#H2OffThePress

The Green Steel case

The challenge of DRI grade iron ore and potential stranded assets

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A recap into the different steel production pathways

Two ways of producing steel today

Coal → **Blast Furnace (BF)** — 92%

Pig iron ↓

Basic Oxygen Furnace (BOF)

Steel

Mining
Iron ore

Hydrogen → **Direct Reduced Iron (DRI)** — 8%

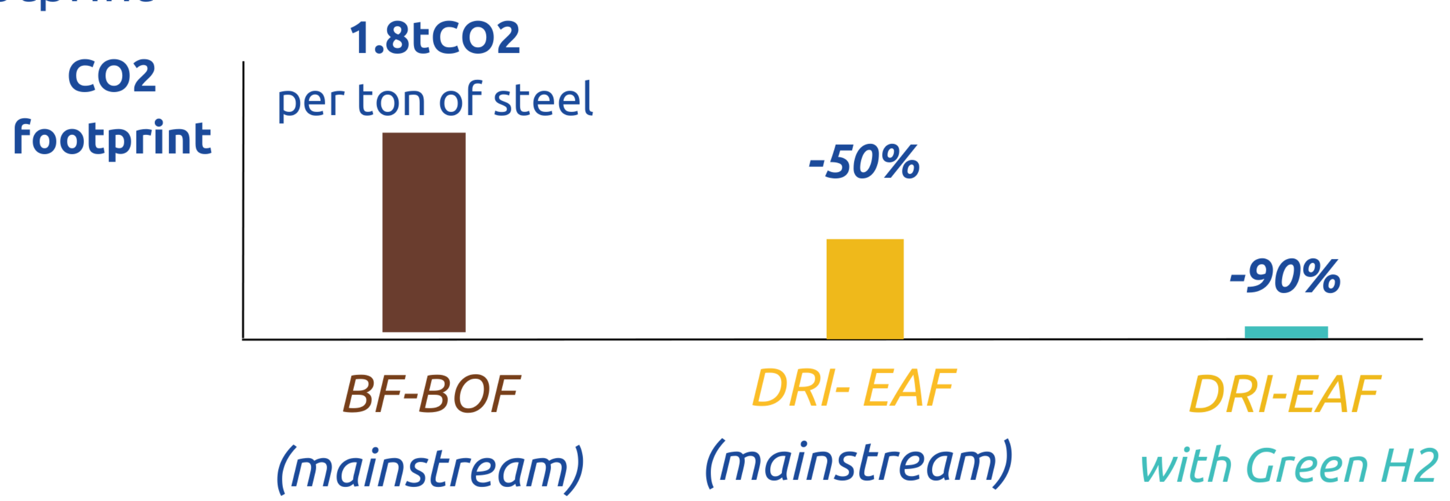
Sponge Iron ↓

Electric Arc Furnace (EAF)

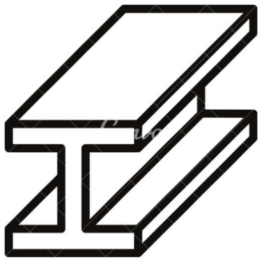
Steel

→ Hydrogen is already used today in the steel value chain (in the DRI process) but only marginally compared to coal in BF (92% of global iron production)

→ **Green hydrogen** use in DRI-EAF process can significantly reduce CO2 footprint



Challenges for the ramp up green steel production

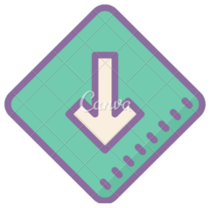


Even with declining cost of green H2 and increase in carbon taxes (CBAM for example), green steel still has some hurdles to cross*

Not all iron ore can be used for the DRI-EAF process.

Qualifications for an iron ore to be used for DRI-EAF process

Minimum elemental iron (Fe) content of about 65%



Low impurities and waste rock

As with all green transitions, the lifetime of existing BF-BOF plants is an issue as

Lifetimes of up to 60 years can cause stranded assets

Large additional maintenance costs

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***GHD, 2023** What's the deal with Green Steel? The Hydrogen Solution*

Not all iron ores are suitable for the DRI process

The availability of DRI grade iron ore plays a crucial role in transitioning from conventional BF ironmaking to the DRI process

→ **On ranking the most common ores based on suitability for DRI**

Hematite

Major exporters:
Australia, Brazil, Chile

Magnetite

Major exporters:
Australia, Sweden, Canada

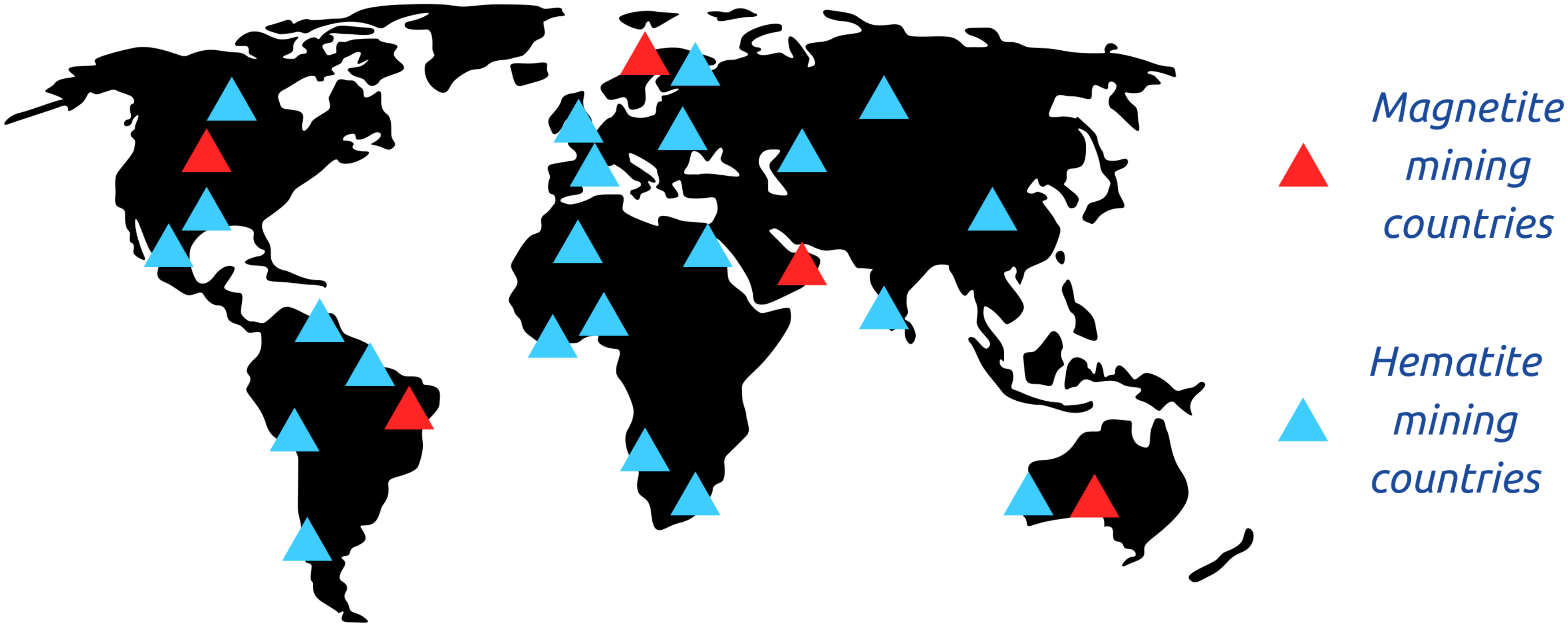
	Hematite	Magnetite
Iron content	**60%**	**25 to 40%** **68% after processing**
Impurities	**High**	**Low**
Abundancy	**High**	**Low**

✔ **Magnetite is the more suitable ore for the DRI process, but its availability is currently an issue**

Ramping up mining of DRI grade iron ore to meet demands

The availability of DRI grade iron ore plays a crucial role in transitioning from conventional BF ironmaking to the DRI process

DRI grade ore mining (Magnetite and high iron pellets) is not as common as Hematite with limited mines across the world



Hence, focus must be shifted towards

Sustainable iron-ore mining of magnetite

Developing technology to use hematite for green steel is needed

Two investment options for BF plants nearing end of life

70 per cent of steel production is based on the BF-BOF process in the major steel-producing countries

→ **Two immediate investment considerations arise when BF reaches near end of life**

	Option 1: Extending their lifetime	***Option 2: Investing in green technologies***
Process needed	*Relining (halting production for repair and replacement)*	*Investing in DRI technology/ Scrap-based steel production in EAFs*
Costs *(for a large scale 4 Mtpa furnace)*	*≈ $300 million*	*≈ $1.4 billion*
Lifetime	*15 years*	*40 years*

With the huge difference in costs, extending the lifetime of existing BF plants is the cheaper alternate but it might not necessarily be the case

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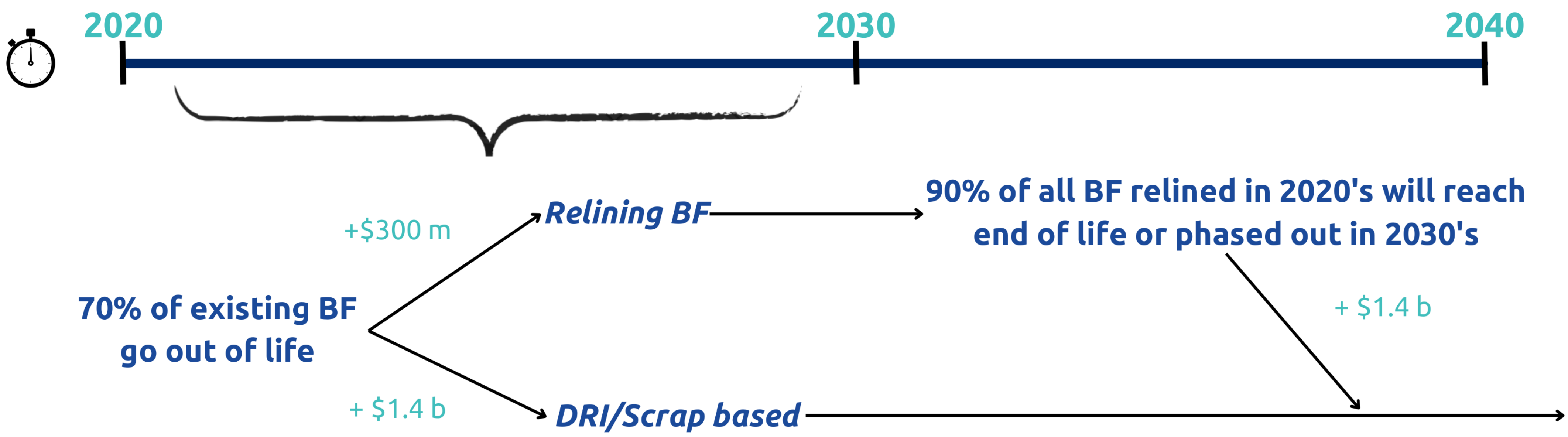
Replacing end of life assets is key for an economical ramp up of production

Investments in H2- DRI technology can be enabled by transitioning BF plants while avoiding the issue of having stranded assets

Even with the large investment needs for green technologies, this may be the right time to discuss this

Most BF plants need re-investment and relining BF plants would only delay the inevitable transition to green alternates thereby adding costs



*While this seems like an easy decision to invest in green technologies rather than relining, **most BF plants are located in emerging economies** making the viability of transition difficult due to rising demands*