UNIVERSITI KEBANGSAAN MALAYSIA
The National University of Malaysia

The Potential of Hydrogen in Green Steel Production

Presented by

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How Green is an Electric Car?

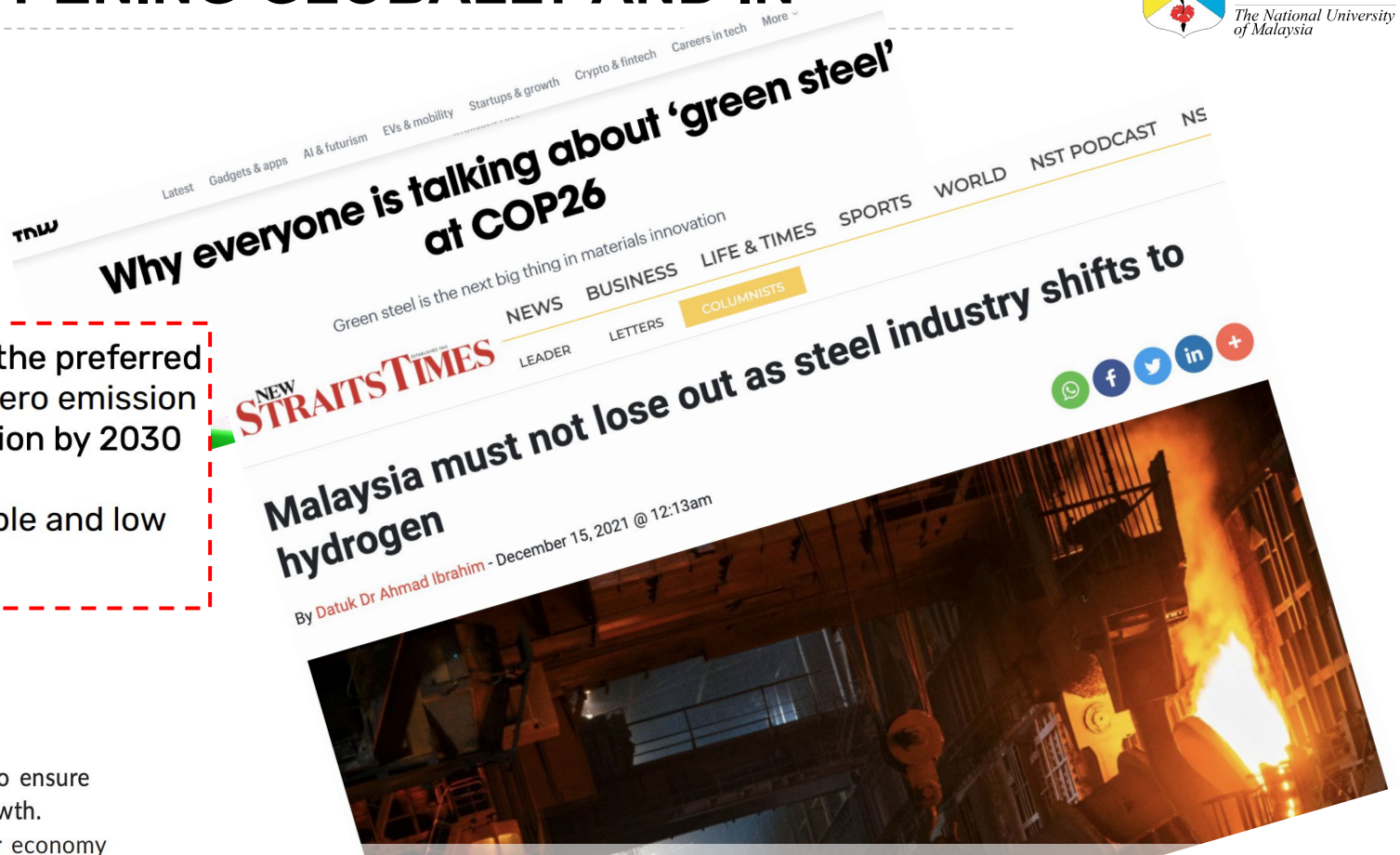
The EV ecosystem must be **green/clean** & **renewable energy** is the key solutions

BACKGROUND: WHAT'S HAPPENING GLOBALLY AND IN MALAYSIA?

The COP26 BREAKTRHOUGH AGENDA

COP26 OUTCOMES

- Steel Breakthrough: making near-zero emission steel the preferred choice in global markets, with efficient use and near-zero emission steel production established and growing in every region by 2030
- Hydrogen Breakthrough: ensuring affordable, renewable and low carbon hydrogen is globally available by 2030



TWELFTH MALAYSIA PLAN
2021-2025
A PROSPEROUS, INCLUSIVE, SUSTAINABLE MALAYSIA

Accelerating Green Initiatives

Implementation of green initiatives will be accelerated to ensure sustainable, responsible and resilient socioeconomic growth. Businesses will be encouraged to implement the circular economy along their value chain, particularly using recycled materials to produce green products. The private sector will also be encouraged to implement energy efficiency initiatives in their operation and premises, as well as intensify development and utilisation of renewable energy sources, including hydrogen. Government green procurement initiative will also be implemented in Sabah and Sarawak as a catalyst in expanding the green market, including the green construction sector.

Malaysia Nationally Determined Contribution (NDC): Unconditionally reduce economy-wide carbon intensity (against gross domestic product [GDP]) of **45% by 2030** compared to 2005 levels

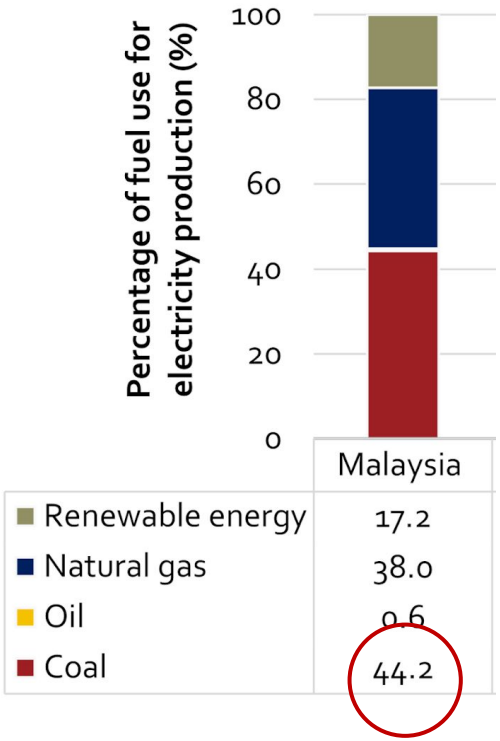
CARBON BORDER ADJUSTMENT MECHANISM (CARBON TAX)

By now, many Malaysian companies would have been warned about the impending impact of carbon taxes on their operations, especially if they are exporters to the European Union (EU).

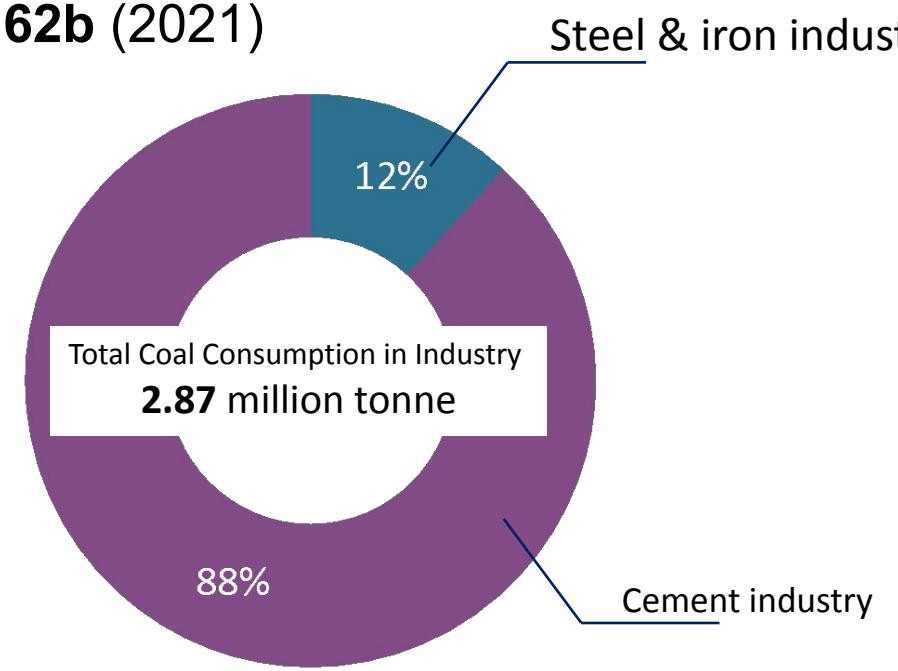
The EU's Carbon Border Adjustment Mechanism (CBAM), which is expected to kick in gradually from 2023, will impose a carbon price on non-EU producers. Basically, EU importers will buy carbon certificates corresponding to the price they would have paid if the goods were covered under the EU's carbon pricing rules. This cost is then charged to non-EU producers.

But if the non-EU producer can show that it already paid a price for the carbon used in the production of the imported goods — like a carbon tax — in another country, then the corresponding cost for the EU importer can be cancelled.

BACKGROUND: COAL CONSUMPTION & ENERGY INTENSIVE INDUSTRY



- Globally, Steel and Iron industry consumes **7%** global energy and contributes to **33%** industrial GHG emissions
- Malaysia steel production ranked **4th** in ASEAN and **23rd** in the world
- In Malaysia:
  - **44%** Power generation by **coal,** take up **92%** of coal consumption
  - **0.34 million tonne** by **Iron and Steel** industry
  - Producing **7.2 million tonne** of CO_2
  - External trade record **~RM62b** (2021)



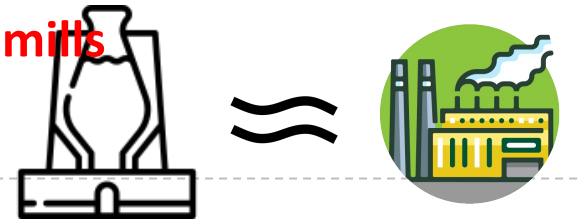
Source: Malaysia Third National Communication and Second Biennial Update Report to the UNFCCC, 2018

Carbon Emission Data in Malaysia

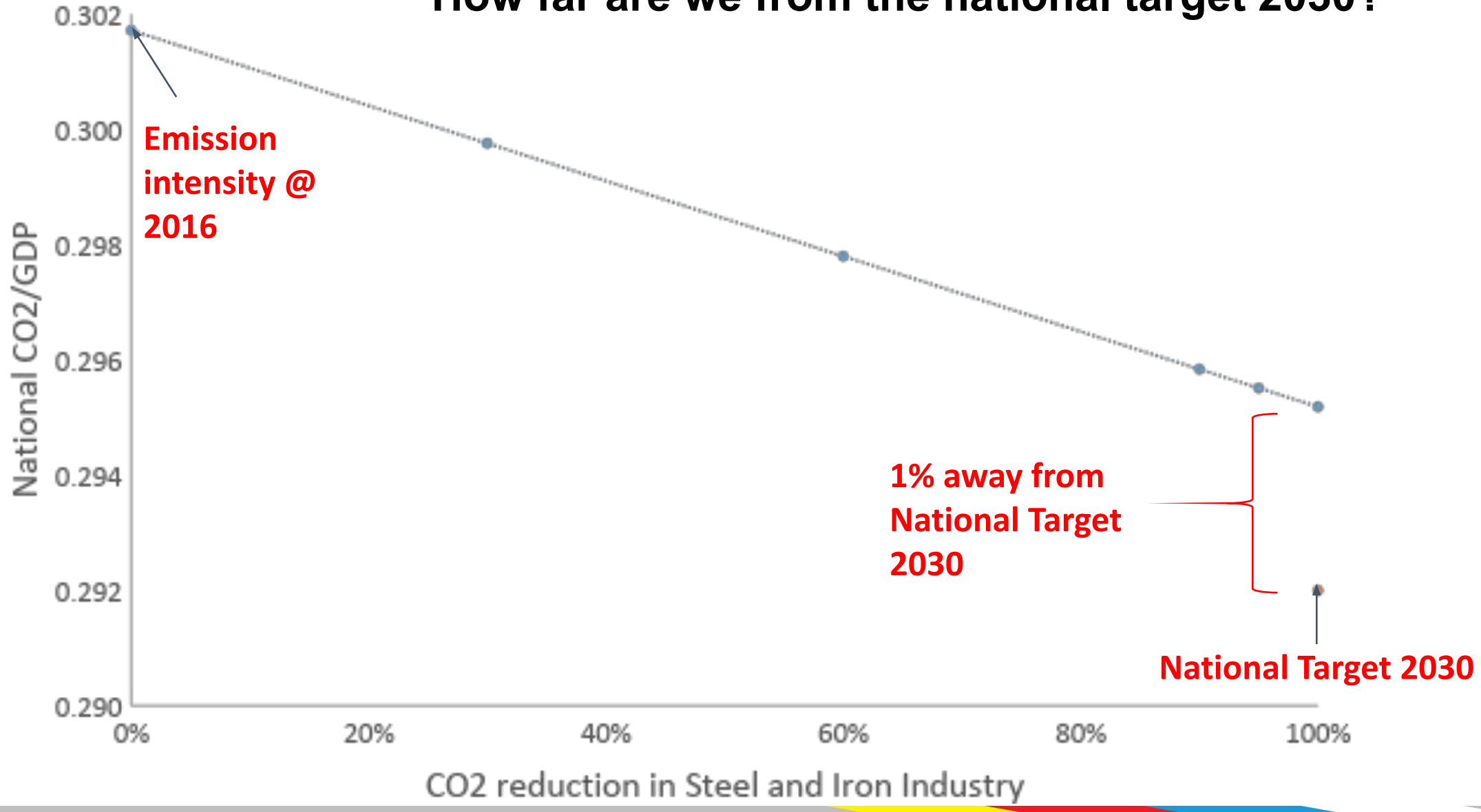
Malaysia Carbon Dioxide Equivalent Emissions Data		
National CO_2e emission (million tonne)	334.586	
National GDP (RM million)	1,108,935	
National CO_2e/GDP (kg/RM) @ 2016	**0.302**	
National target CO_2e/GDP (kg/RM) @ 2030	**0.292** (↓45% @2005)	
	Iron & Steel Sector	Palm Oil Sector
GDP by industry (%)	2.9	6.1
GDP by industry (RM million)	32,159	67,645
CO_2e emission (million tonne)	7.245	13.928*
CO_2e/GDP by industry (kg/RM)	0.255	0.206

** Based on Palm Oil Mill Effluent (POME)*

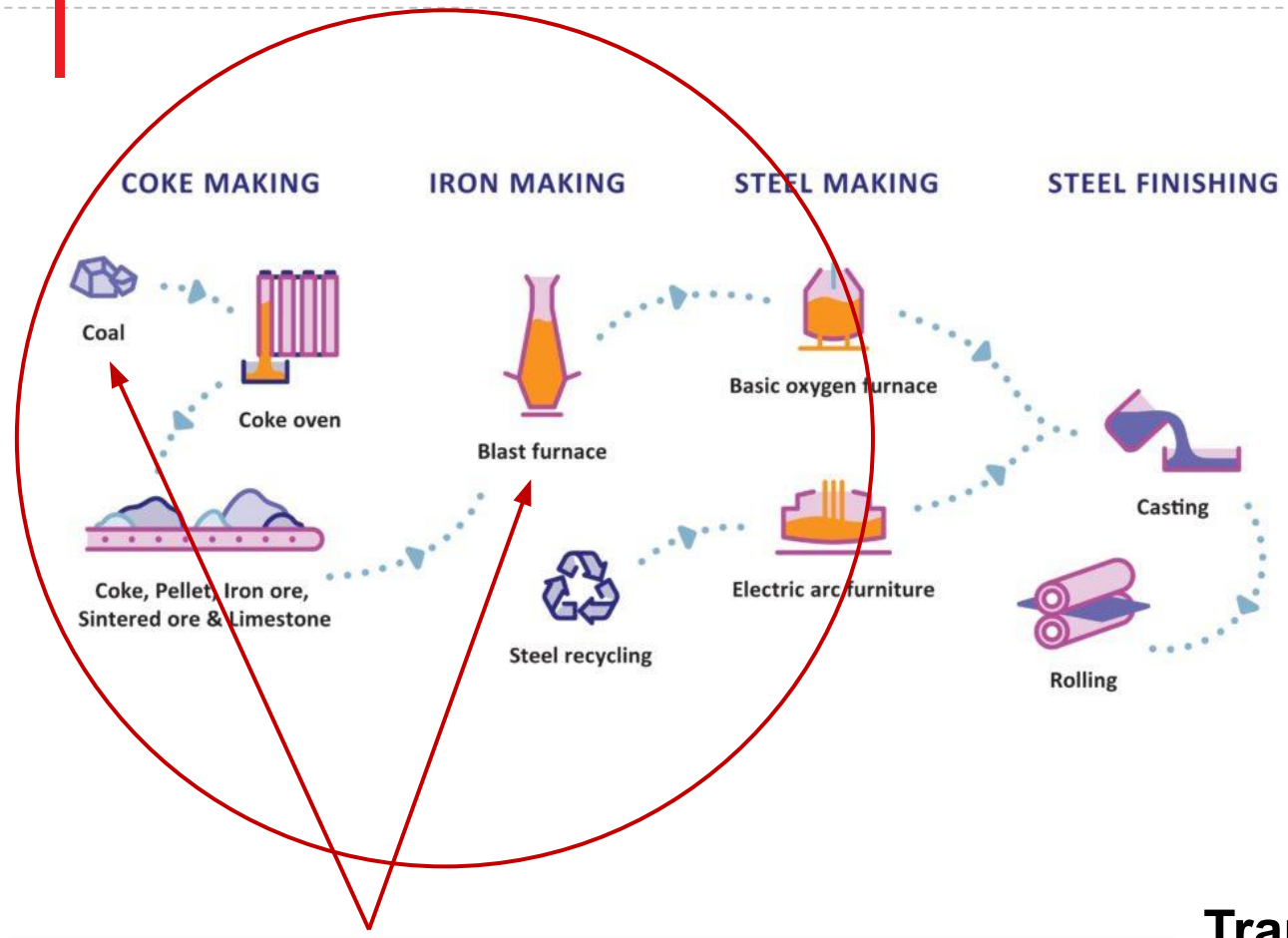
1 S&I Plant **50 Palm oil mills**

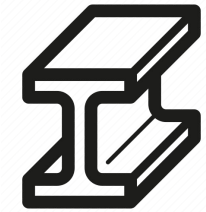


How far are we from the national target 2030?

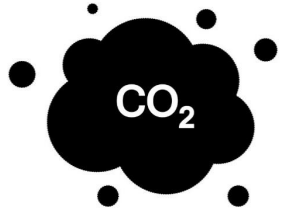


BACKGROUND: COAL USAGE IN IRON AND STEEL INDUSTRY





1 tonne



~1.9 tonne

3.9 million tonne/yr

7.2 million tonne/yr

70% of steel produced uses **COAL** as **metallurgical coke** for reduction of iron ore and **fuel** for blast furnace

Translating into ~RM1.1 Billion* Carbon Tax Levy annually

*RM150/t CO_2e by end 2030 (proposed by Penang Institute)

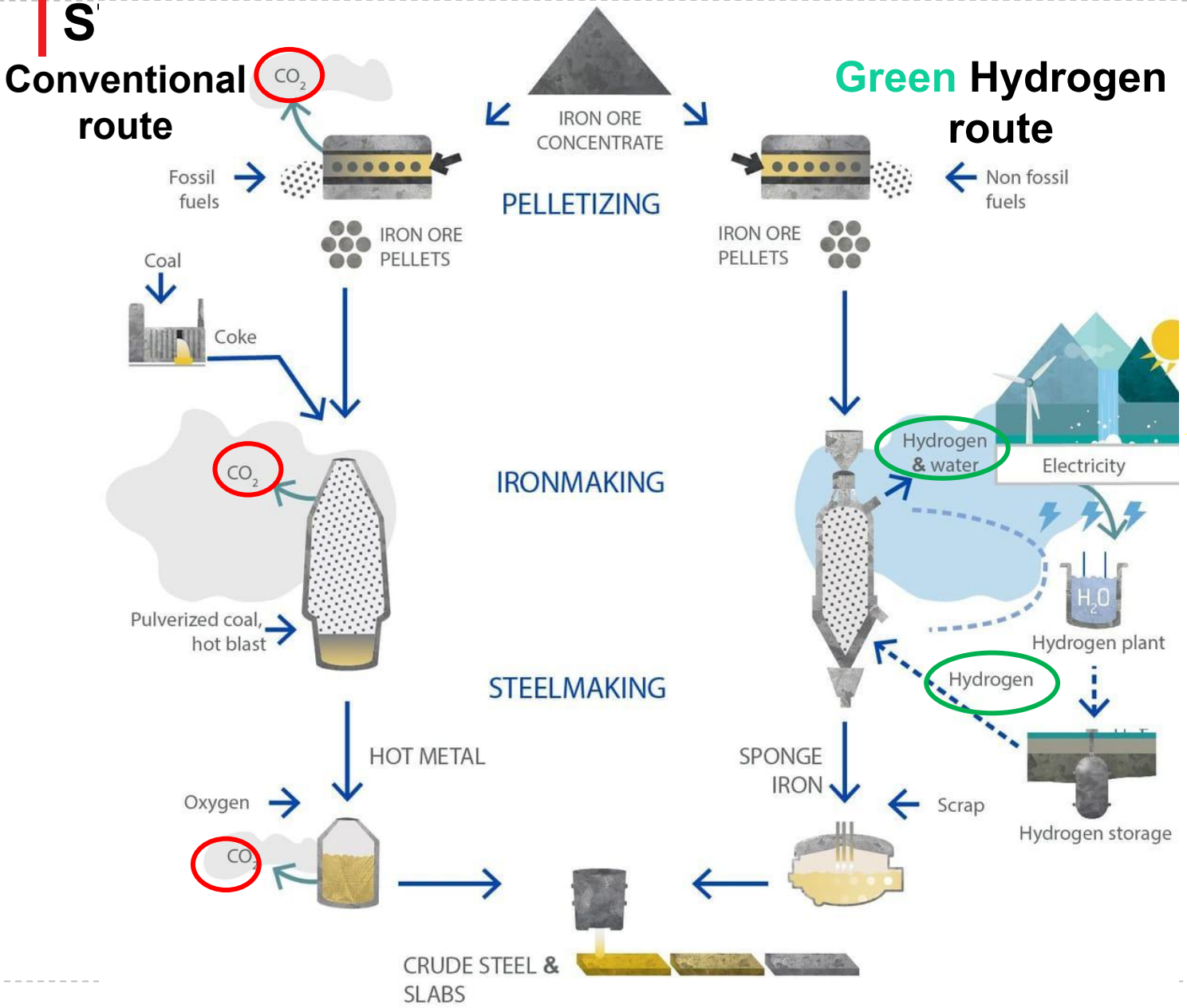
Possible EXPORT RESTRICTION of coal-based steel ESG non-compliance

GAP ANALYSIS

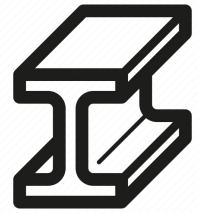
DRI – Direct Reduction Iron
BF – Blast Furnace
EAF – Electrical Arc Furnace

Emerging Commercial Technologies	Potential CO_2 reduction	Benefits	Challenges
Scrap EAF	80%	High CO_2 reduction; technology readily available	High scrap supply needed; energy needs of EAF may add to emissions
BF with Biofuel	20-50%	Easier to implement by altering the input mix in BF	High quantity of biofuel required; increase storage and transportation cost; high moisture content of biofuel
BF with Carbon Capture	30%	Can be easily integrated of BF	Large infrastructure investment for storage and transport; difficult to capture all CO_2 emission
Natural Gas-DRI & EAF	40%	High energy and emission savings	Adequate and affordable supply of natural gas critical to determine affordability
Green Hydrogen DRI (H_2-DRI-EAF)	80-95%	Increased flexibility as hydrogen and hot briquet iron can be stored	High green hydrogen cost compared with black hydrogen cost

IMPORTANCE OF GREEN HYDROGEN & GREEN S



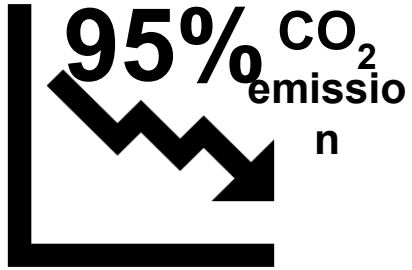
~50-55 kg



1 tonne

High Impact

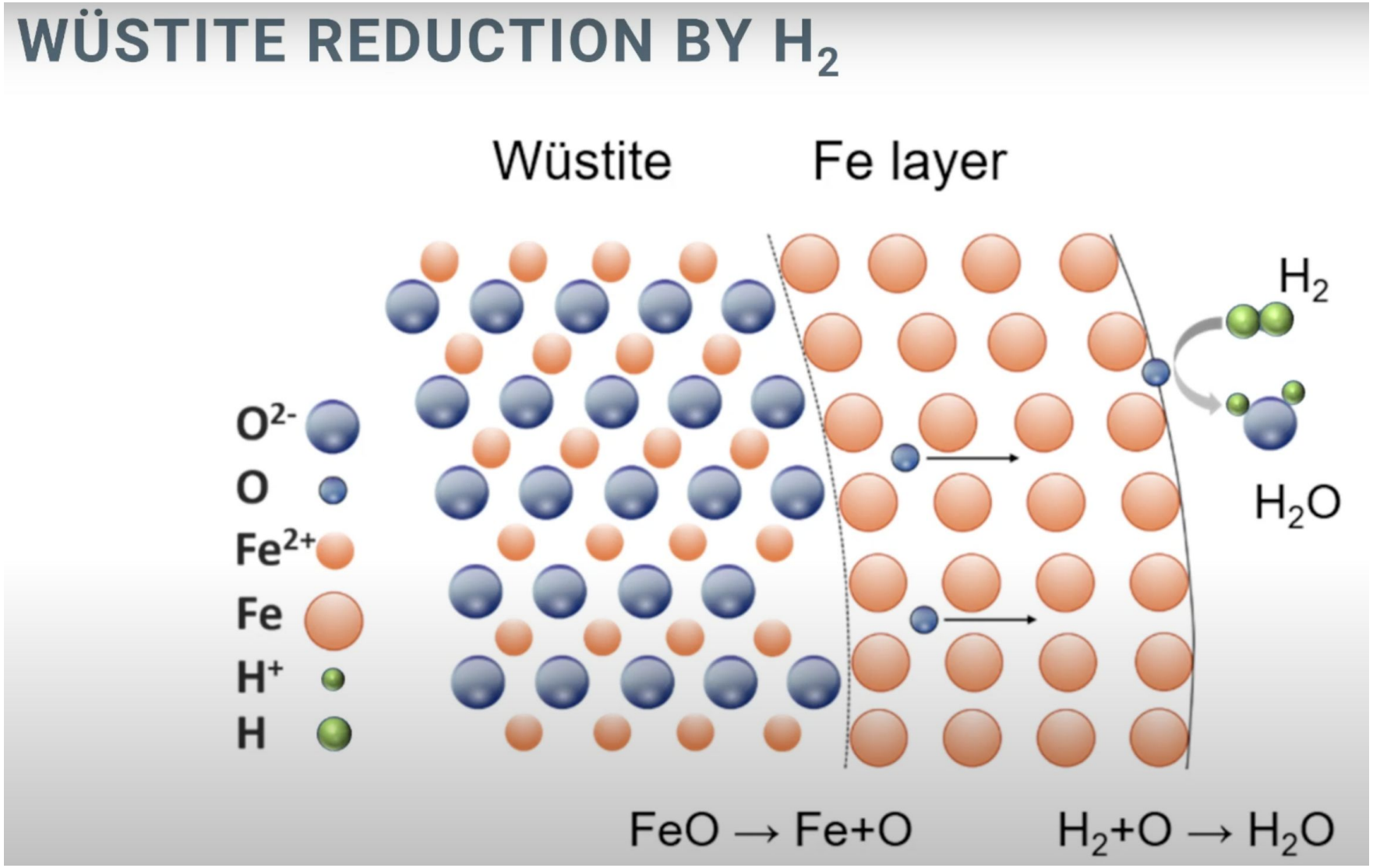
GH2



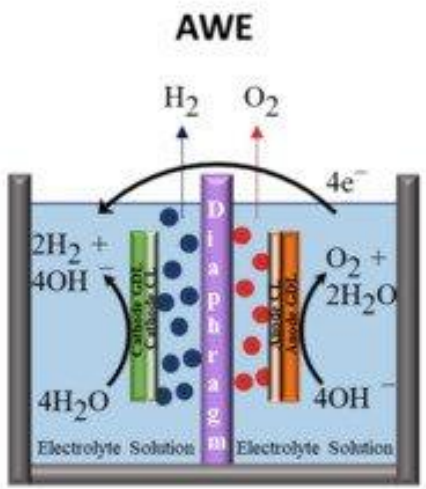
GH2 could be the **cheapest** production method for steel and capture **31%** of the market by **2050**

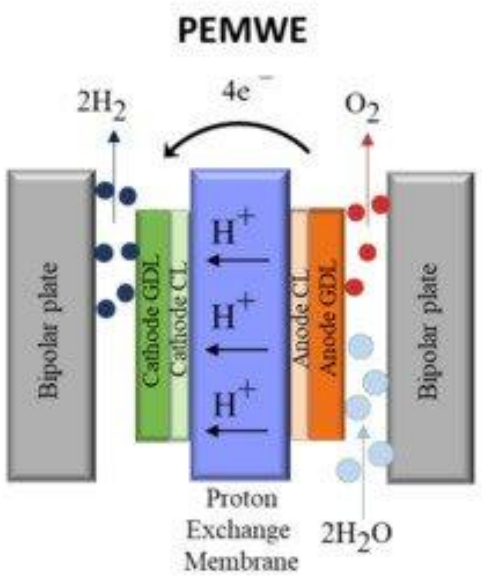
Source: BloombergNEF (BNEF)

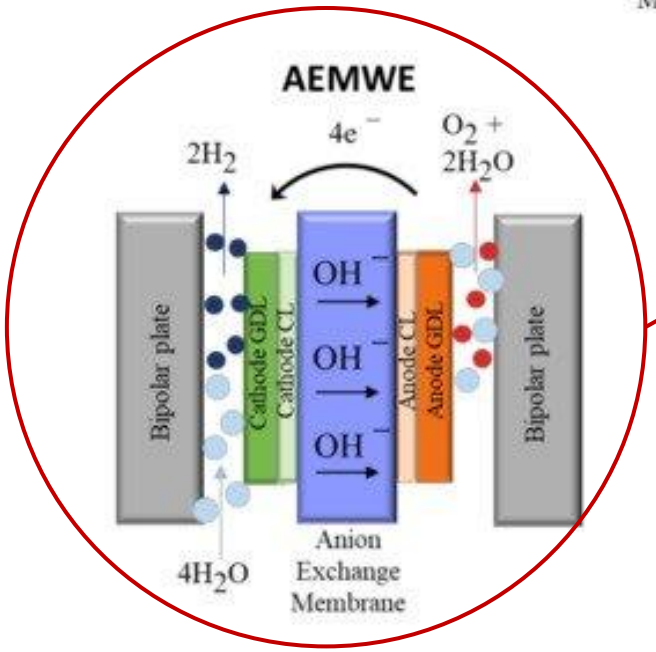
IRON REDUCTION REACTION WITH H_2

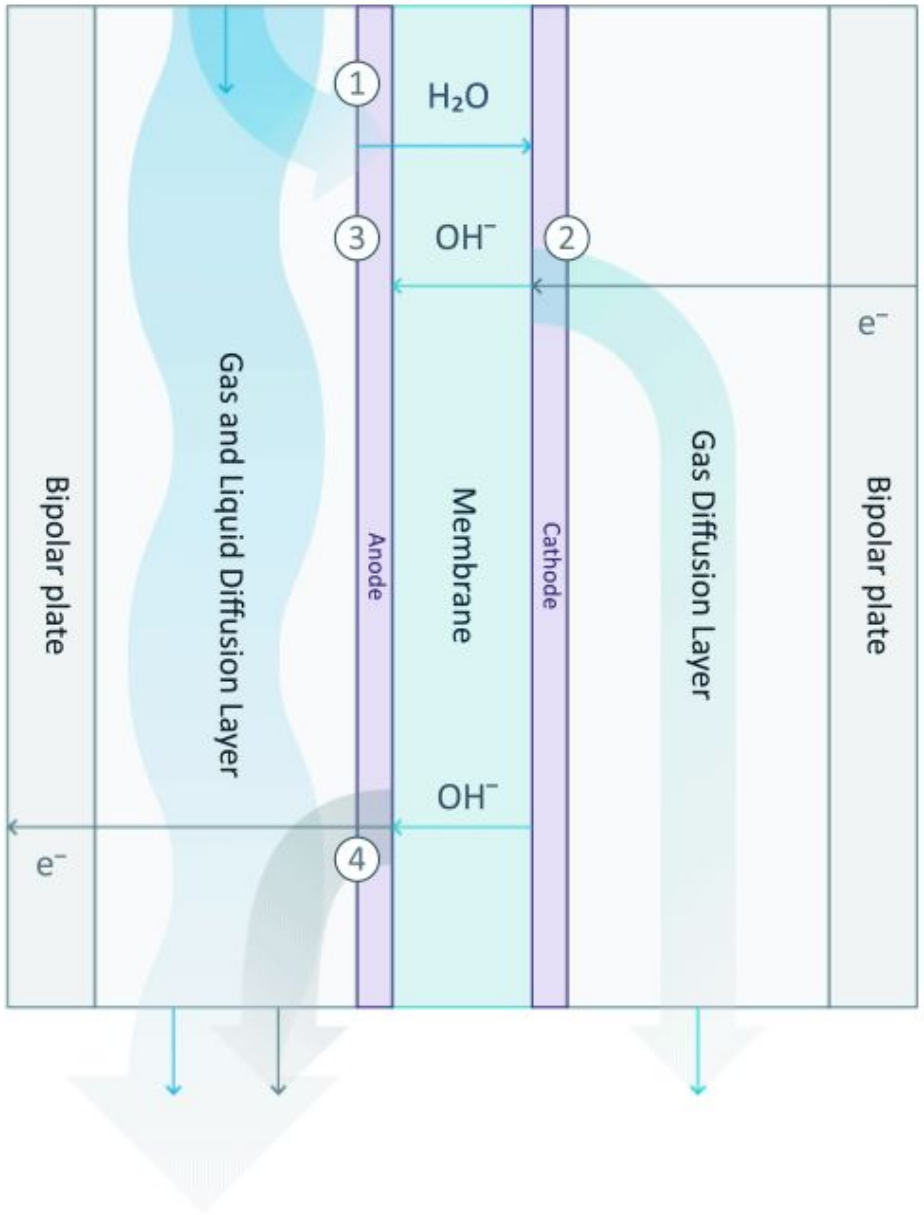


Low Temperature Water Electrolyser

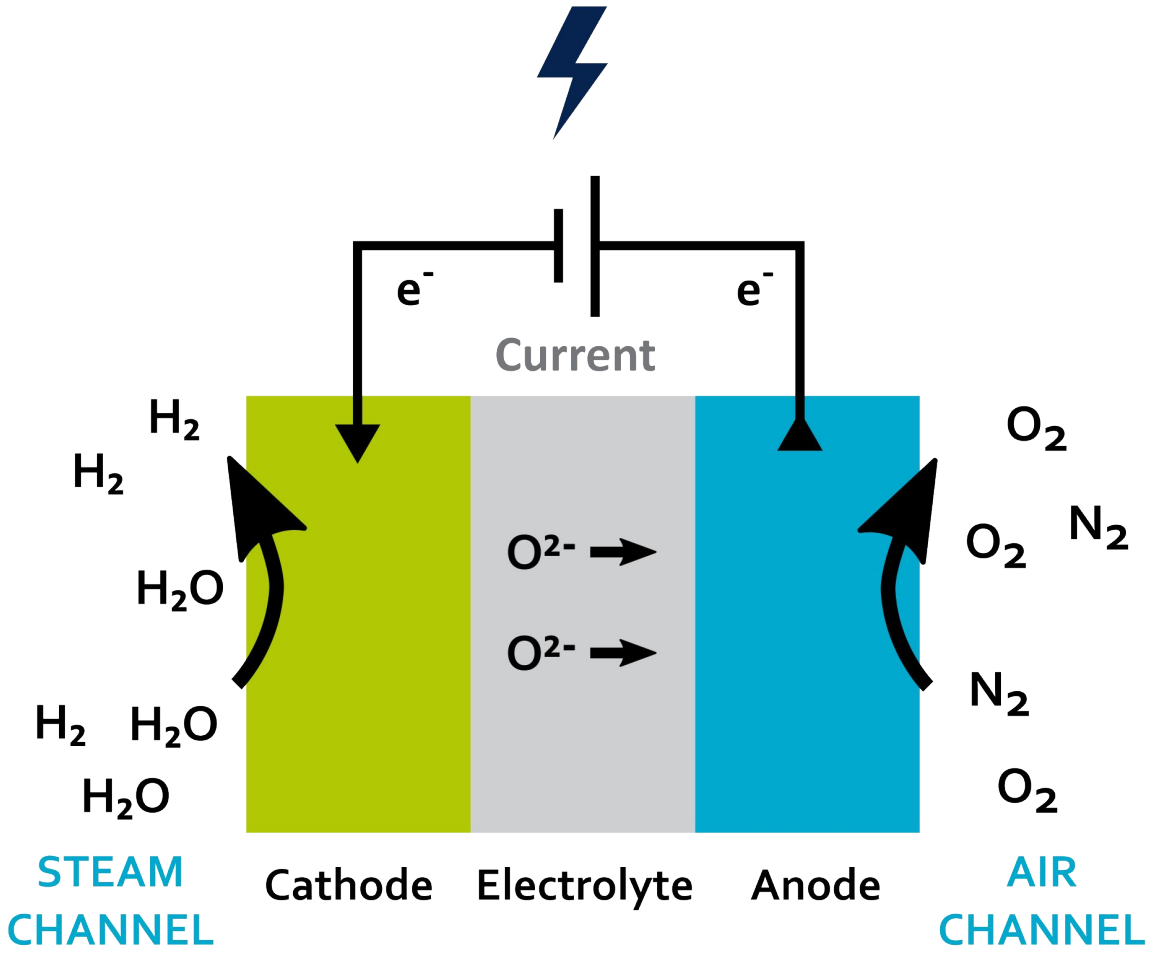






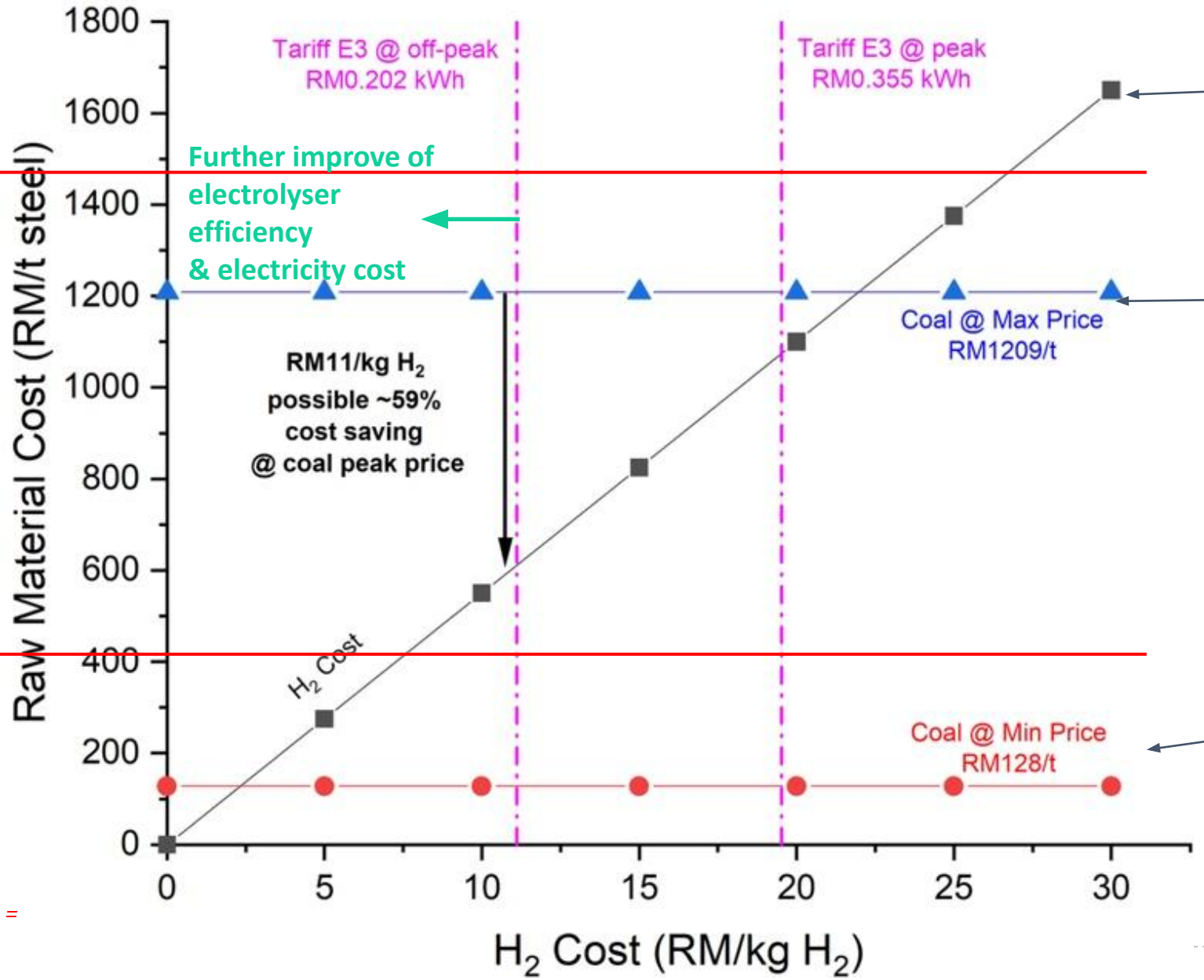


High Temperature Water Electrolyser (Lab-scale/prototype)



SOEC (Solid Oxide Electrolysis Cell)
Operating Temp: 700-850 °C
Efficiency: ~60-80%

FEASIBILITY OF HYDROGEN AS RAW MATERIAL



+ Carbon tax (~RM285/t)

*Based on the existing CO_2 emissions

+ Carbon tax

H_2 (RM/kg H_2)

Coal @ Max Price (RM 1209/t)

Coal @ Min Price (RM 129/t)

**Conversion rate USD$1 = RM4.40*

The missing pieces in conventional feasibility analysis…

Economic

Resources disruption cost?

The Conventional model

OPEX, CAPEX

Environment

Carbon price across the value chain?

Disaster recovery cost?

Social

Medical cost?

Food & living cost?

IF WE DON'T TAKE ACTION NOW…

Penalty to the energy intensive industries and environment

CO_2 emission intensity increases with increased production capacity

Vulnerable to global supply chain disruption

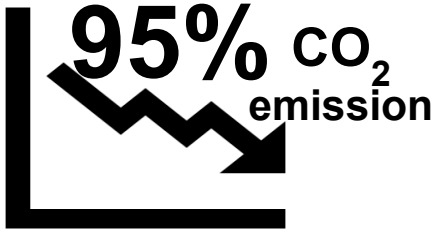
Russian-Ukraine War

Indonesia coal export ban

Impact to business

Losing market share and competitiveness

Poor ESG rating -> export restriction **(loss RM30b/yr)**



7.2 → **0.4**

million tonne/yr

Impact to nation

Missing NDC target

Take more effort to reduce carbon emission intensity

Climate Change Worsens

Extreme weather events & disaster risks

CONCLUSION

A Whole-of-Nation Strategy
Strengthen Adaptive Capacity of

Steel & Iron Industry

to **Climate Change**

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THANK YOU | TERIMA KASIH

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