Hydrogen for Iron and Steel: Industrial opportunity

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Climate Transparency

IDDRI

Context: Iron & Steel, and hydrogen

- Iron production is CO2 intensive ‘hard to decarbonise’
- Hydrogen economy and global market (opportunities for exporting green commodities)

ArcelorMittal Europe sets out path to net zero by 2050, with pioneering technologies at the forefront of the company’s roadmap for carbon-neutral steelmaking

- **Europe’s largest steelmaker, unveils breakthrough technologies that will take the company to 30% lower CO_2 emissions by 2030, and carbon neutrality by 2050**
- **ArcelorMittal Europe is investing in two routes to carbon neutrality, Smart Carbon and an innovative DRI-based route, in recognition of the need to act now to reduce CO_2 emissions, in line with the EU’s Green Deal and the Paris Agreement**
- **Calls for new policy framework, to support the industry in its transition to carbon neutrality, naming five market conditions that are needed for Europe’s steelmakers to compete globally**

ArcelorMittal

ArcelorMittal sets 2050 group carbon emissions target of net zero

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September 30, 2020 03:00 ET | **Source:** ArcelorMittal S.A.

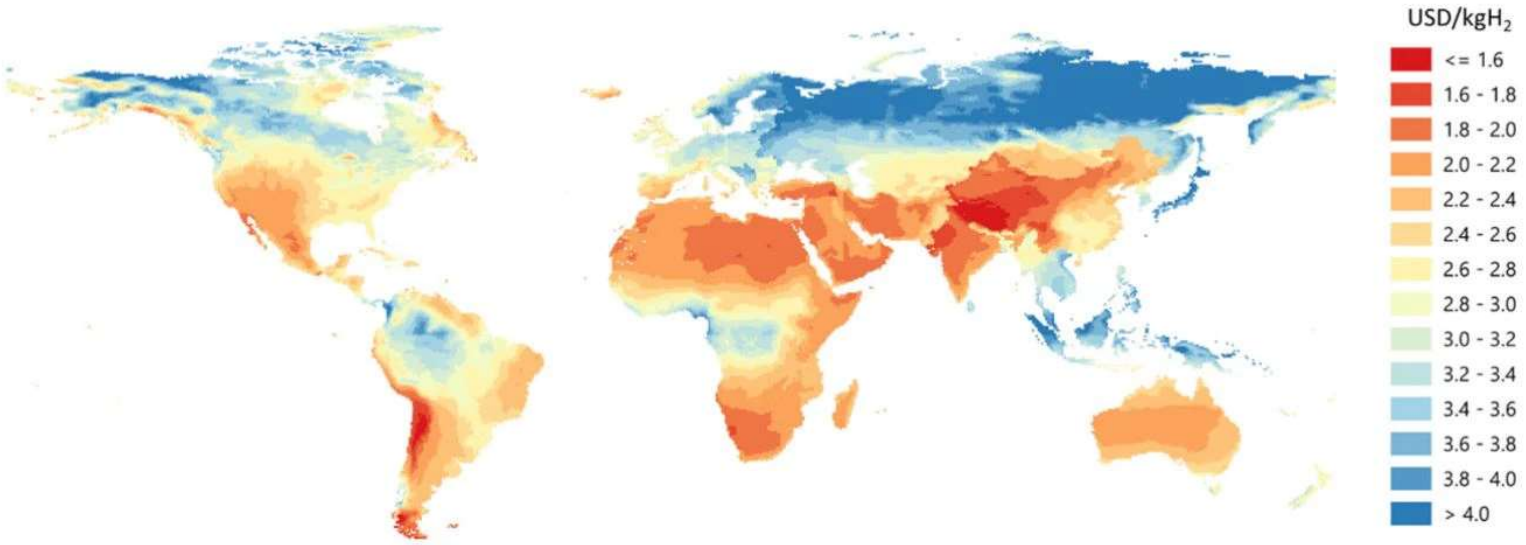
South Australia pushes green hydrogen export project

The South Australian government has followed up the recent launch of its Hydrogen Export Prospectus with a promise to provide US$27 million in funding for export infrastructure upgrades to a new green hydrogen and green ammonia project.

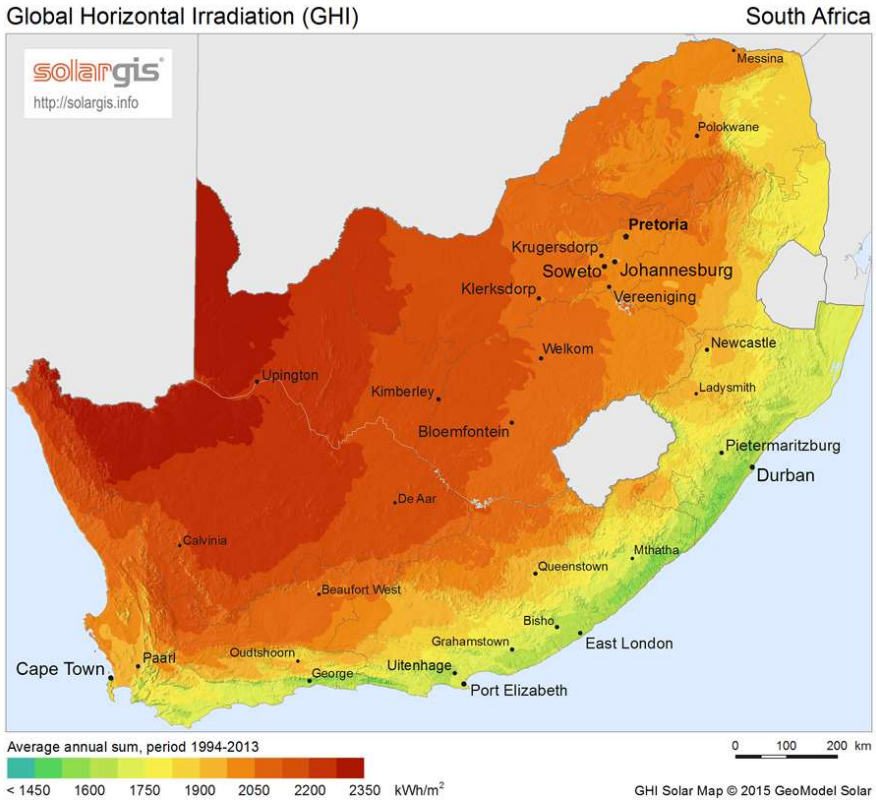
NOVEMBER 9, 2020 BLAKE MATICH

Potential future markets

Hydrogen costs from hybrid solar PV and onshore wind systems in the long term



Renewable potential



Hydrogen based iron production

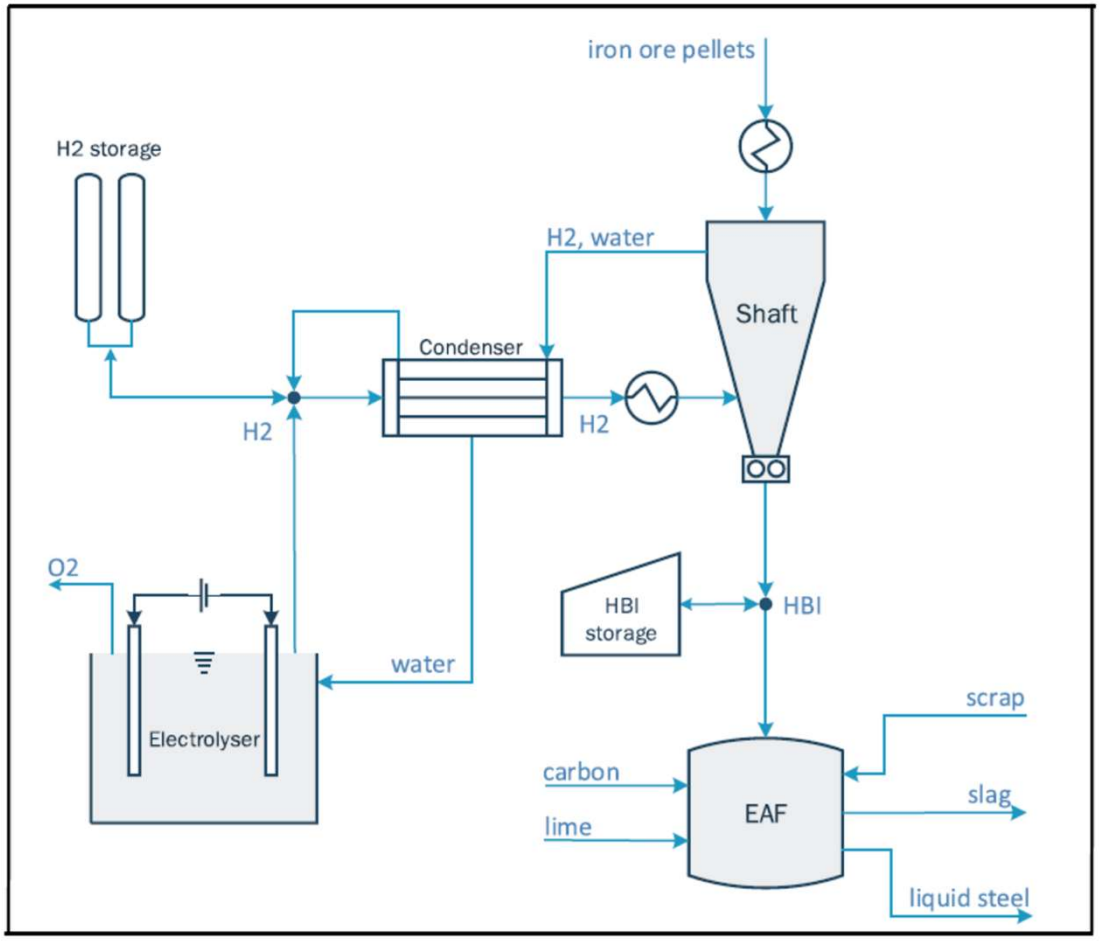
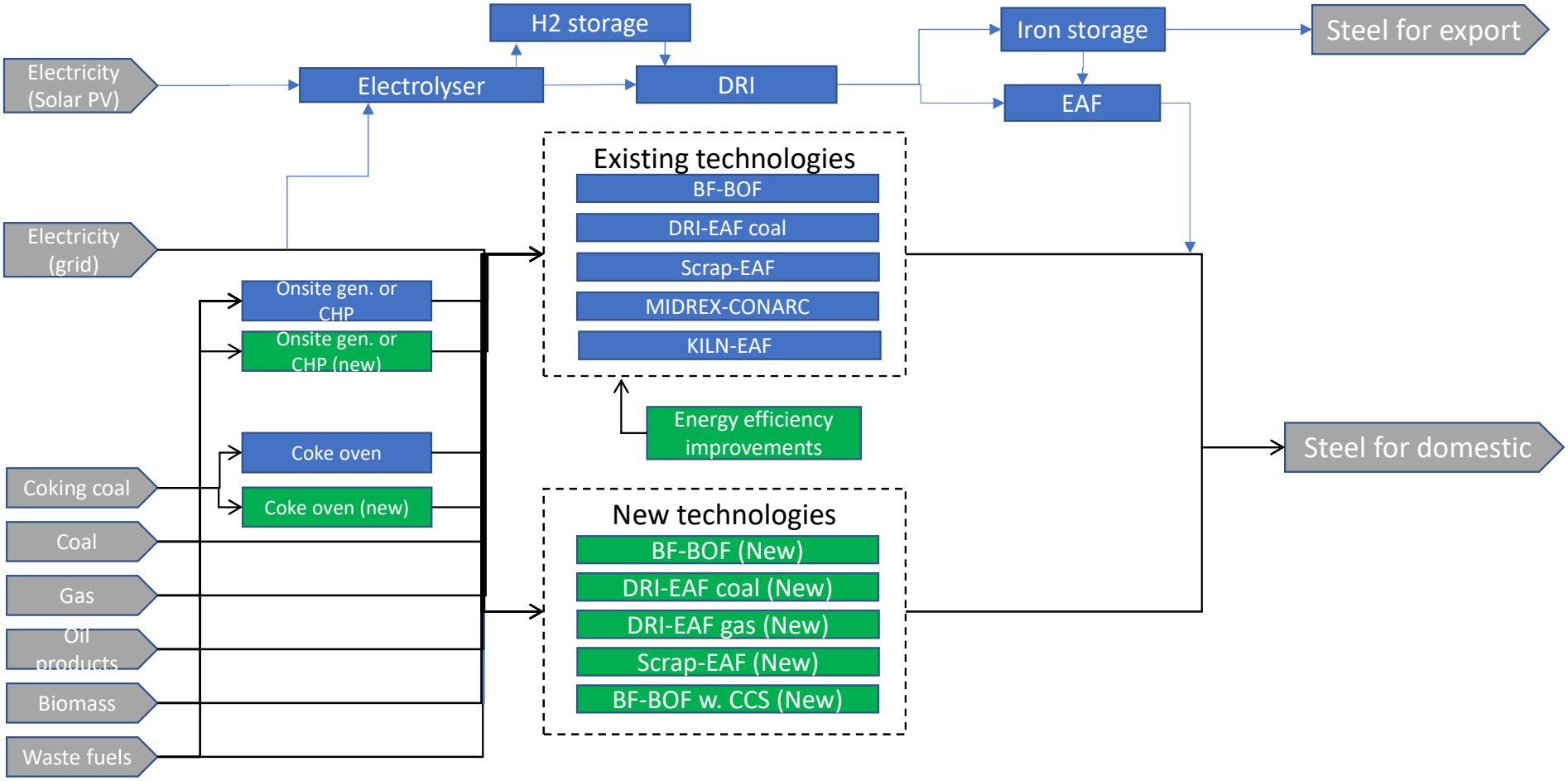


Fig. 1. Proposed process design for hydrogen direct reduction (H-DR) process.

For 1 tonne iron – need roughly 51kg Hydrogen

Vogl. et al 2018

I&S with H-DRI


H2 storage
Electricity (Solar PV)
Electrolyser
DRI
Iron storage
Steel for export
EAF
Existing technologies
BF-BOF
DRI-EAF coal
Scrap-EAF
MIDREX-CONARC
KILN-EAF
Electricity (grid)
Onsite gen. or CHP
Onsite gen. or CHP (new)
Energy efficiency improvements
Coke oven
Coke oven (new)
Steel for domestic
Coking coal
Coal
Gas
Oil products
Biomass
Waste fuels
New technologies
BF-BOF (New)
DRI-EAF coal (New)
DRI-EAF gas (New)
Scrap-EAF (New)
BF-BOF w. CCS (New)

Costs…

Table 3. Techno-economic characteristics of different electrolyser technologies

	Alkaline electrolyser			PEM electrolyser			SOEC electrolyser		
	Today	2030	Long term	Today	2030	Long-term	Today	2030	Long term
Electrical efficiency (%, LHV)	63–70	65–71	70–80	56–60	63–68	67–74	74–81	77–84	77–90
Operating pressure (bar)	1–30			30–80			1		
Operating temperature (°C)	60–80			50–80			650 – 1 000		
Stack lifetime (operating hours)	60 000 – 90 000	90 000 – 100 000	100 000 – 150 000	30 000 – 90 000	60 000 – 90 000	100 000 – 150 000	10 000 – 30 000	40 000 – 60 000	75 000 – 100 00
Load range (%, relative to nominal load)	10–110			0–160			20–100		
Plant footprint (m^2/kW_e)	0.095			0.048					

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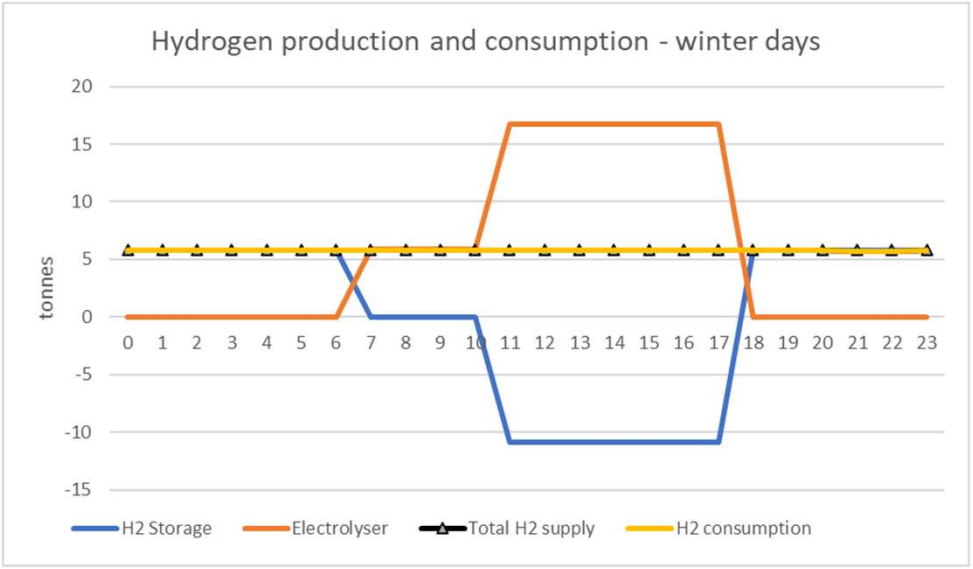
CAPEX (USD/kW_e)	500 – 1400	400 – 850	200 – 700	1 100 – 1 800	650 – 1 500	200 – 900	2 800 – 5 600	800 – 2 800	500 – 1 000

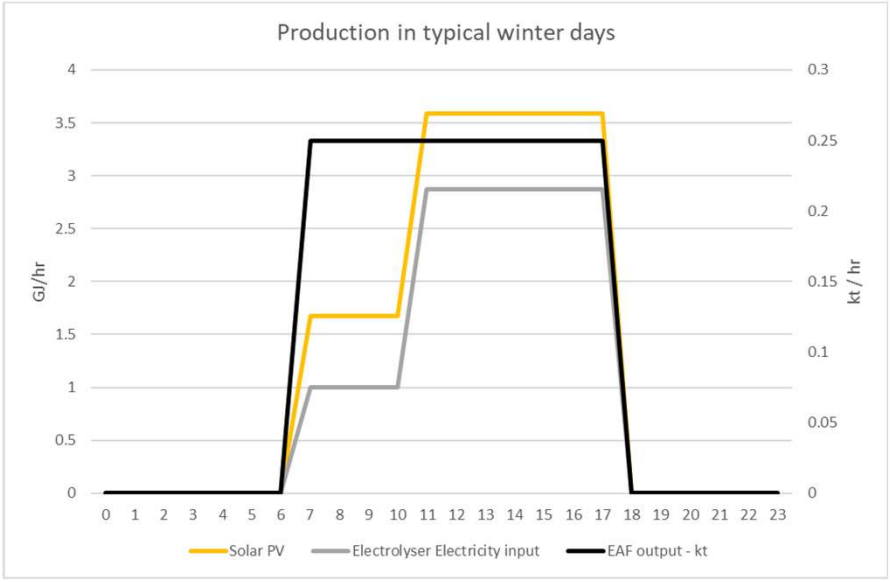
IEA future of hydrogen, 2019

Operations – producing 1Mt steel pa



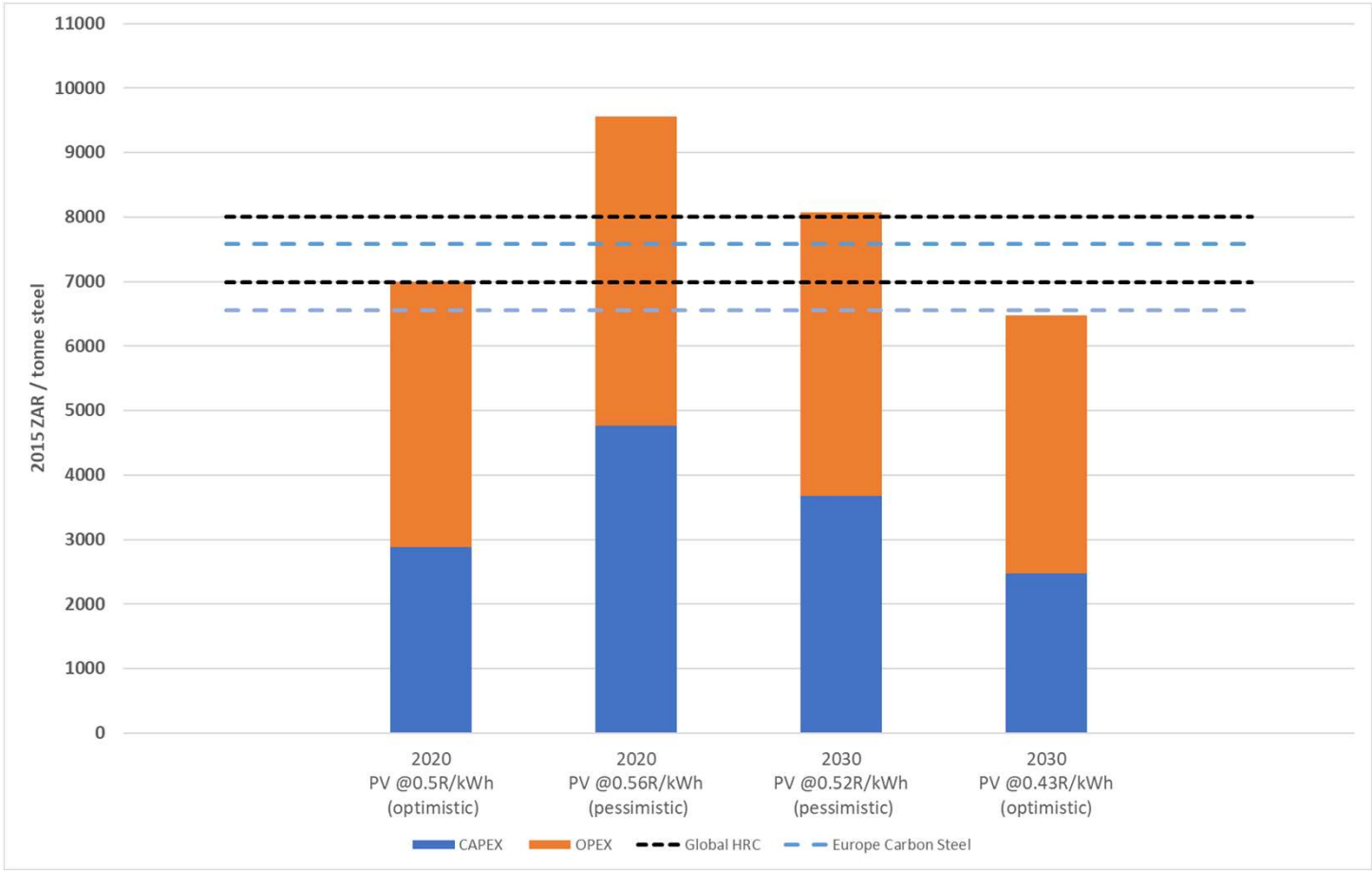
	Capacity		Annual utilisation
Direct Reduction furnace:	1.11	Mt	90%
Electrolyser	0.80	GW	35%
Solar PV:	1.40	GW	26%
H2 Storage	76.667	tonnes H2	
iron storage	0.002	Mt	
Battery 4hr	-	GW	

Oversize electrolyser and PV to accommodate for winter period – means curtailment in summer (opportunities).

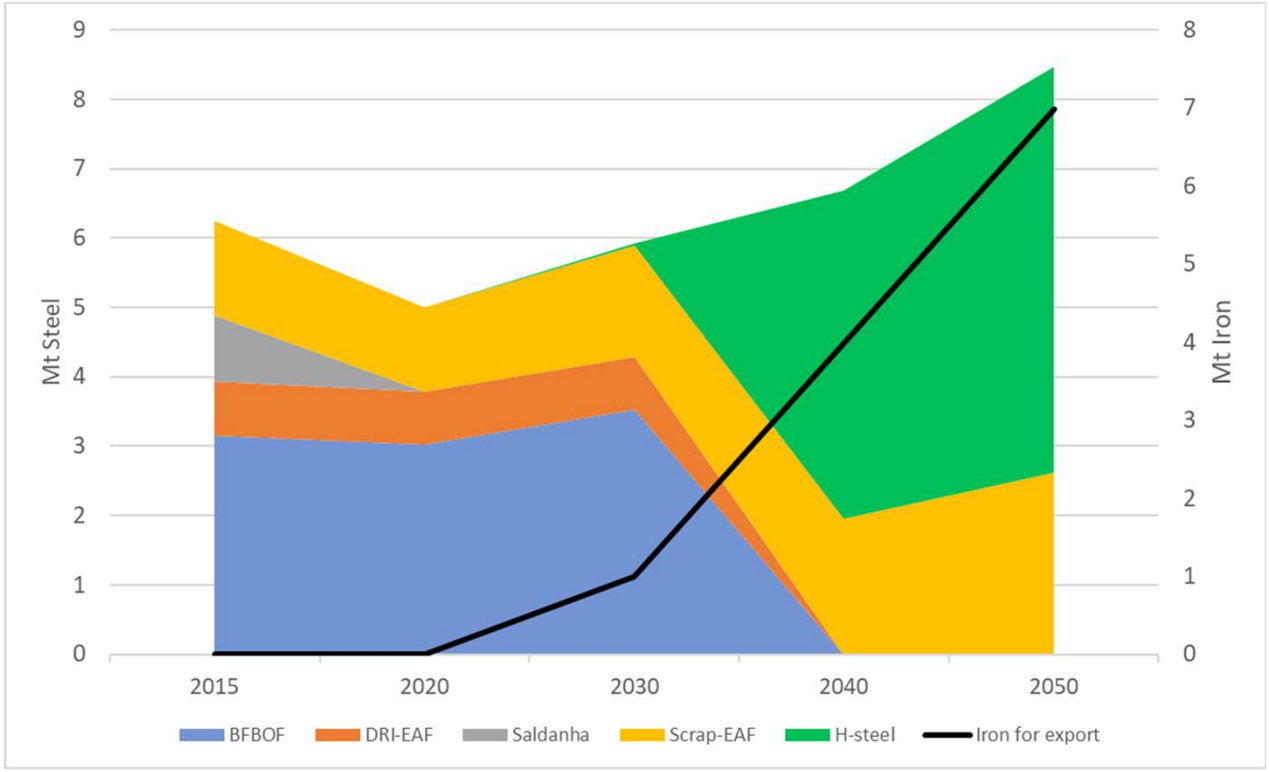


Cost competitive…

…almost



South African I&S in low carbon future…



More…

Technical…

- PEM electrolysers offer grid renewables curtailment opportunities
- Once grid is decarbonised – sizing of components can be smaller
- Global push for hydrogen – electrolyser costs to go the way that RE did?

Markets…

- Oxygen and hydrogen local economies and industrial uses
- Export green commodities to EU or rest of world
- Exports to help pay for declining coal, and ICE car sales in decarbonised world

THANKS!