

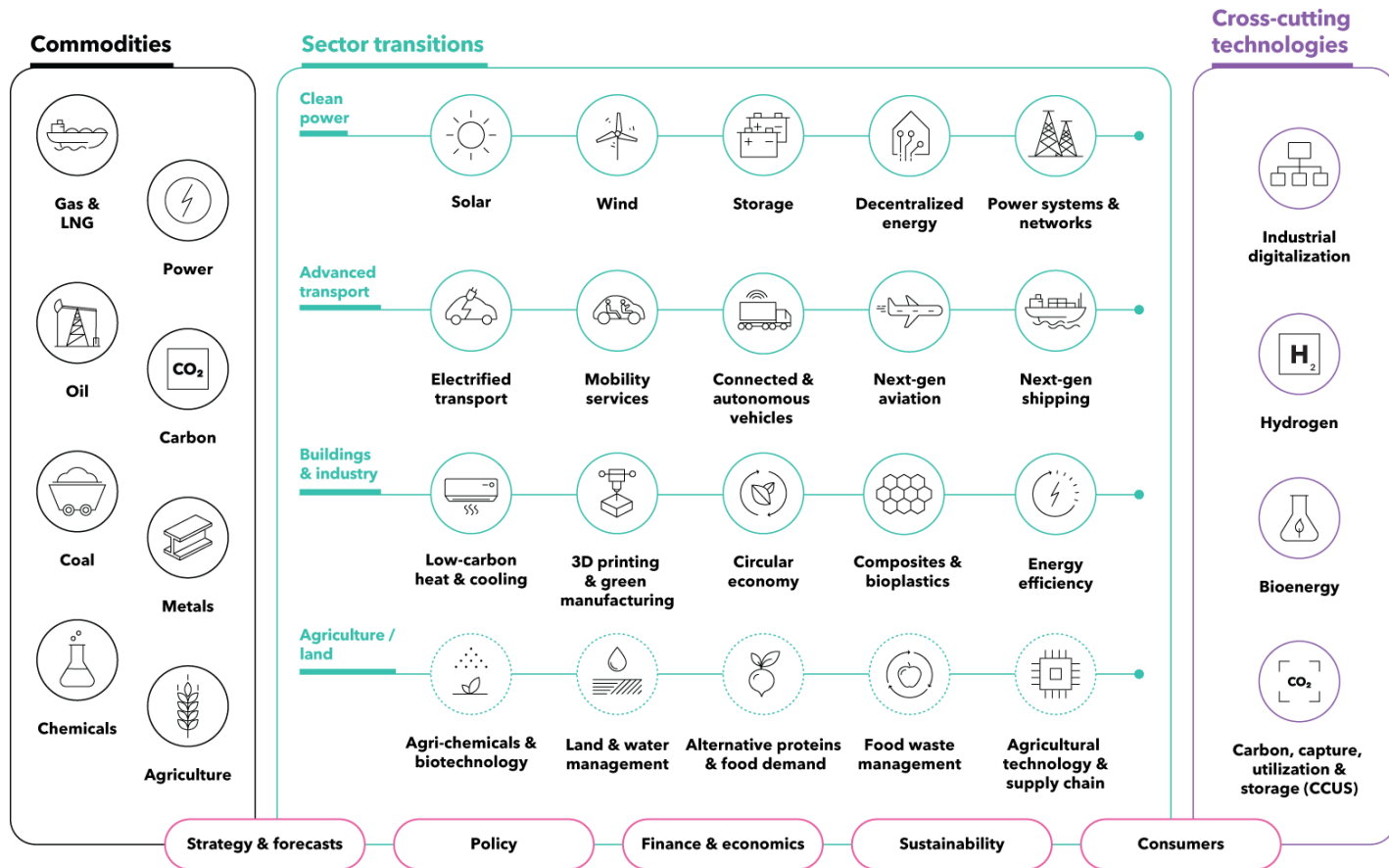
Digitalization in Mining

Danya Liu

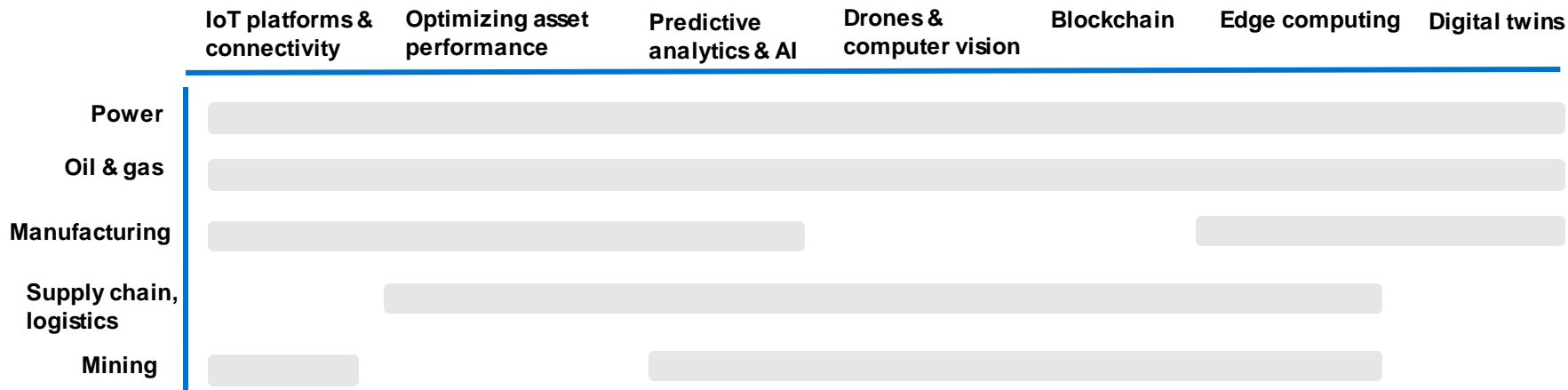
BloombergNEF

BNEF coverage

Strategies for a cleaner, more competitive future



Digital Industry

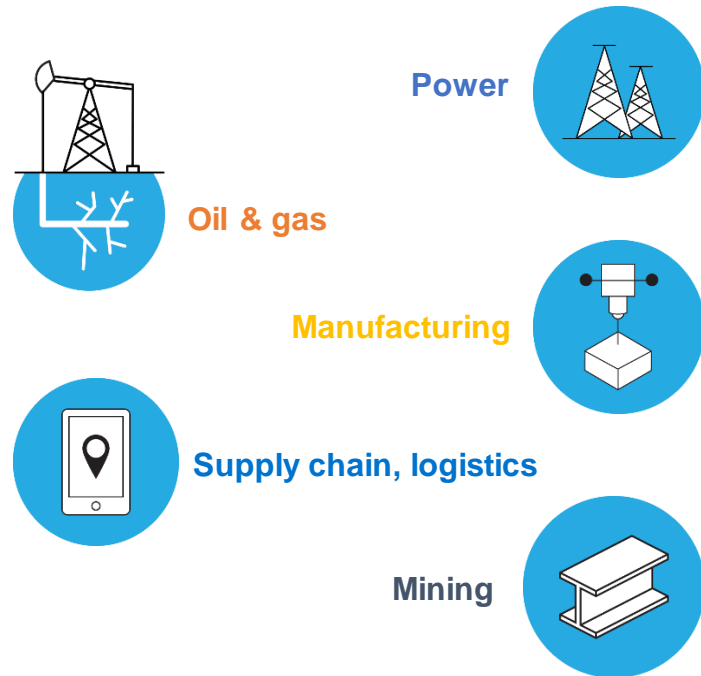


Competitive landscape and strategies

- Digital technology startups
- VC/PE, M&A flows
- Hardware to software business transformation
- Company and country rankings
- IoT platform differentiation
- Industrial business strategy & transformation
- 'As a service' business models
- Regulation & policy
- Data-centric business models
- National technology strategies
- Incubators, accelerators and strategic investor strategies

Why do digital?

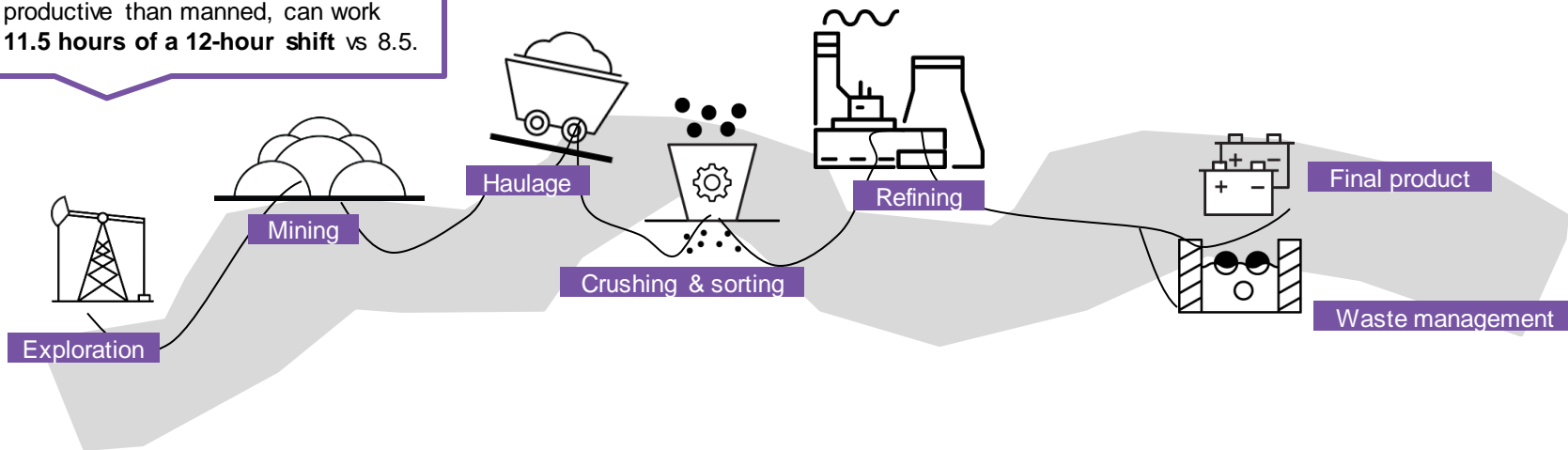
1. Reduce uncertainty and minimize losses
2. Automate regulatory requirements
3. Generate new value and outpace competitors
4. Shift the business model



Source: BloombergNEF

Tracking efficiency improvements

Sensors on drill bits reduce mapping time from **months to weeks**.
Autonomous drills **10-20%** more productive than manned, can work **11.5 hours of a 12-hour shift** vs 8.5.

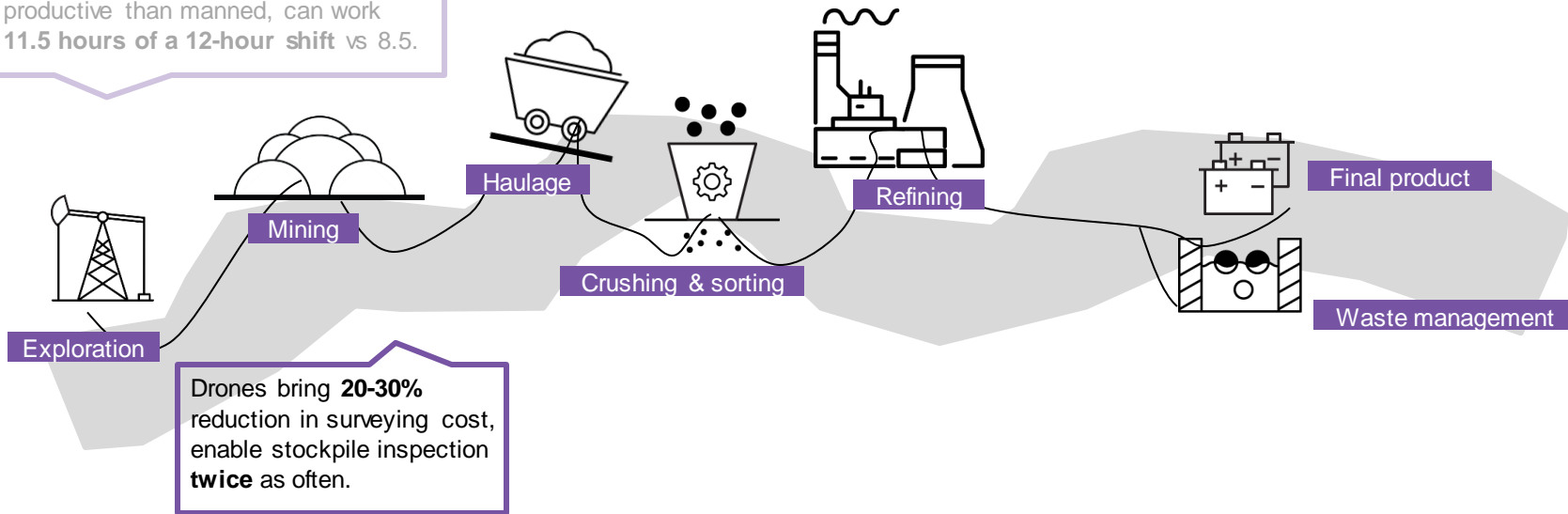


Source: BloombergNEF, company reports

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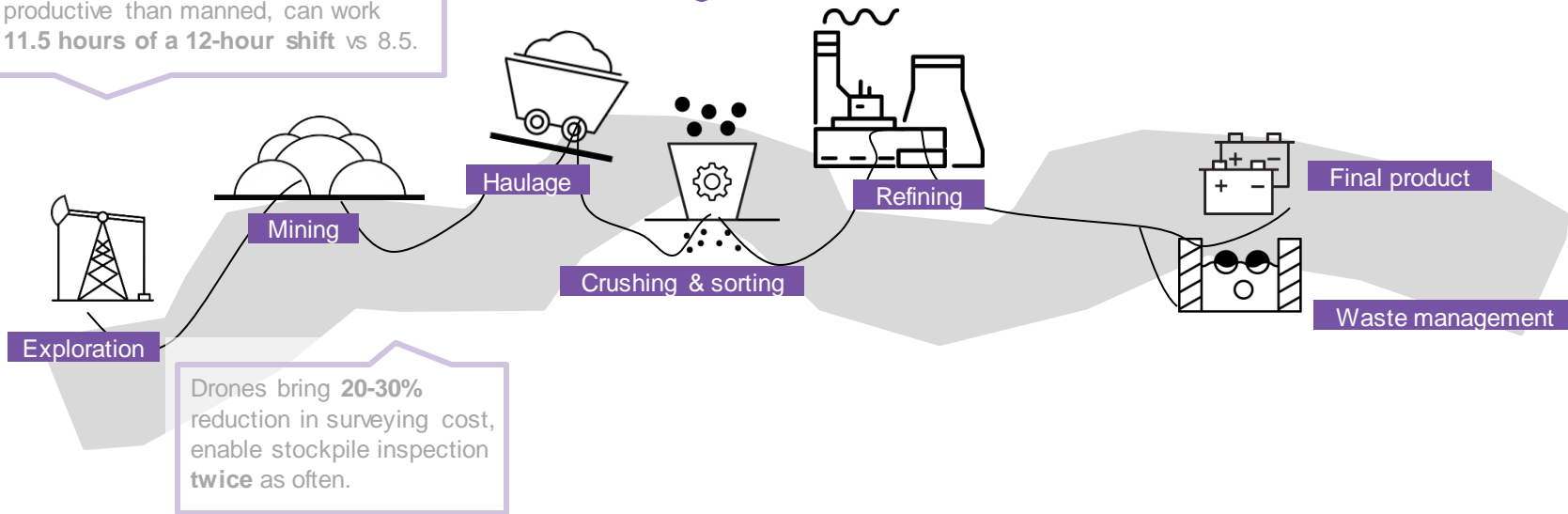
Source: BloombergNEF, company reports

Tracking efficiency improvements

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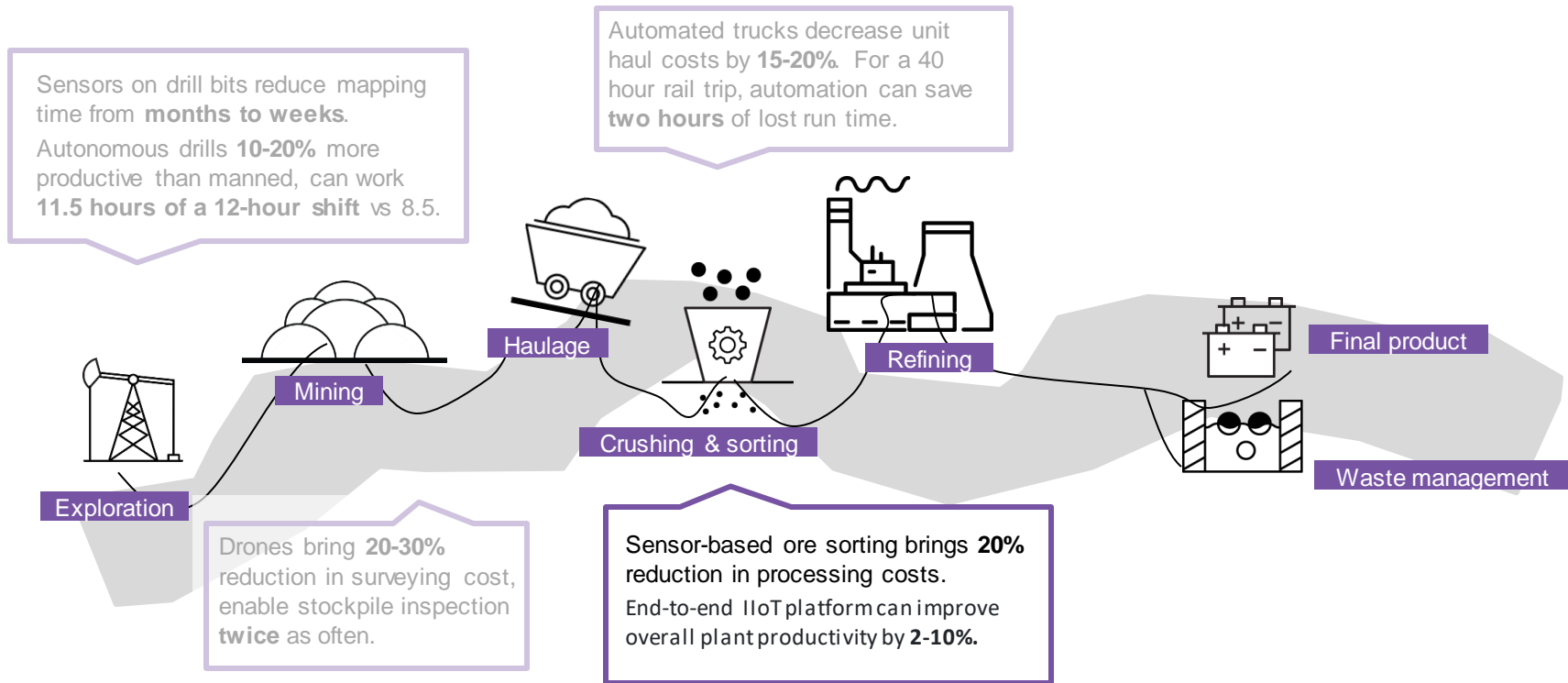
Autonomous drills **10-20%** more productive than manned, can work **11.5 hours** of a 12-hour shift vs 8.5.

Automated trucks decrease unit haul costs by **15-20%**. For a 40 hour rail trip, automation can save **two hours** of lost run time.



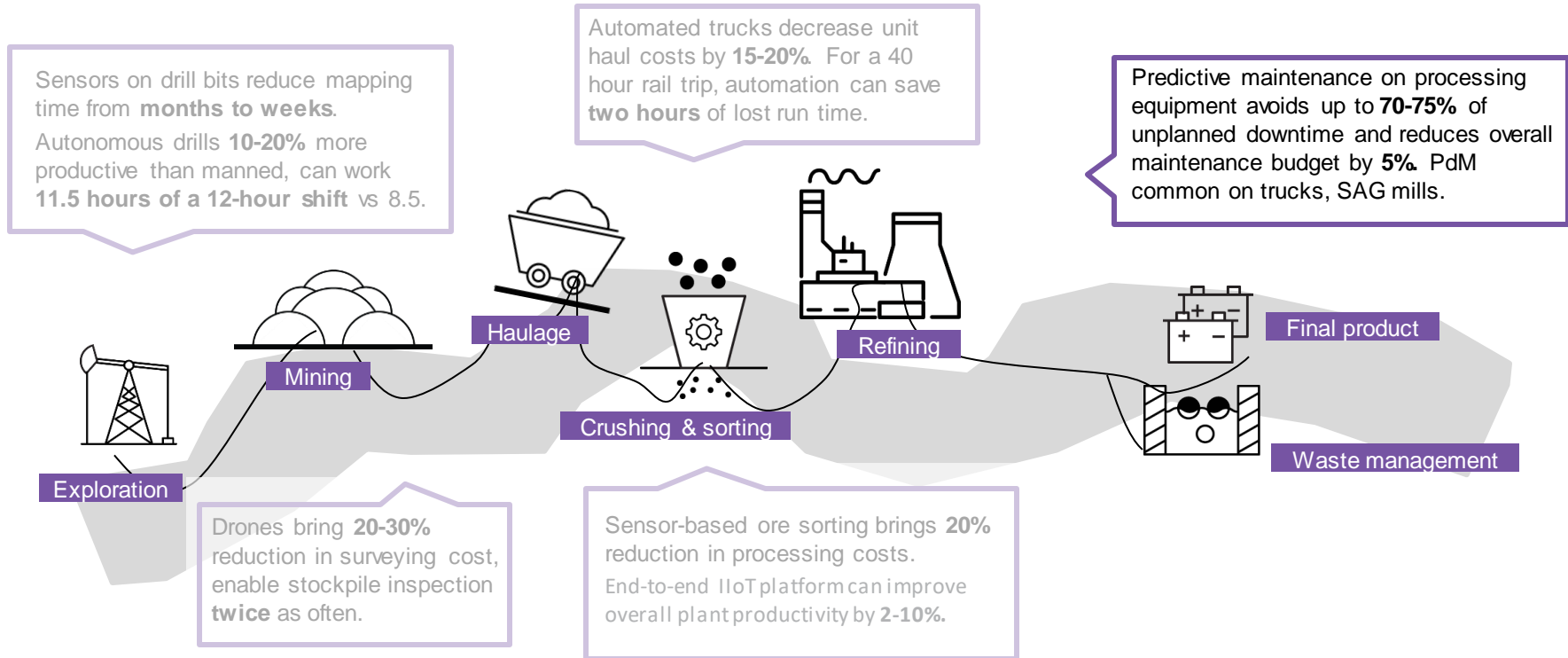
Source: BloombergNEF, company reports

Tracking efficiency improvements



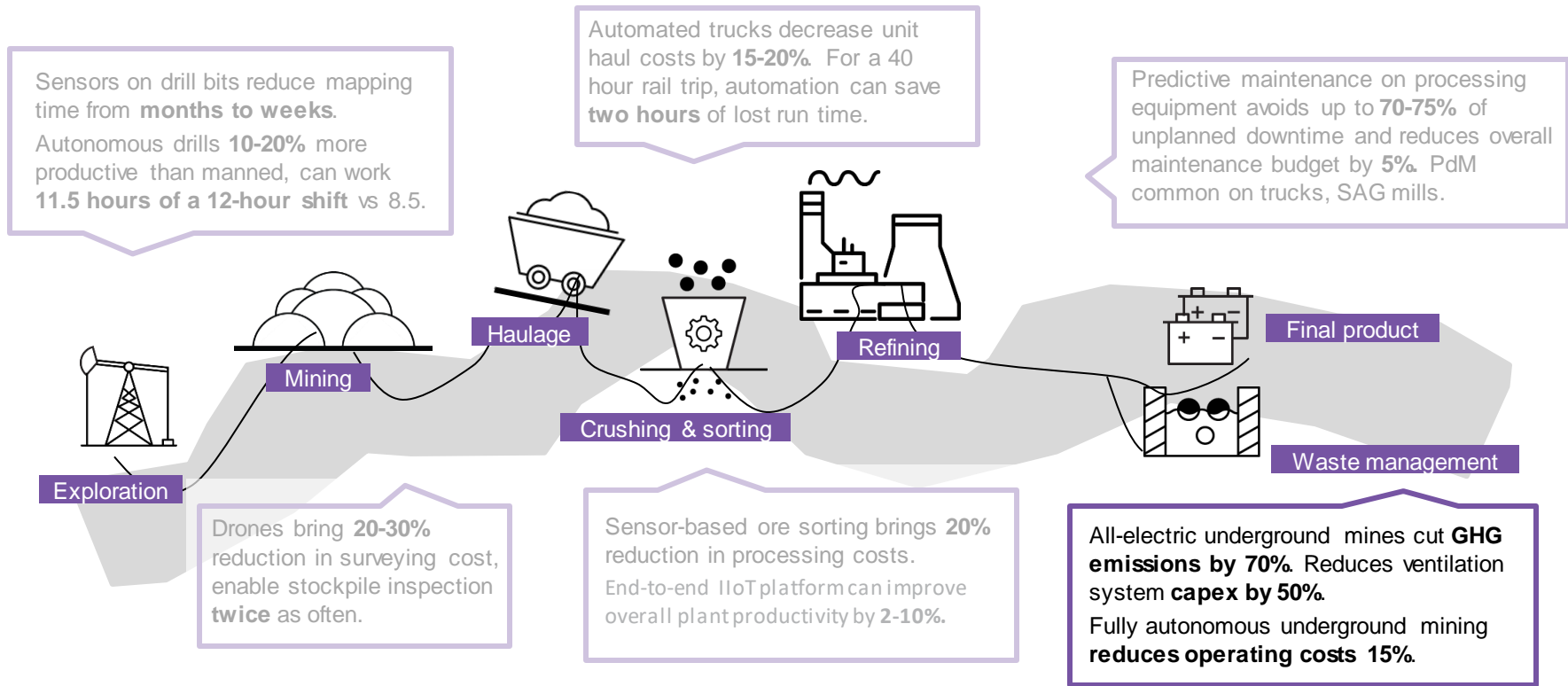
Source: BloombergNEF, company reports

Tracking efficiency improvements



Source: BloombergNEF, company reports

Tracking efficiency improvements



Source: BloombergNEF, company reports

Digital adoption

ANGLO
AMERICAN

BARRICK

BHP



CODELCO

RioTinto







VALE

	ANGLO AMERICAN	BARRICK	BHP	CODELCO	RioTinto	VALE
Cloud computing	Pilot	Deployed	Deployed	Deployed	Deployed	Deployed
IIoT platform & analytics	Pilot	Deployed	Deployed	Pilot	Deployed	Deployed
Connected sensors	Deployed	Deployed	Deployed	Deployed	Deployed	Deployed
Remote operations	Pilot	Deployed	Deployed	Deployed	Deployed	Deployed
Predictive maintenance	Pilot	Deployed	Deployed	Pilot	Deployed	Deployed
Digital twins	Pilot	Inactive/unknown	Pilot	Inactive/unknown	Pilot	Inactive/unknown
Autonomous trucks	Pilot	Pilot	Pilot	Deployed	Deployed	Pilot
Autonomous drills	Deployed	Deployed	Deployed	Inactive/unknown	Deployed	Pilot
Connected worker	Deployed	Deployed	Pilot	Pilot	Pilot	Inactive/unknown
Drones	Deployed	Deployed	Deployed	Pilot	Pilot	Deployed
AI	Inactive/unknown	Inactive/unknown	Deployed	Inactive/unknown	Inactive/unknown	Deployed

Source: BloombergNEF, company presentations, research calls, company web sites.

Corporate case studies

Company	Technology	Impact
	Autonomous technology	Autonomous trucks operate 700 hours longer, with <u>15% lower costs</u> . Trains deliver <u>20% faster</u> . Drills reduce downtime by <u>10%</u> .
	Predictive maintenance	Cortez vehicle fleet costs \$60M per year to maintain. Most PdM systems estimate 10% O&M reductions, suggesting <u>\$6M in savings per year</u> for one site.
	Connected worker	Smartcaps resulted in a reduction of safety incidents.
	Robotics	Rock cutting robots bring <u>20-30% increases</u> in productivity, reduces employee exposure to potential risks.

Source: BloombergNEF, company presentations, research calls, company websites

Elements of Digital Strategy

Motivation: the forces behind digitalization push and the ultimate goals

- What is the primary motivation for digitalization?
- Are they using technology for own sake, or considering selling it to peers?
- Is the company developing proprietary technology or sourcing externally?



Integration: the structure of technology decision-making

- Are technology decisions made mine by mine or top down across the whole company?
- Does the company run separate pilots at each mine or have one testbed for everything?
- How do digital, innovation, operations teams interact with each other?



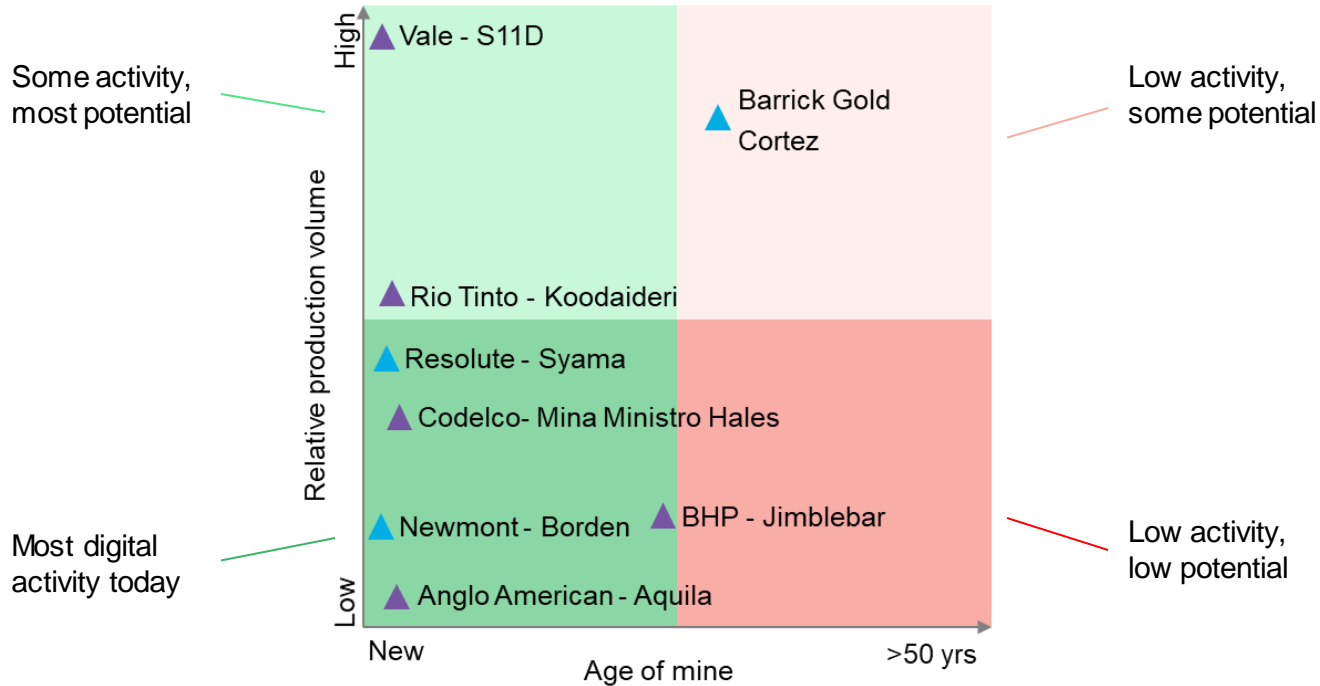
Technology scope: the volume and mode of technology development

- What's the breadth of digital technologies they are considering? Has there been significant investment?
- What is the role of the VC? Strategic investments or lead company into new areas?



Which sites to digitalize

▲ Precious metal ▲ Base metal



Source: BloombergNEF, company sites. Volume is relative to average industry mine for that metal.

Which sites to digitalize

Factors to consider when evaluating order of digitalization

	Dimension	Example
Internal	Mine Characteristics	<ul style="list-style-type: none">• Underground or open-pit• Relation to rest of portfolio• Percent ownership
	Technology Considerations	<ul style="list-style-type: none">• Ore complexity• Scattered or expansive site?• Production bottleneck
External	State of the Market	<ul style="list-style-type: none">• Cost of labor• Cost of externalities• Phase in commodity cycle

Source: BloombergNEF

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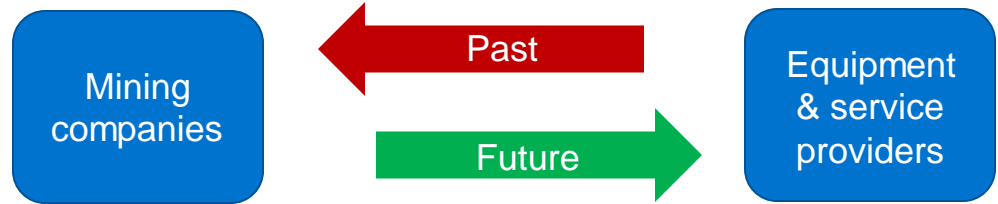
VALE

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What next?

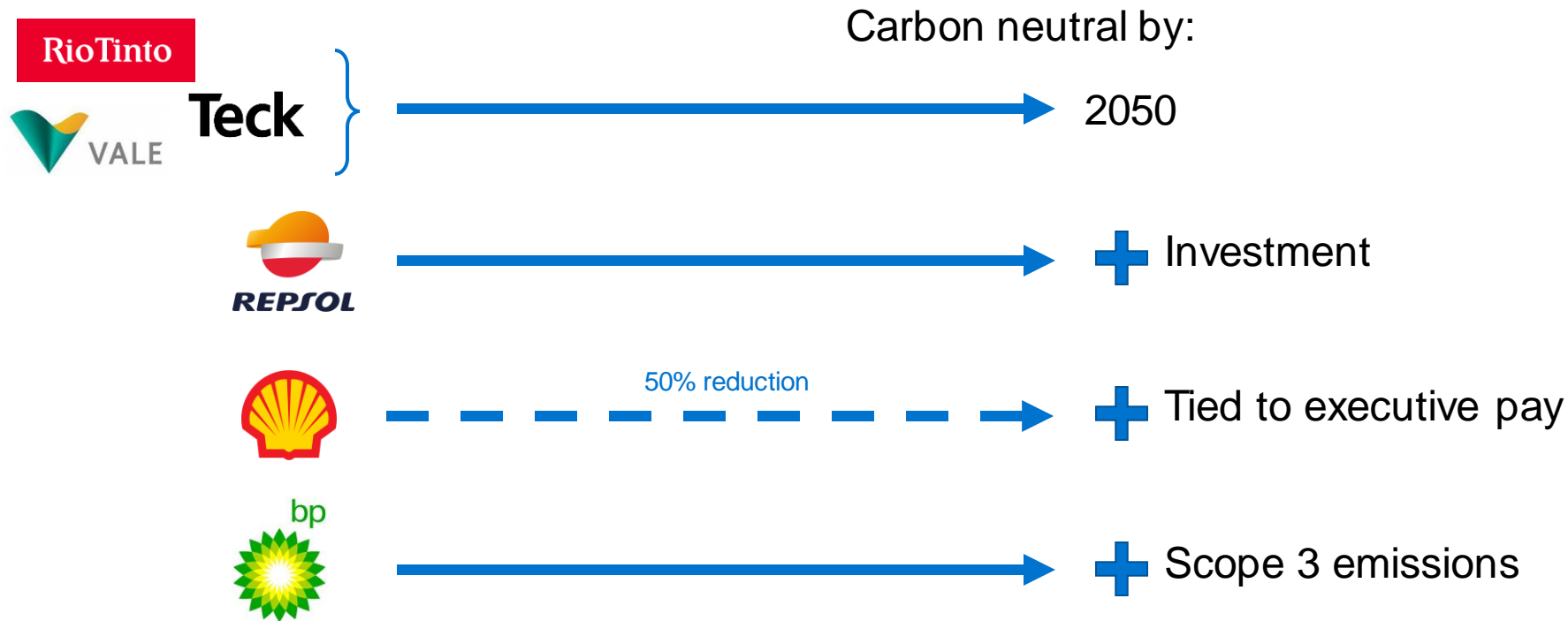
Technology flow



Decision-making



What next?



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