FY20 GHG emissions data has been adjusted for divestments and methodology changes. Decarbonisation pathway represents planned decarbonisation activities to reach BHP's operational emissions target and goal. Organic growth with no decarbonisation represents business-as-usual emissions forecast without abatement projects. Range of uncertainty refers to higher risk options currently identified that may enable faster or more substantive decarbonisation, but which currently have a relatively low Technology Readiness Level (TRL) or are not yet commercially available. BHP's net zero trajectory refers to a straight line between our FY20 baseline, FY30 medium-term target, and 2050 net zero goal. Negative emissions solutions include carbon credits (avoidance, reductions or removals), or other technologies that result in emissions reductions; this shows the requirement in order to reach net zero if decarbonisation at the lower line of the 'Range of uncertainty' were achieved (but does not reflect probability). Emissions calculation methodology changes may affect the information presented in these charts. 'Fugitives/Other' estimated in accordance with the Australian National Greenhouse and Energy Reporting (NGER) measurement methodology and does not reflect the tendency for methane density to increase as coal mines deepen, due to current uncertainty with respect to future opportunities to manage methane at our BMA mines.

# BHP

## Operational decarbonisation

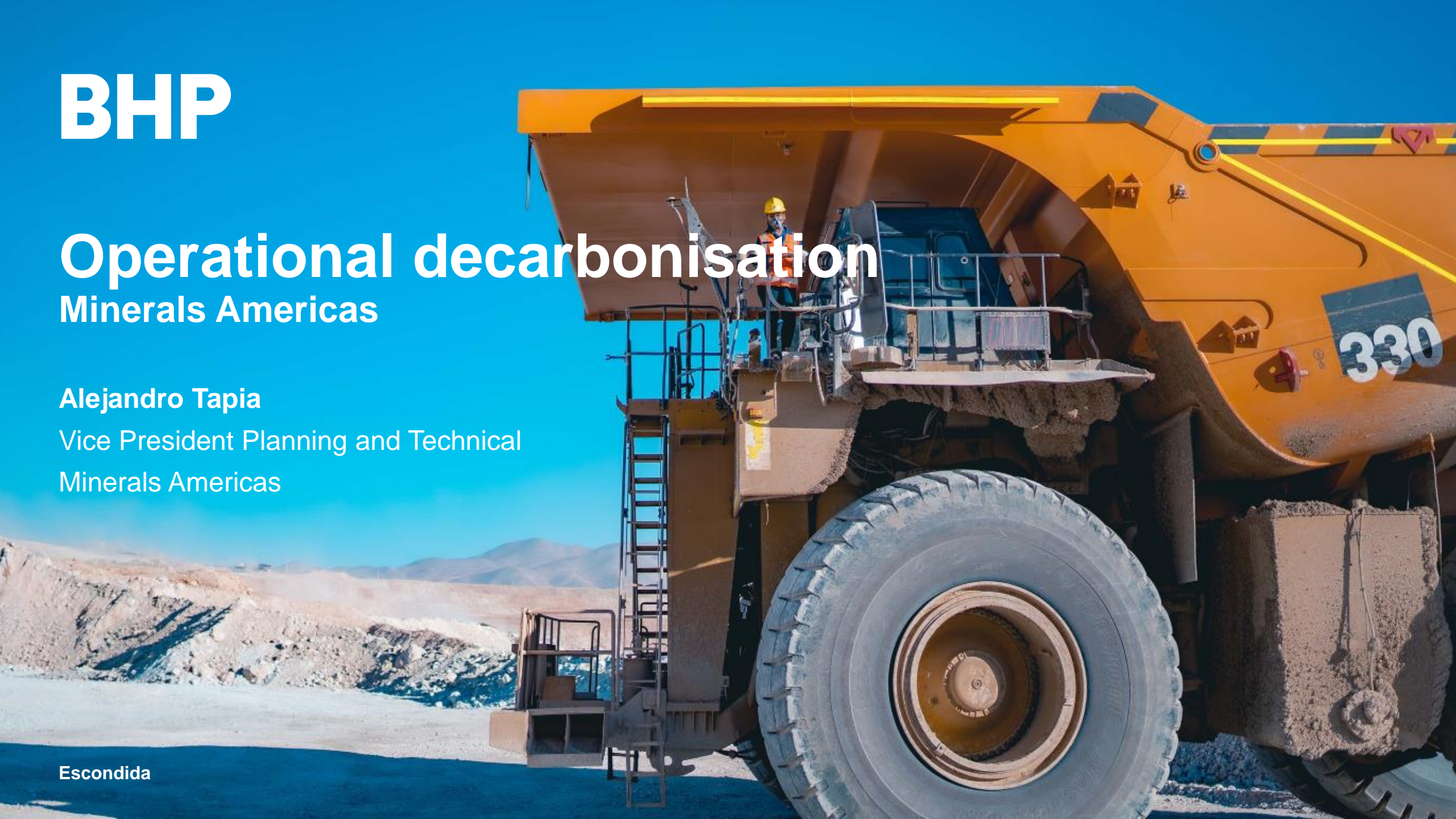
Minerals Americas

Alejandro Tapia

Vice President Planning and Technical

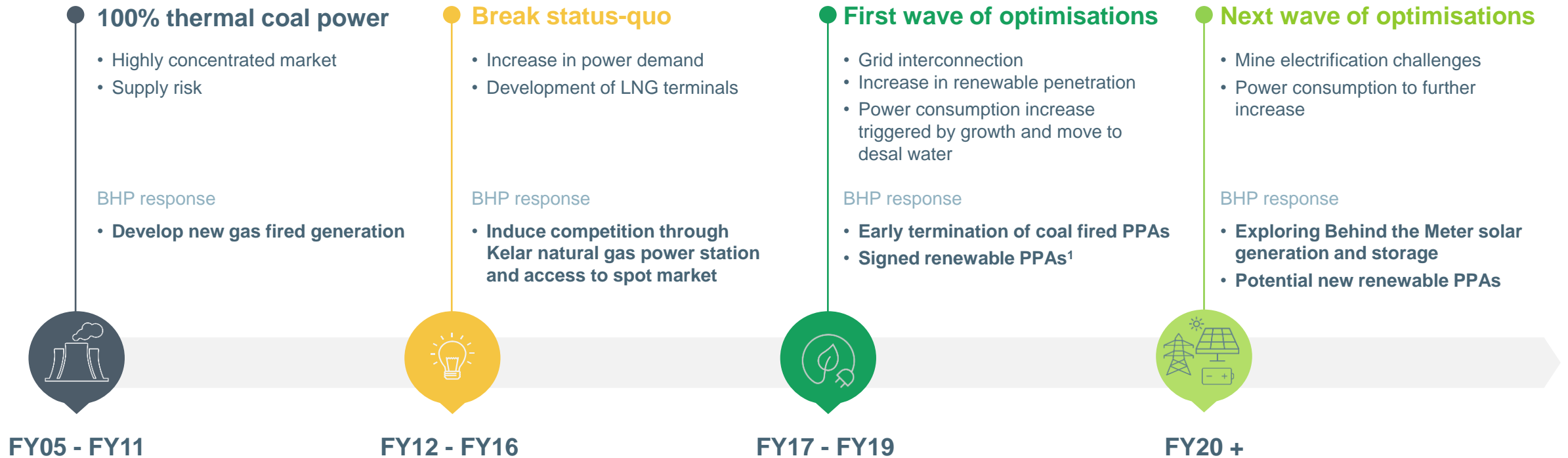
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Escondida



# BHP at the forefront of the sector's sustainability efforts

Facilitated region's move to renewable power, positioning operations for further electrification

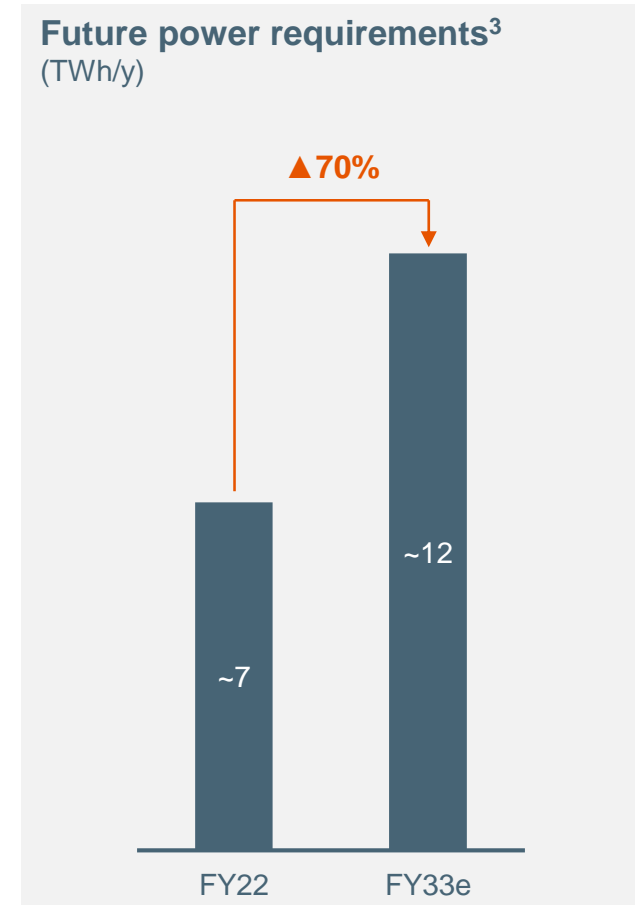
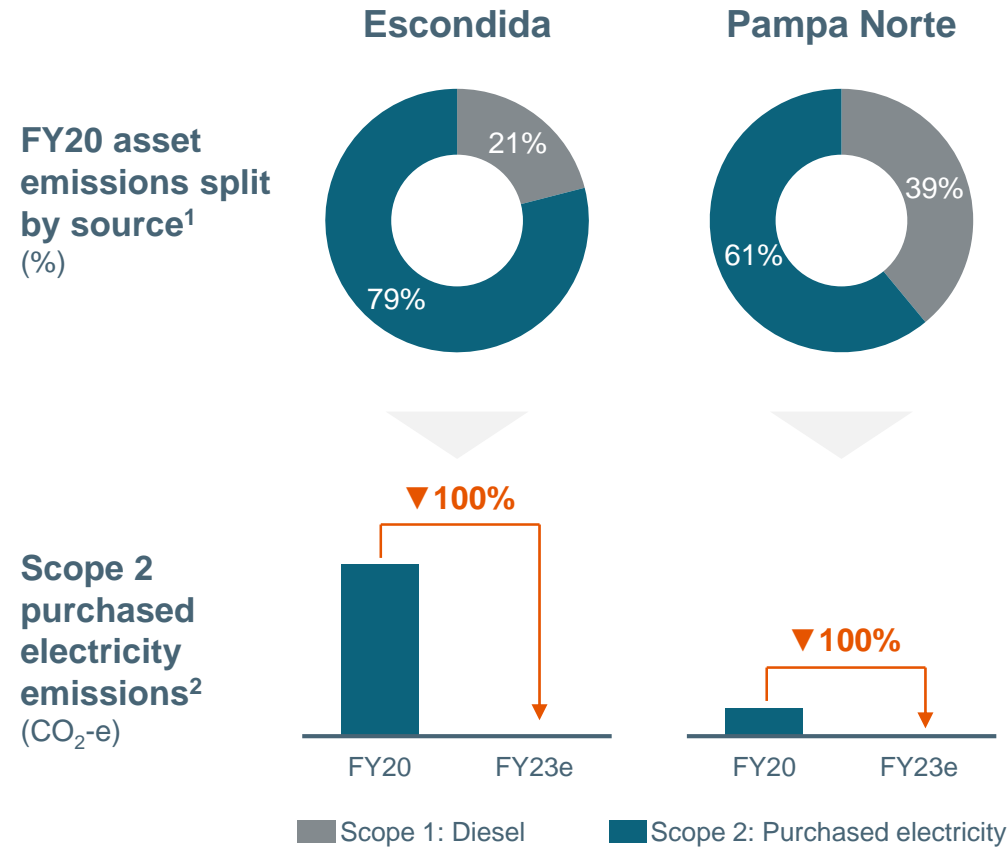
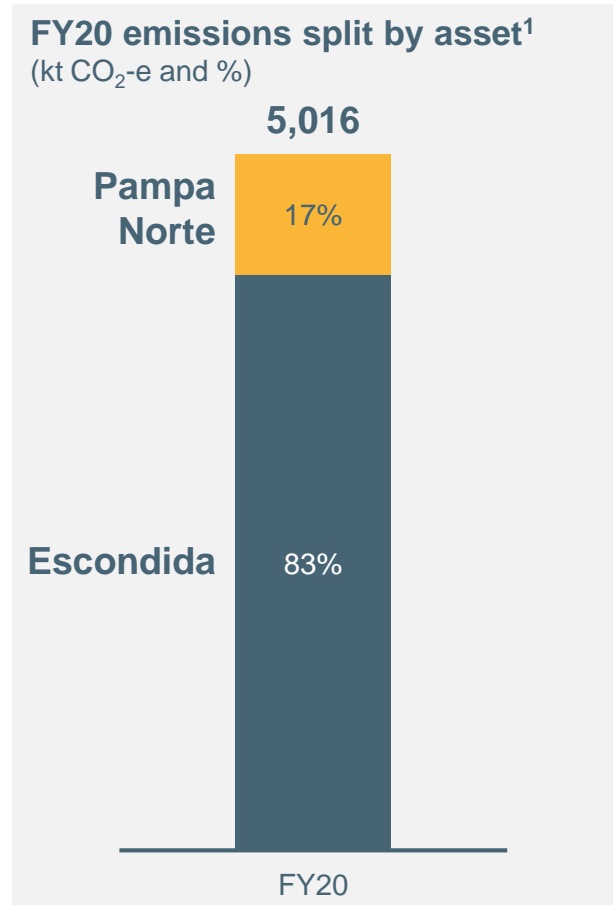


Significant change to move to renewable power: Escondida and Spence account for ~9% of total Chilean power demand

1. Power Purchase Agreements (PPAs) started in FY22.

# Chilean operational emissions snapshot

Early progress enhances competitiveness of future Scope 1 reduction projects



1. FY20 is the baseline year for BHP's Group-level FY30 operational emissions reduction target. Emissions are presented on a 100% basis as per the operational control approach described by the Greenhouse Gas Protocol Corporate Accounting and Reporting Standard, for example this includes 100% of Escondida's emissions (while BHP's ownership is 57.5%). Excludes projects, exploration, and legacy assets.
2. Escondida and Pampa Norte reported net-zero scope 2 GHG emissions throughout CY22 up until the end of May 2023. This position is expected to be maintained.
3. The expected increase in future power requirements includes growth projects and partial electrification to FY33. Forecast electricity consumption reflects our latest forecast and is subject to change as our estimates and mine plans evolve.

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# Displace 100% of diesel in boilers at cathode operations

First major step to displace Scope 1 emissions at Escondida and Spence in Chile

## > Project impact<sup>1</sup>

- Displace diesel consumption from CY25 in stationary equipment with zero-emission heat sources based on thermo-solar and electric boilers solution



Diesel displaced per year



Scope 1 emissions displaced per year<sup>2</sup>



Round trips by diesel trucks avoided per year



Total capex

## > Project scope



**Solar collectors** use solar radiation to heat a glycol-water fluid



**Electric solution** maintains stored fluid at 90°C in steel tanks



The heated water is connected to the existing boiler circuit in the Electrowinning plants



Escondida's project would be one of the **largest thermo-solar production facilities in the world**

## > Copper rollout

- Operations scheduled to start in CY25 at Escondida
- Execution approved for Spence to begin operations in CY26<sup>3</sup>
- Under review as a potential option for Cerro Colorado Life Extension<sup>4</sup>

1. Includes Escondida and Spence but excludes Cerro Colorado, which is transitioning to closure by December 2023, when its environmental licence expires.

2. Expected average between FY24 and FY30.

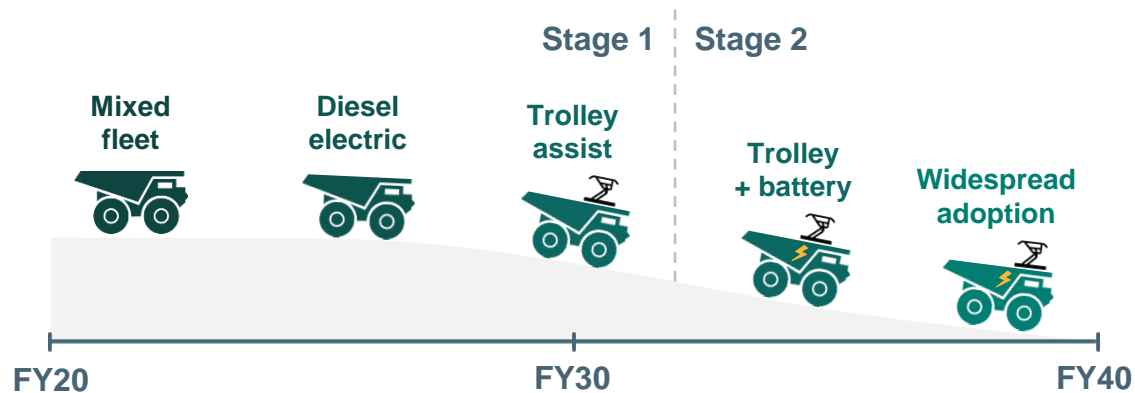
3. Commencement of rollout at Spence in CY26 is subject to environmental permit approval of leaching extension.

4. Cerro Colorado Life Extension is an option under study.

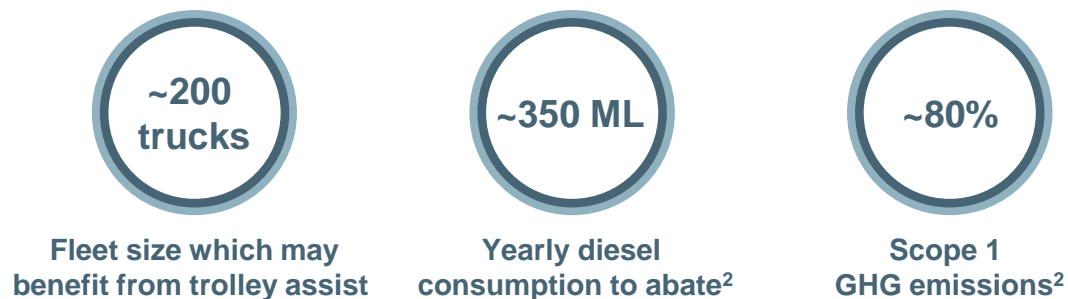
# Trolley assist to advance fleet decarbonisation in Chile

Trolley assist to aid in delivering FY30 operational emissions reduction target

## ➤ Electric fleet transition<sup>1</sup>



## ➤ Truck fleet at Escondida and Spence



1. This pathway depends on the commercial availability of the required technologies.

2. Expected average between FY24 and FY30.

3. To enable the corresponding diesel displacement, ~300GWh pa of renewable power is required. Haul truck emissions represent approximately 80% of Scope 1 emissions at Escondida and Spence.

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## ➤ Project definition

- Installation of electric trolley power lines to power the electric drives of diesel - electric trucks and dynamically charge the batteries of battery electric vehicle (BEV) trucks
- Implementation targeted to start at Escondida in FY28, and FY29 at Spence
- Signed agreement with Caterpillar and Finning to replace Escondida fleet over next 10 years

## ➤ Sources of value

- For Stage 1: ~30% reduction of haul truck emissions<sup>3</sup>
- For Stage 2: 100% reduction of haul truck emissions
- Increase speed of trucks and shorten haulage cycle
- Electric fleet enabler through dynamic charging

# Sustainable future: operations powered by renewables

Vision to maximise sustainability at Escondida and Spence over the next 10-15 years

Ambition includes...

## ➤ Electricity

- 100% renewable PPAs to power operations 24 hours per day, 7 days per week
- Behind the meter renewable electricity to reduce costs and transmission infrastructure



## ➤ Desalination

- Escondida and Spence concentrators supplied 100% by desalinated water
- Conveyance systems powered by renewable energy



## ➤ Diesel displacement

- Zero emissions material movement: trolley + batteries for haul trucks
- Thermo-solar solution executed to displace diesel used for cathode production



Note: Subject to further investigation of technical and commercial feasibility at scale and operational trials.

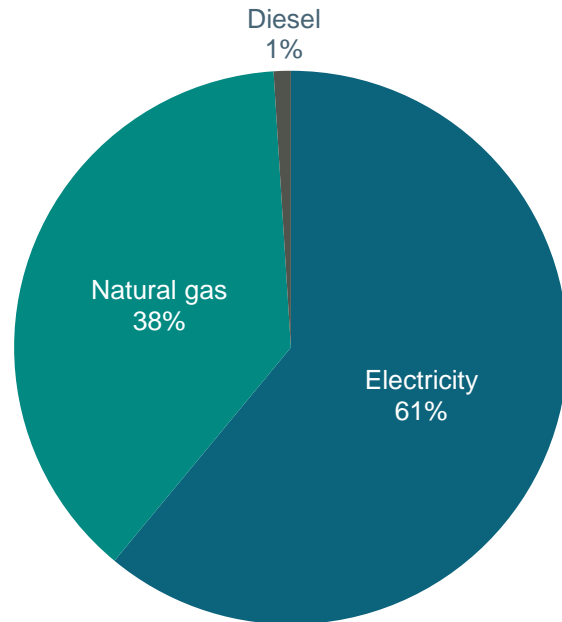
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# Potash: Jansen has a low emissions design

Designed to maximise sustainability, with low operational emissions, and to enable a path to net zero

## Stage 1 operational GHG emissions<sup>1</sup> (% emission source)



## ➤ Highly efficient from day 1

Jansen expected to emit  
**~50% less Scope 1**  
CO<sub>2</sub>-e emissions per tonne of product<sup>2</sup>  
vs. average performer in  
Saskatchewan basin

Underground mining and  
support fleet will be more than  
**80% battery  
electric vehicles**  
by consumption with plans to  
implement 100% electrification

## ➤ Investment in path to net zero

Working with local Saskatchewan  
Government to secure all power from  
**renewable and low  
emissions sources**  
for Stage 1, with options to scale  
for potential future stages

Pursuing **carbon-neutral  
electricity by 2035**  
through commercial partnerships  
with local businesses

1. Jansen Stage 1 operational GHG emissions as at FY30, based on SaskPower, BHP forecasts.

2. Jansen expected to emit ~0.025 tonne of Scope 1 CO<sub>2</sub>-e emissions per tonne of product, about half the average emissions of current Saskatchewan potash mines, including solution mines.



An aerial photograph of a BHP train carrying iron ore through a desert landscape. The train is a long line of orange and grey locomotives and freight cars, stretching from the bottom center towards the top of the frame. The surrounding terrain is arid, with sparse green and yellow vegetation and reddish-brown soil. The train is moving along a set of tracks that cut through the landscape.

# BHP

## Operational decarbonisation

### Minerals Australia

**Anna Wiley**

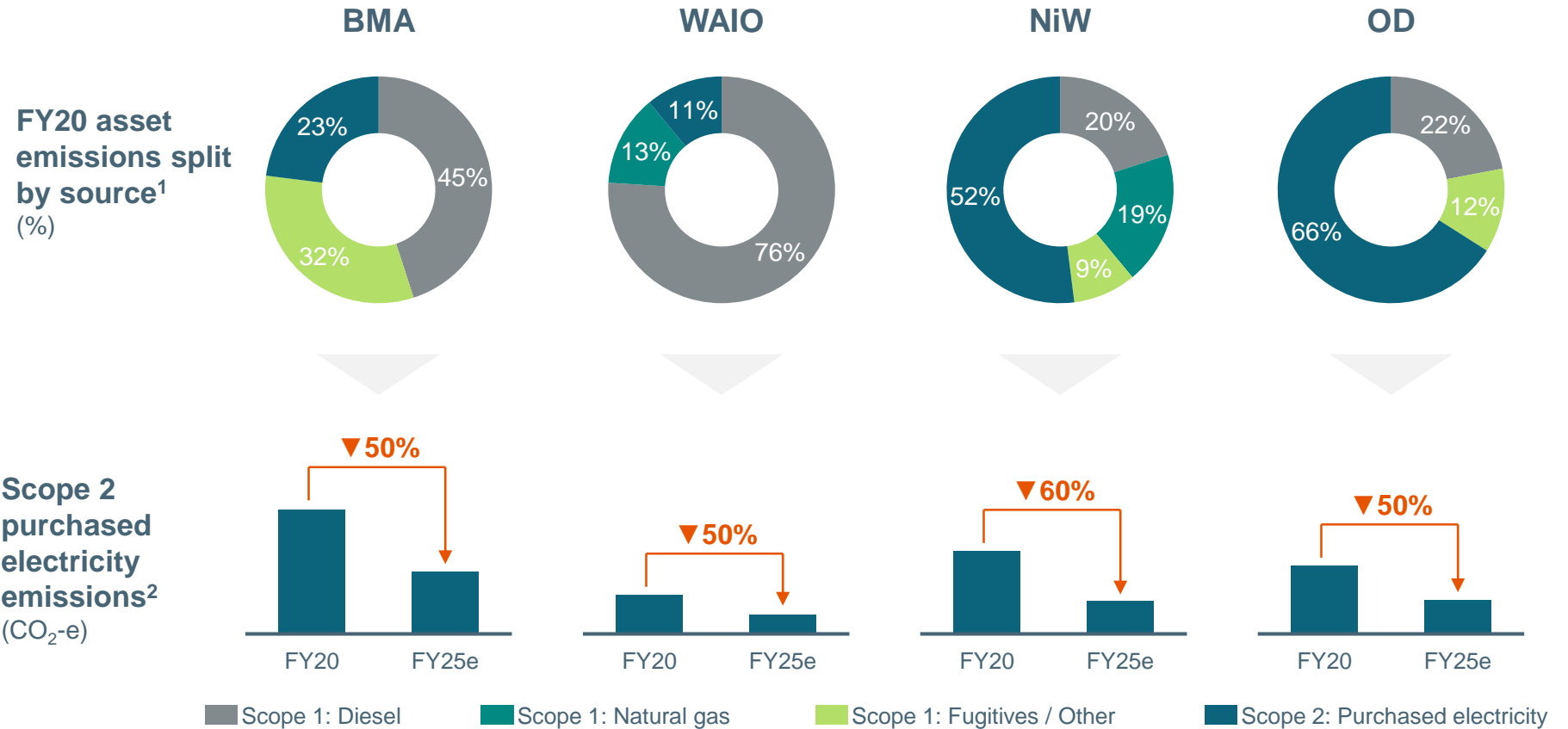
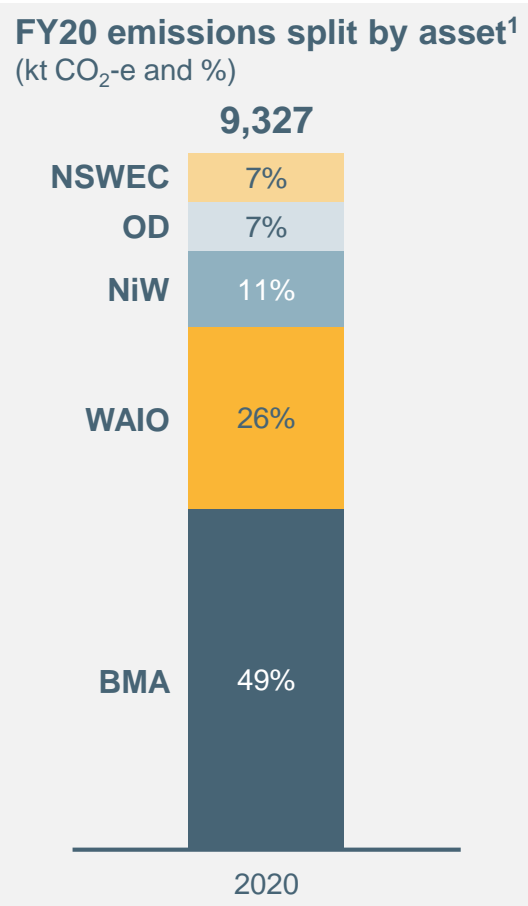
Vice President Planning and Technical

Minerals Australia

Western Australia Iron Ore

# Australian operational emissions snapshot

Strong progress made in reduction of Scope 2 emissions by signing multiple low emissions PPAs at Australian assets

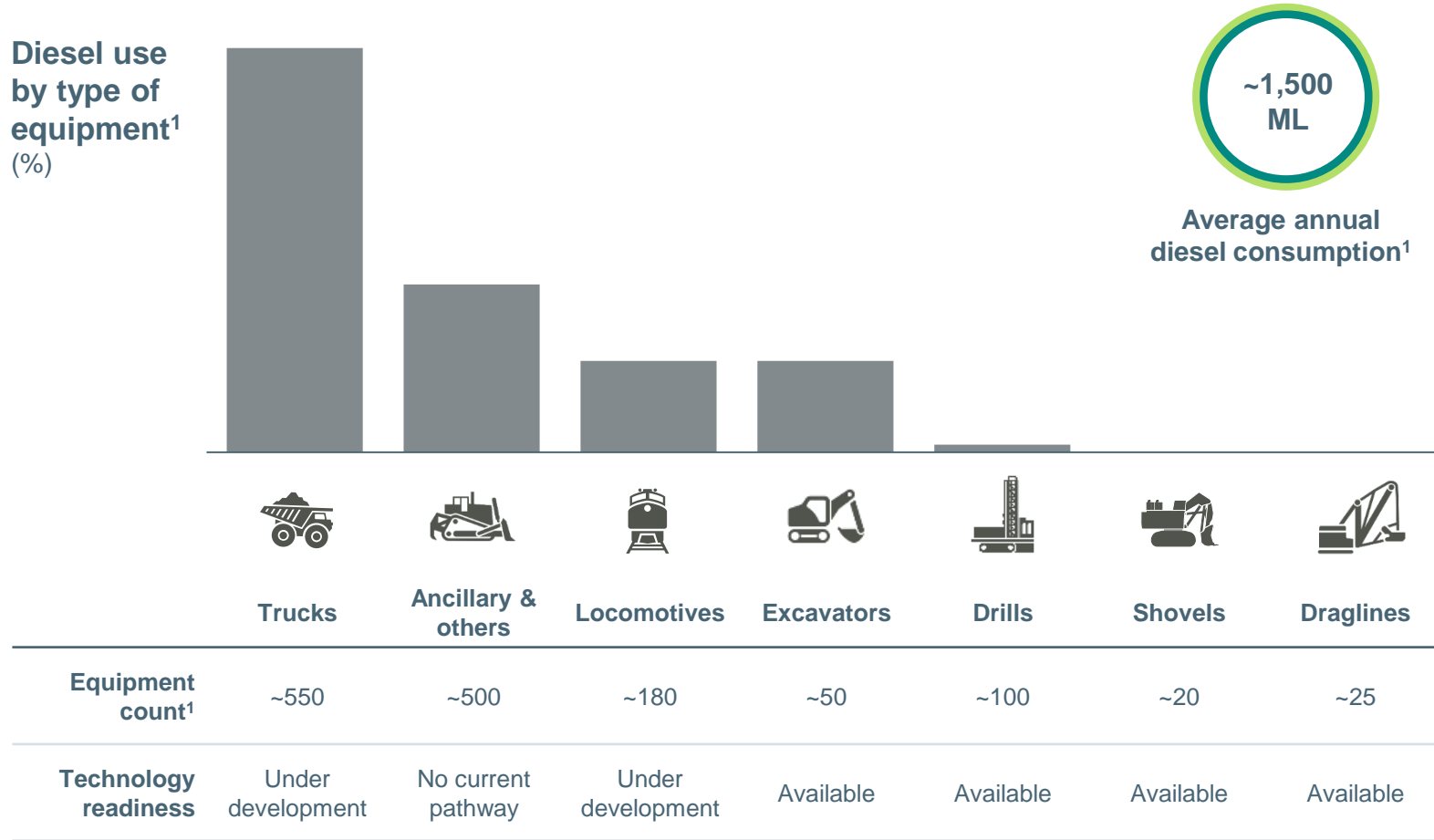


1. FY20 is the baseline year for BHP's Group-level FY30 operational emissions reduction target. Excludes OZ Minerals assets and plans. Emissions are presented on a 100% basis as per the operational control approach described by the Greenhouse Gas Protocol Corporate Accounting and Reporting Standard. For example, this includes 100% of BMA's emissions (while BHP's ownership is 50%). Excludes projects, exploration, and legacy assets.

2. Percentage reduction figures are estimates based on FY20 levels and calculated based on forecast electricity consumption, which is subject to change as our estimates and mine plans evolve. Percentage reductions based on PPAs already signed.

# Haul trucks are the largest user of diesel in Australia

Our preferred pathway to eliminate diesel is via electrification



Direct electrification is the most efficient<sup>2</sup>

Fuel source	Electricity	Hydrogen	Diesel
Fuel-to-tank efficiency	Large bubble	Medium bubble	Medium bubble
Tank-to-wheel efficiency	Large bubble	Small bubble	Small bubble
<b>Overarching efficiency<sup>2</sup></b> Fuel-to-wheel efficiency	~80%	~30%	~30%

1. Excludes OZ Minerals and NSWEC assets.

2. BHP analysis (based on modelling and initial studies). Bubble size represents estimated comparative efficiency.

# Partnering widely and building our knowledge base

Operational trials and collaboration with our vendors and industry to accelerate development are critical to success

	Partners	Operating prototype	BHP operating trial	BHP target deployment <sup>1</sup>
	Caterpillar	2022 <sup>2</sup>	2024	From 2028 <sup>3</sup>
	Komatsu	2021	~2025	
	Progress Rail	2022	2024	From 2029
	Wabtec	2021	2024	
	Liebherr	-	2024	~2027

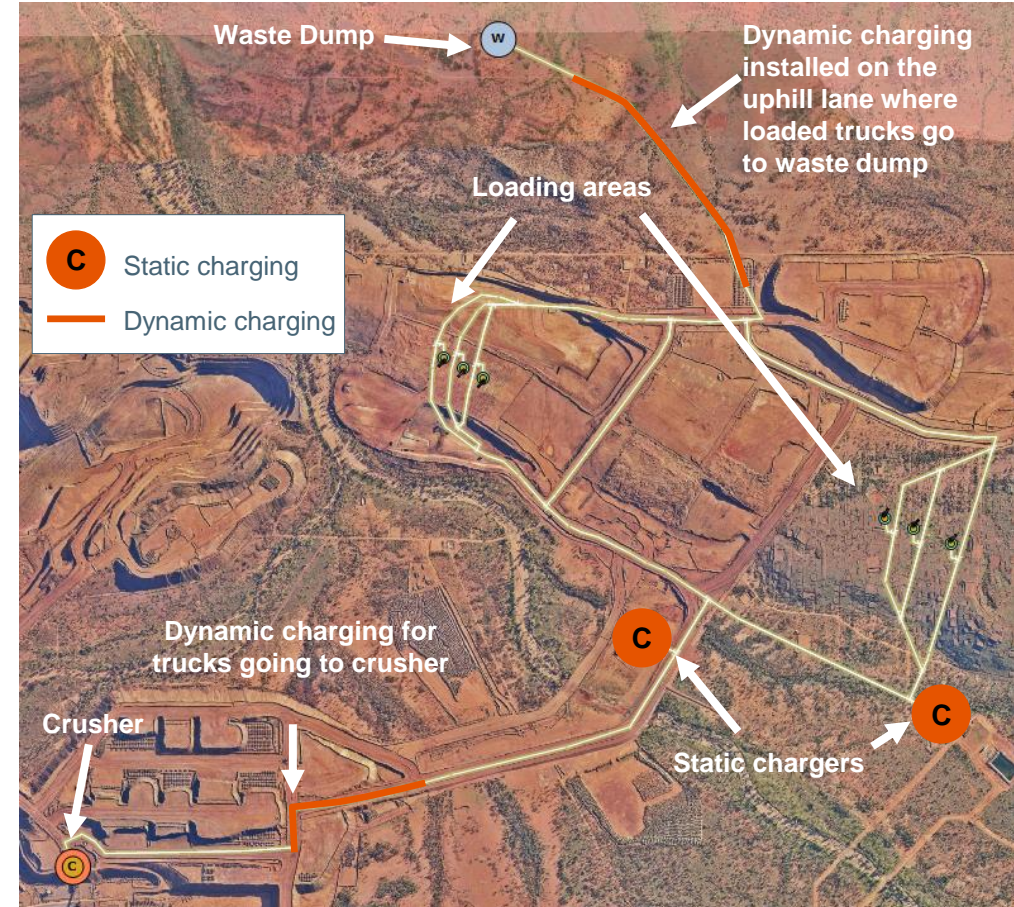
Note: Years shown are calendar years. All dates are approximate and subject to change.

1. Upon completion of successful trials.
2. At Caterpillar's Tucson, Arizona Proving Ground.
3. Smaller pilot fleets may be deployed earlier, subject to technology readiness.
4. Modelling is indicative, based on current assumptions and subject to change.

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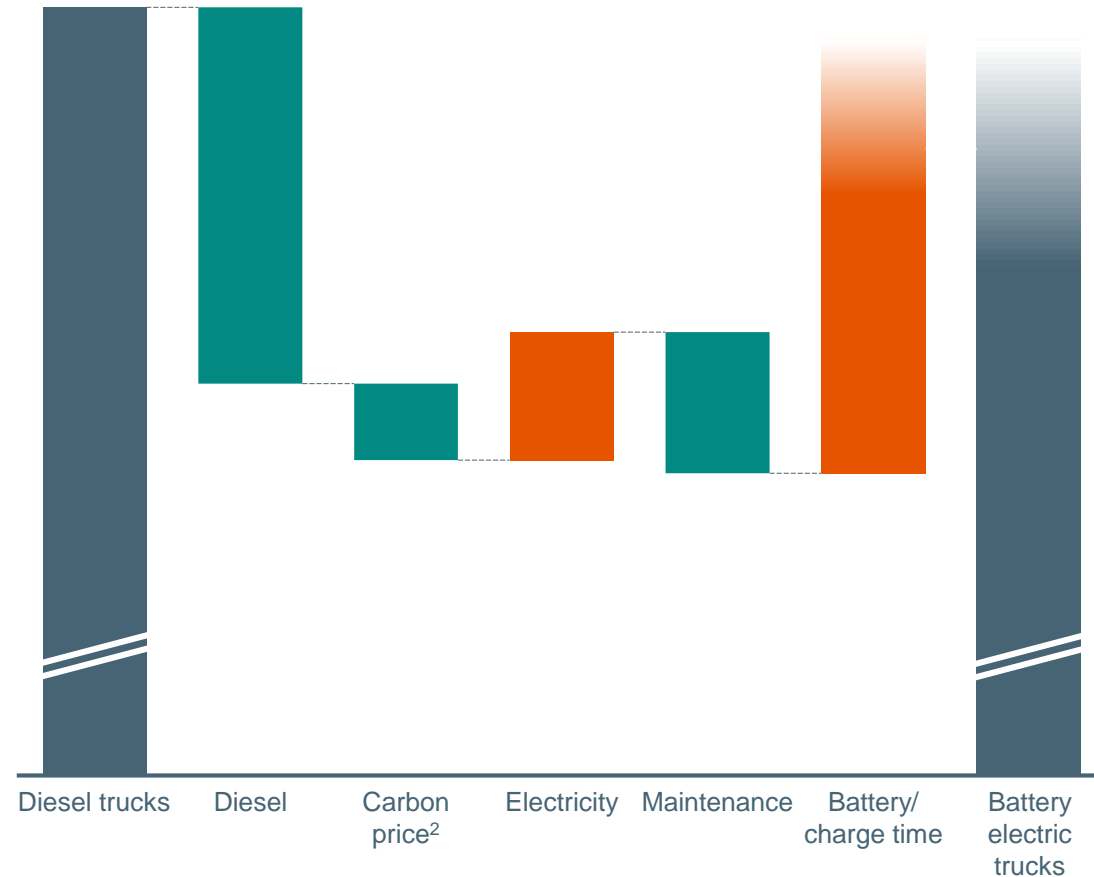
Concept of Operations modelling showing potential locations of charging stations<sup>4</sup>



# Battery truck opex expected to be comparable to diesel

Understanding of battery electric truck operating costs are developing and we will learn more through operational trials

Opex changes between diesel and electric truck fleet<sup>1</sup>



1. Representative of an open cut mine site.  
2. Representative carbon price of ~US\$50/t.

## > Fuel source

- Removes the need to purchase diesel and any associated carbon price
- Electric trucks are expected to have ~2x engine efficiency versus diesel trucks

## > Maintenance

- Reduced spend on maintenance as battery trucks have fewer moving parts

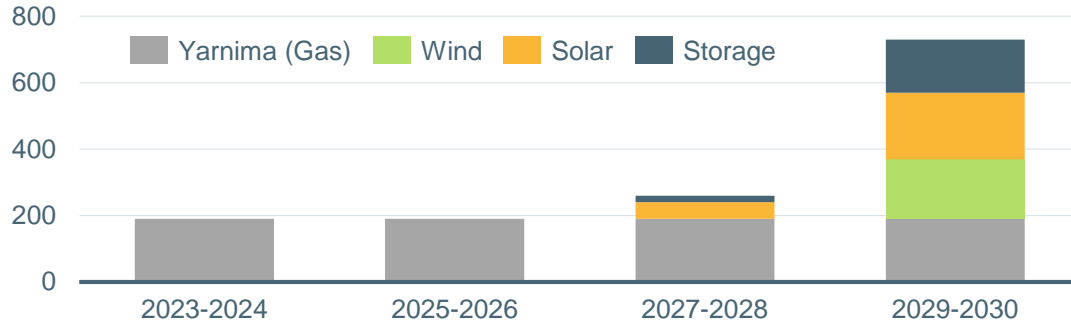
## > Unknowns

- Battery electric trucks may require charging more frequently, which could require more truck hours to produce same volumes
- Battery life will potentially be shorter than truck life, in which case batteries will need to be replaced
- Operational trials will help us learn more about battery management and battery truck operation

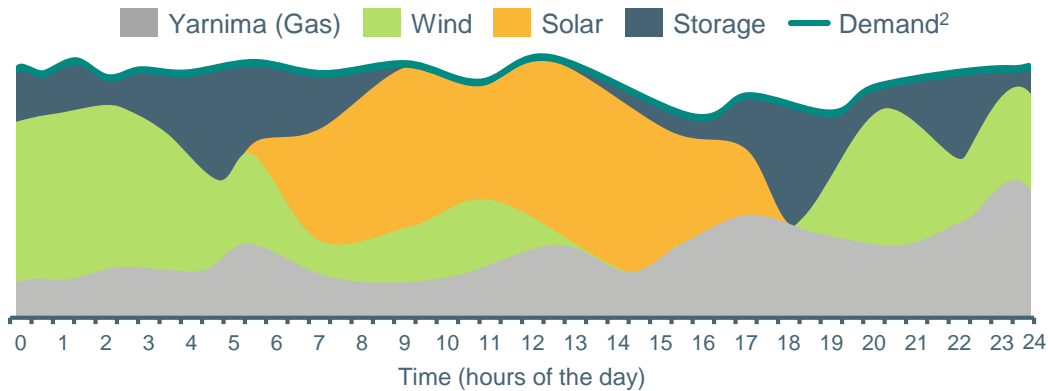
# Powering our mines in the Pilbara

We are working on technical solutions to meet the growing demand for power due to fleet electrification

Indicative future Pilbara installed generation<sup>1</sup>  
(MW)



Indicative power sources over a typical day in 2030<sup>2</sup>  
(MW)



- Our inland Pilbara operations are not connected to an electricity grid
- Power is currently supplied by our highly efficient 190MW Yarnima gas fired power station, which emits over 35% less CO<sub>2</sub>/MWh than the Australian average
- Planning for up to 500MW additional renewable generation and storage capacity installed by the end of the decade
- Yarnima will be required to provide power during periods of lower renewable generation
- Exploring options for interconnection to the NWIS<sup>3</sup> electricity grid in the future

1. Subject to renewable resource assessments and approvals.

2. Based on forecast electricity consumption, which is subject to change.

3. North West Interconnected System.

## Operational decarbonisation

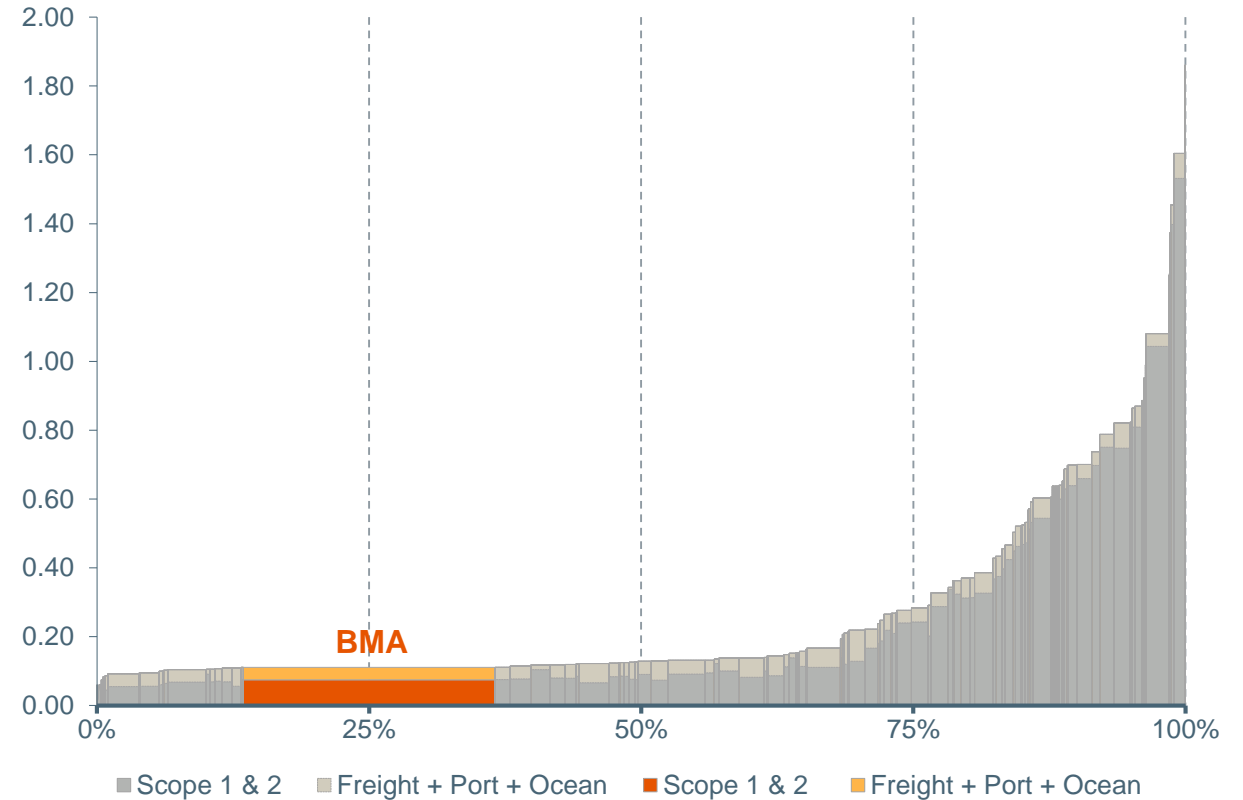
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# Addressing methane emissions

## BMA's higher quality metallurgical coal helps steel mills reduce their own emissions intensity

- Methane accounted for 32% of BMA's and 15% of Minerals Australia's reported operational emissions for FY20<sup>1</sup>
- BMA is one of the lowest carbon intensity emitters among our global coal competition
- With currently available technology, we anticipate that up to 50% of BMA's total forecast methane emissions could be extracted and actively managed
- We are accelerating work to understand the characteristics of this gas and determine its optimal use, including:
  - using it for safe, reliable and relatively low emission power generation
  - selling it for use in other industrial processes
- We are exploring new and innovative technology options to allow us to extract and manage the remaining forecast methane emissions

**2021 carbon intensity – metallurgical coal**  
(Tonnes CO<sub>2</sub>-e per tonne of saleable metallurgical coal)



Source: Skarn Associates; 2022 BHP Annual Report.

1. FY20 is the baseline year for BHP's Group-level FY30 operational emissions reduction target. Excludes OZ Minerals assets and plans. Emissions are calculated on a 100% basis as per the operational control approach described by the Greenhouse Gas Protocol Corporate Accounting and Reporting Standard. For example, this includes 100% of BMA's emissions (while BHP's ownership is 50%).

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# BHP

## Operational decarbonisation

### Decision Evaluation

Patrick Collins

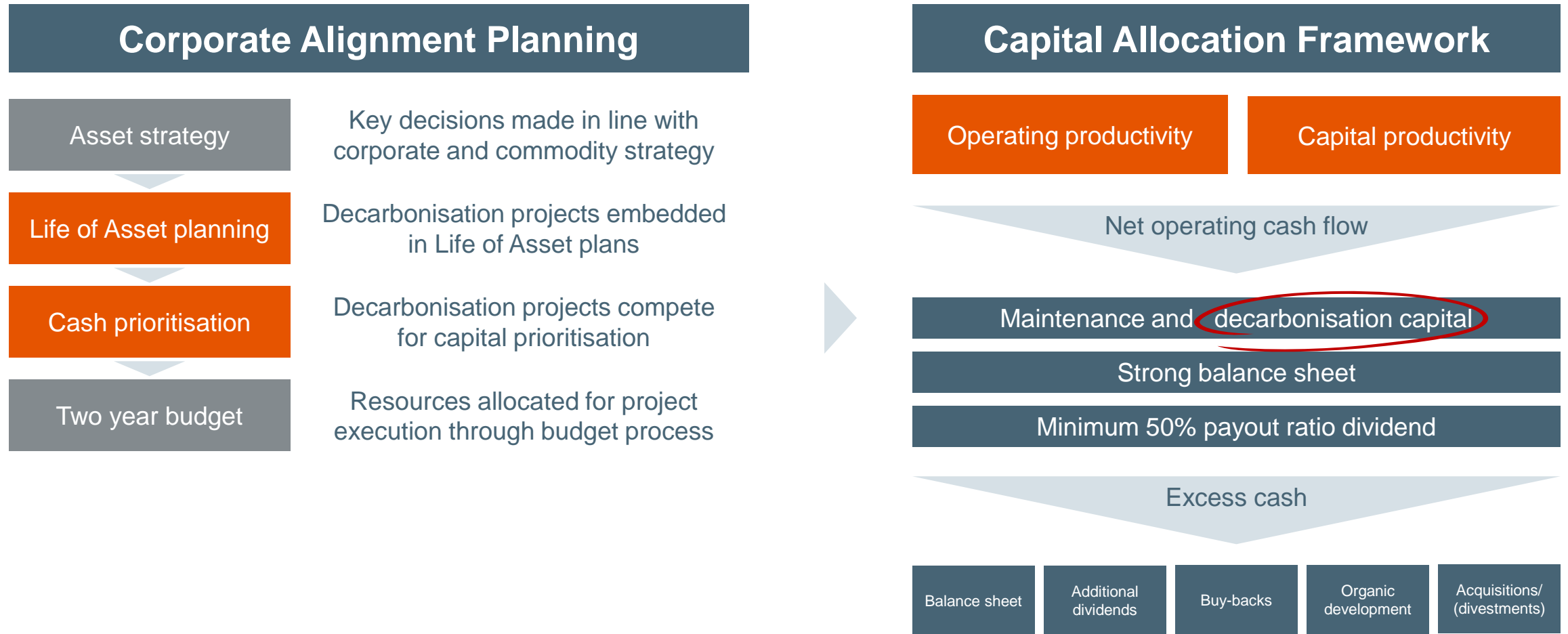
Head of Decision Evaluation

Transformation Portfolio & Performance



# Operational decarbonisation is owned by our assets

Decarbonisation commitments are embedded in mine plans for all operated assets

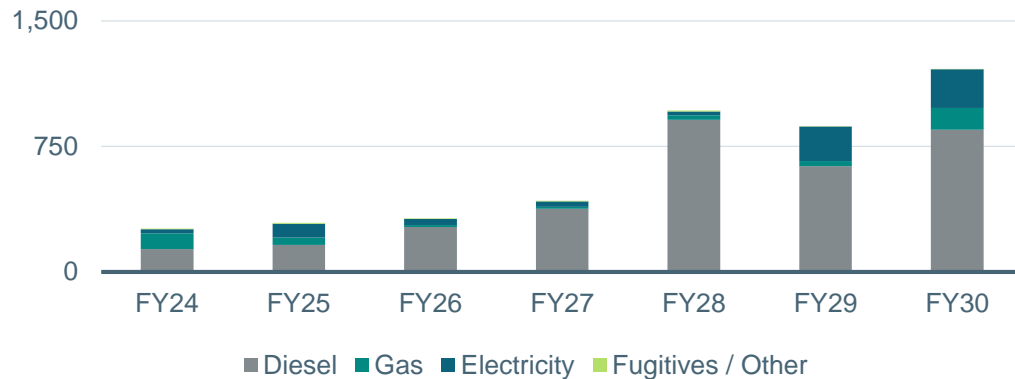


# Operational decarbonisation capital expenditure

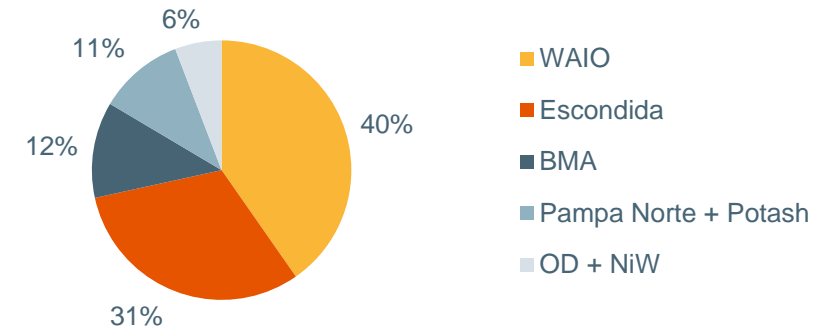
Decarbonisation investments compete for capital under the Capital Allocation Framework

Expected capital expenditure to FY30<sup>1</sup>  
**~US\$4 billion**  
 Majority of spend toward end of decade allowing technology to mature

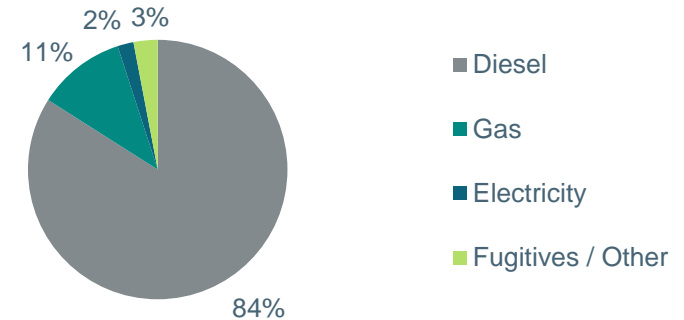
Capital expenditure to FY30 by emissions source  
 (US\$m, nominal, consolidated<sup>1</sup>)



Capex spend FY24 - FY30 by asset



Emissions reduction contribution by project type, FY31 - FY50



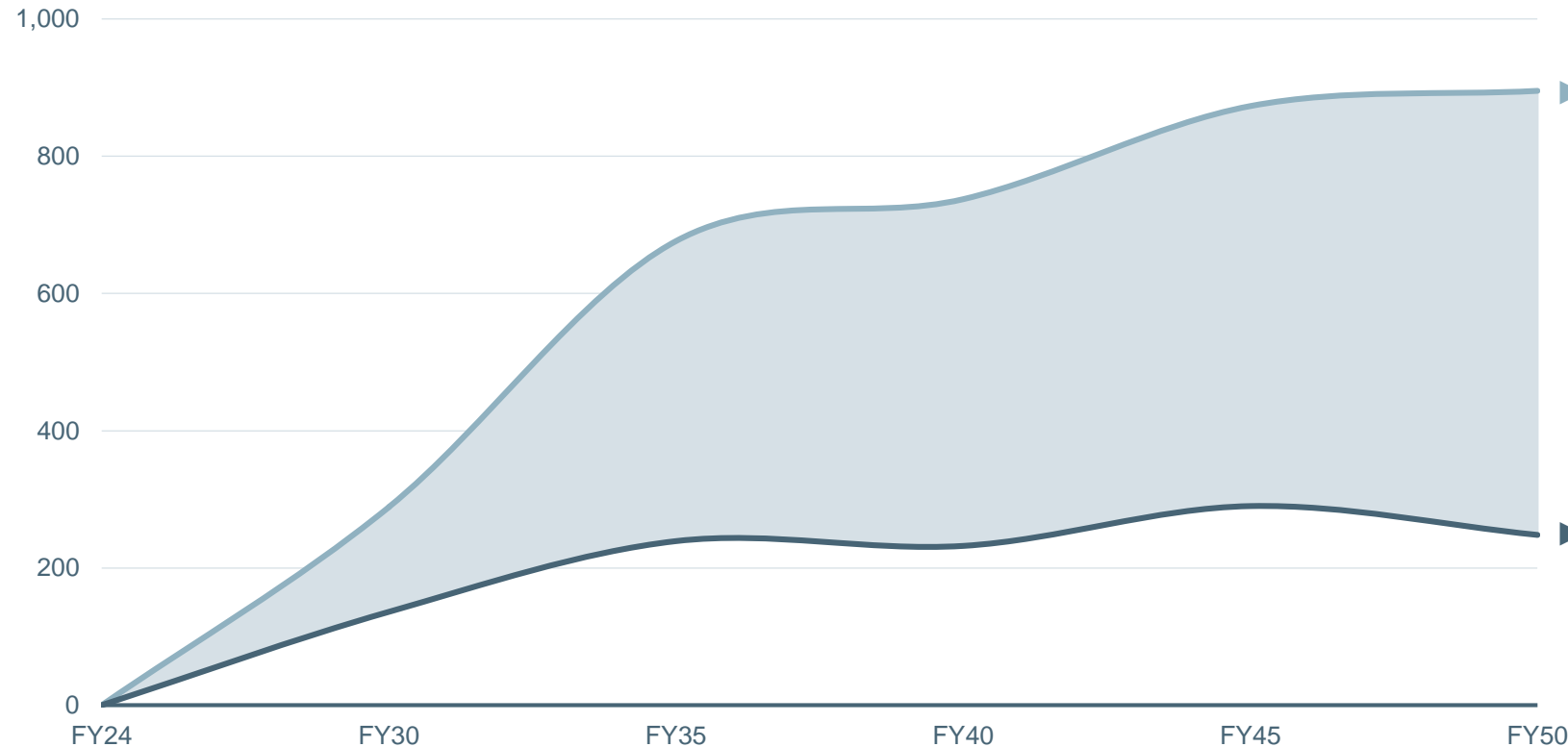
Note: Spend to FY30 based on latest annual business plans. Excludes OZ Minerals assets.

1. Nominal, consolidated allocation equity share, except Escondida at 100% share. Diesel capital expenditure represents incremental spend above Internal Combustion Engine replacement costs and supporting site infrastructure.

# Operating cost savings from future investments to FY30

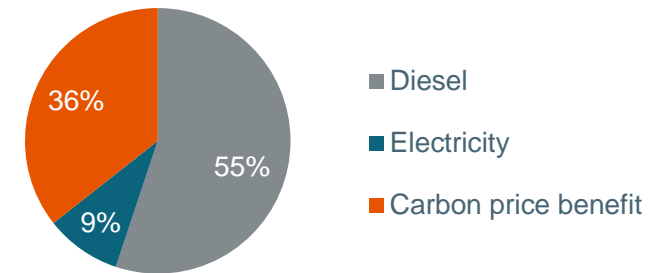
Majority of savings expected to be realised post-2030, driven by technology-reliant diesel reduction projects and carbon price benefits

**Potential net opex savings - projects with investment FY24 - FY30<sup>1</sup>**  
(US\$m, real (1 Jan 23), BHP share)

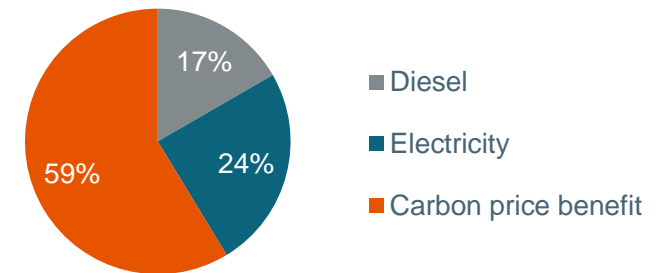


**Potential opex savings<sup>2</sup> by project type**  
(Average FY31-FY50)

► **Projects with allocated spend FY24 - FY30**



► **Projects excluding fleet and rail electrification**



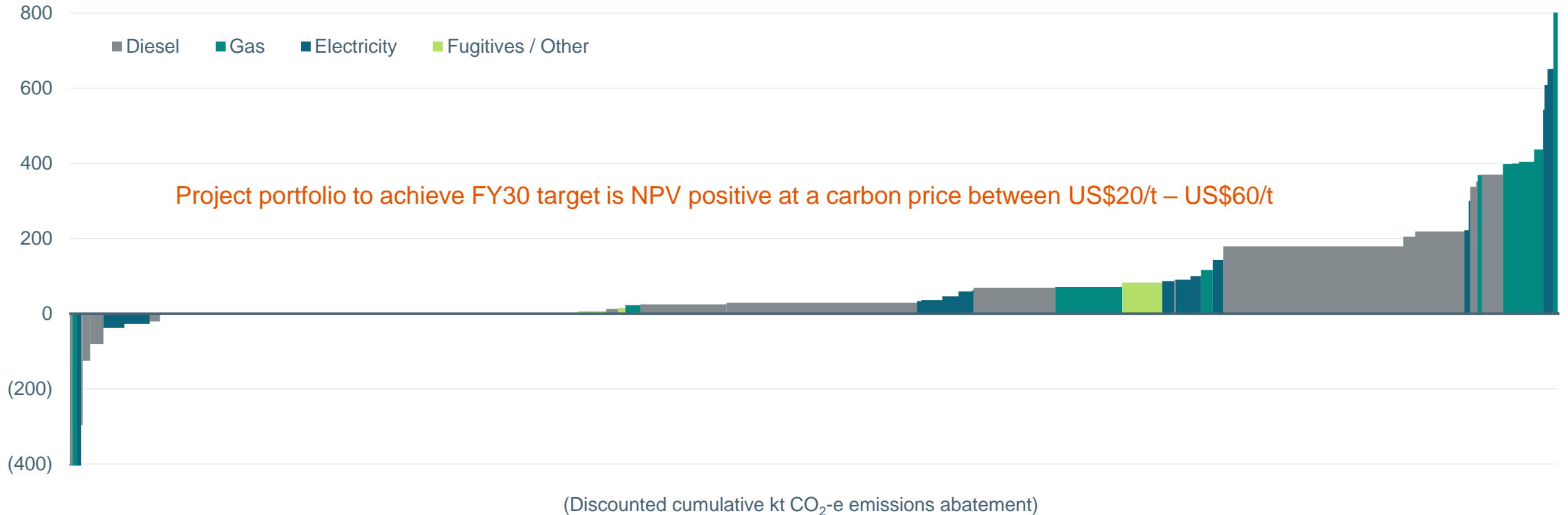
1. Based on latest annual business plans. Projects have ongoing sustaining capital spend beyond FY30.

2. Based on flat carbon price US\$50/t.

# Marginal Abatement Cost Curve

Our group portfolio Marginal Abatement Cost Curve allows us to rank and prioritise projects for efficient capital deployment

Marginal Abatement Cost Curve<sup>1</sup>  
(US\$/tCO<sub>2</sub>-e)



1. Marginal Abatement Cost (MAC) Curve includes projects with planned investment FY24-FY50. MAC Curve reflects discounted present cost of capital investment and operating cost savings (excluding carbon price benefits) and discounted emission tonnes for the life of the assets. Reflective of carbon price needed for abatement portfolio to be cost neutral. Note that outliers with immaterial emissions impact have been removed from the chart.

# Our focus on operational decarbonisation

Working with global partners and other stakeholders in the value chain

On track to reduce our operational emissions by at least 30% by FY30 from FY20 levels

We have an aspirational goal to achieve net zero operational emissions by 2050

## To succeed:

- technology must advance quickly from where it is now
- we must collaborate with our vendors and industry
- we must effectively integrate decarbonisation into all aspects of our business

The pathway to **net zero will be non-linear** as we grow the business

Working hard to find the **most capital efficient carbon abatement solutions**



**BHP**