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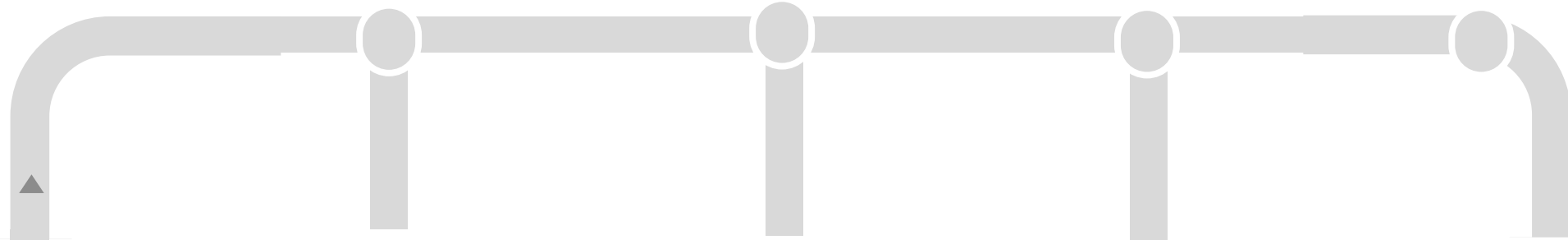
Green Hydrogen by Women
July 2021

01

My Journey to Work in Hydrogen

My Journey

My career has spanned several professions, a couple of countries and areas of interest – all of which has led me to work in hydrogen



Educational Background

Bachelor of Commerce

Bachelor of Laws

Trading

Started my career journey working in the stock market in Canada. This helped me to understand the commercial implications for businesses of government policies and announcements.

Lawyer

After a few years working in the market I went back to school and became a lawyer. I practiced for several years mostly in administrative and planning law. This led me to working in utilities regulation.

While working in utilities regulation I was involved in hearings relating to new generation facilities, new transmission infrastructure and setting rates to be charged to customers.

Energy Policy

I was presented an opportunity to move to Australia to work in energy policy with one of the Australian market bodies – the Australian Energy Market Commission.

Here I worked on energy policy in both the electricity and gas markets, including market design and major market reforms.

Consulting

My experience in energy policy took me to Deloitte to work in the Energy & Climate Advisory team. Within a couple weeks of my start, I was asked to lead a hydrogen project that we were doing to support Australia's National Hydrogen Strategy. From there, I have been involved in a large portion of the hydrogen projects that Deloitte has undertaken over the past couple of years.

02

Australia's National Hydrogen Strategy

The path to hydrogen deployment, both domestically and internationally, is not certain and could unfold in numerous ways.

01 *Hydrogen: Energy of the future:* This scenario provides information on the impact that hydrogen demand can have for Australia where all aspects of industry development are favourable for hydrogen

03 *Business as usual:* Under this scenario, Australia follows a path in which social, economic and technological trends do not shift markedly from historical patterns. However, there are shifts in global markets removing some barriers for hydrogen deployment

02 *Hydrogen: Targeted deployment:* Under this scenario, countries adopt a targeted approach which aims to maximise economic value and benefits for effort in the deployment of hydrogen

04 *Electric breakthrough:* Under this scenario, there is rapid technological development in electrification.

Deloitte analysis indicate that market activation will be driven by China, Japan, Korea and Singapore while pipeline gas is predicted to dominate from an application perspective

DEMAND BY REGION

From 2030 onwards, a clear increase in hydrogen demand is forecasted, driven by Asian countries **Japan, South Korea, China and Singapore**. Note that the rate of uptake depends on scenario and is strongest under *Energy of the Future*.

Region	Targets	Key Drivers
Japan	<ul style="list-style-type: none"> 800,000 FCEV by 2030 320 Hydrogen refuelling stations by 2030 	<ul style="list-style-type: none"> Energy security and reliability
South Korea	<ul style="list-style-type: none"> 630,000 FCEV by 2030 520 Hydrogen refuelling stations by 2030 	<ul style="list-style-type: none"> Energy security and reliability
China	<ul style="list-style-type: none"> 1 million FCEV by 2030 500 hydrogen refuelling stations by 2030 	<ul style="list-style-type: none"> Decarbonisation and air quality
Singapore	<ul style="list-style-type: none"> Developing hydrogen national strategy to accelerate hydrogen economy 	<ul style="list-style-type: none"> Economic development

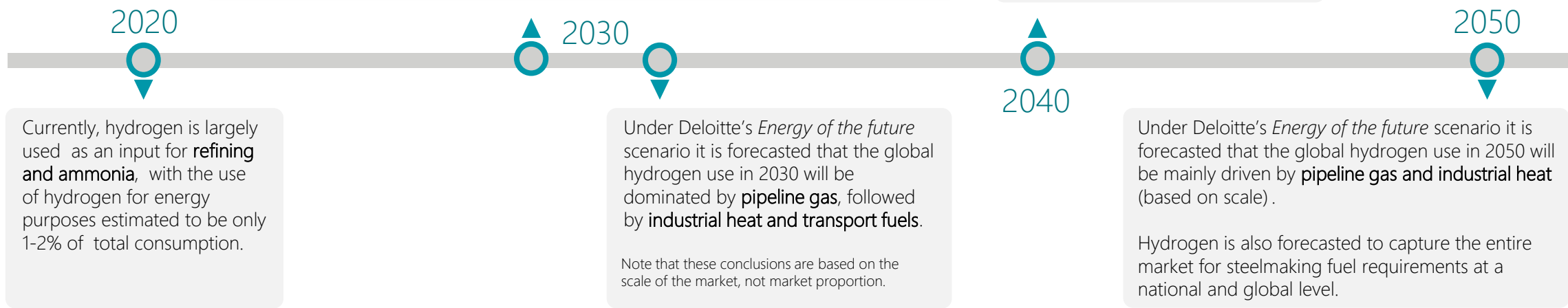
From 2040 onwards, it is forecasted that the rest of the world (such as Europe and the US) begins to play a more dominant role in hydrogen demand, and the combined demand of key hydrogen consumers in **Europe and America** quickly displaces the key Asian economies.

SIDE NOTE

The scale of demand and proportion of end-use application that might be captured by hydrogen use are highly debateable. Scale and proportions are determined by factors such as hydrogen cost reductions, government support in various markets and global drive towards decarbonisation⁸.

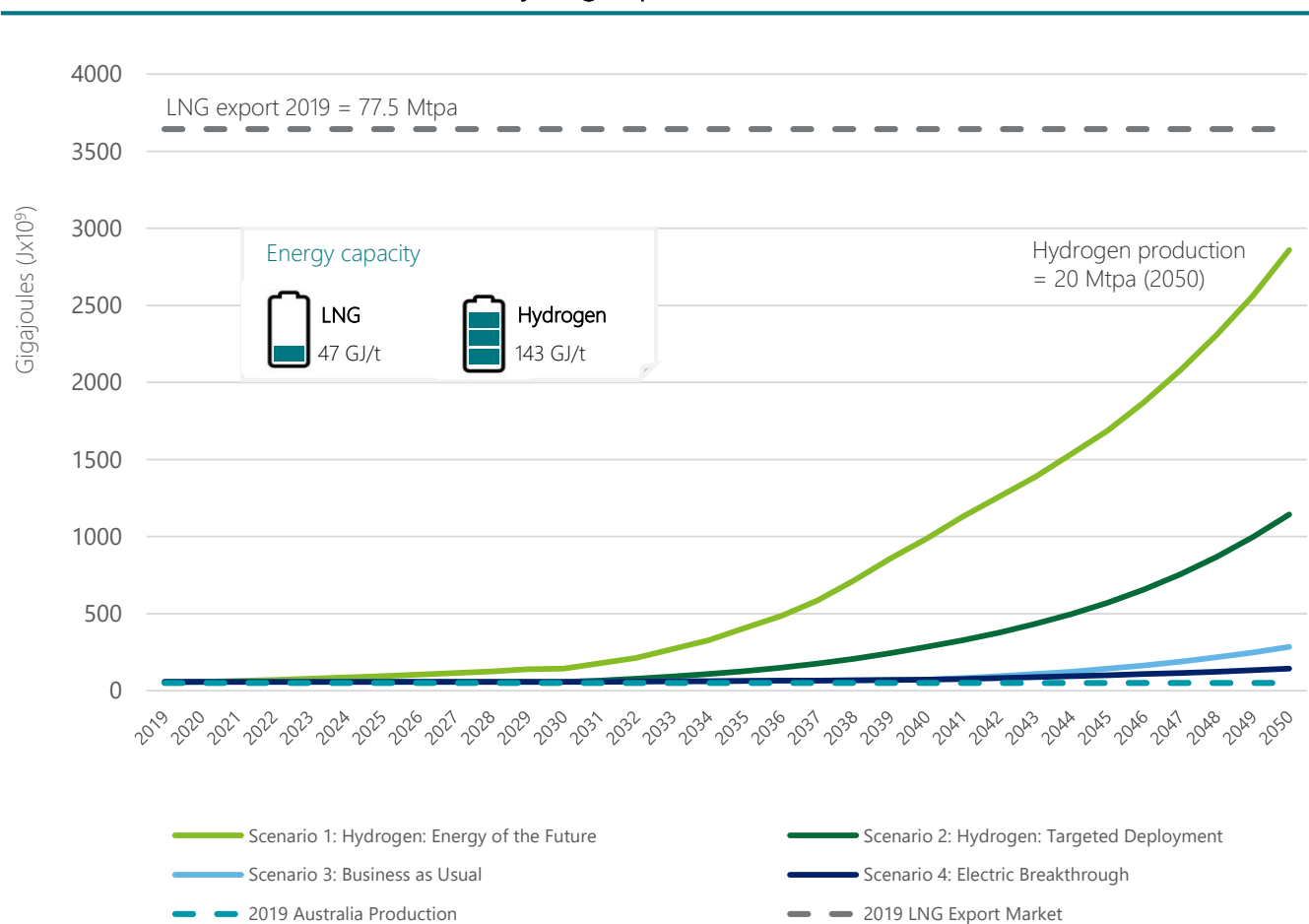
Therefore, a **qualitative** discussion of the trends over time is provided rather than a quantitative discussion based on the *Energy of the future* scenario.

DEMAND BY APPLICATION



Deloitte's Energy of the future scenario estimates that the domestic hydrogen production by 2050 could be as large as 70% of the energy capacity of the LNG export market in 2019

Additional hydrogen production from Australia



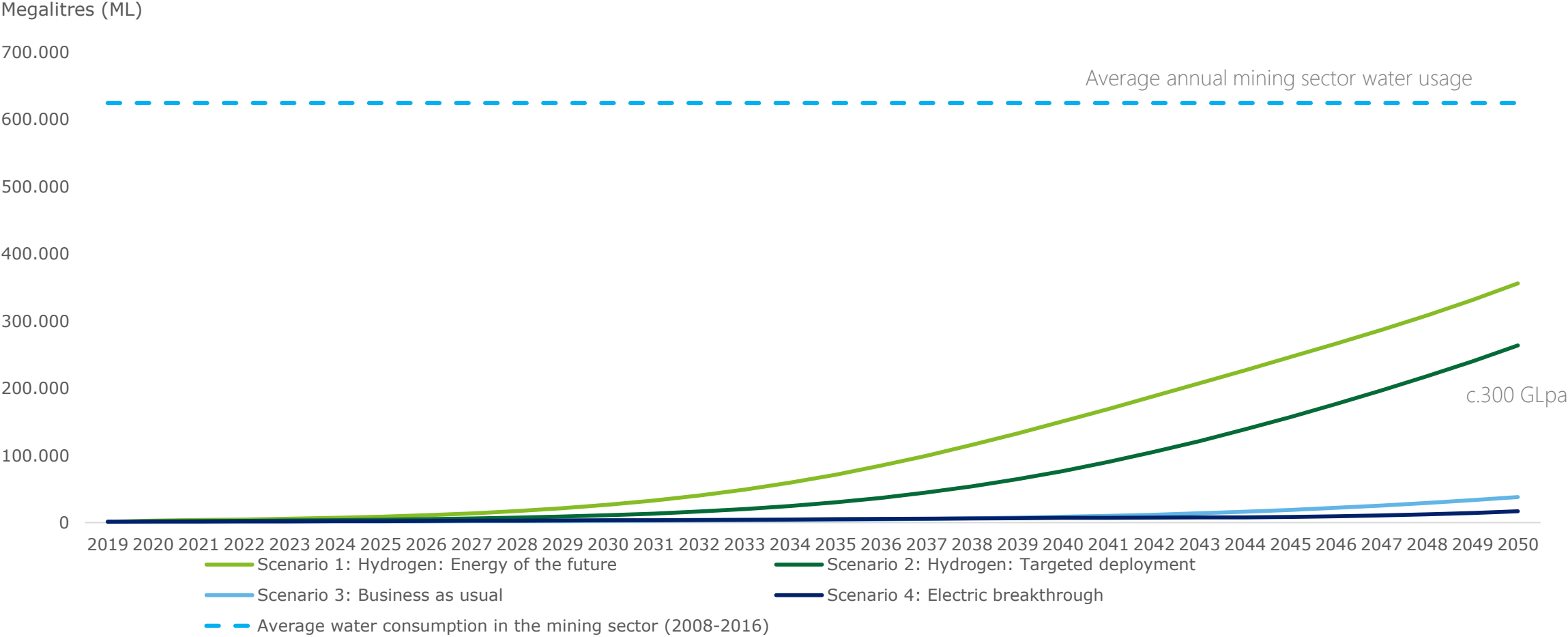
Energy of the future scenario discussed

- **Scale** - Under *Energy of the future* scenario Australia could produce 20 Mtpa of hydrogen by 2050. This equates to 70% of the LNG export market energy capacity in 2019.
- **Drivers** - Strong international and domestic policies to remove barriers and enable access to hydrogen translate to aggressive cost reductions for hydrogen production, improving hydrogen's cost-competitiveness with alternative fuels. This effectively leads to high proportions of end-use markets captured for hydrogen, leading to further increases in demand for Australian produced hydrogen.
- **End use** - By 2050, pipeline gas and transportation requirements constitute 68% of the total domestic hydrogen demand.
- **Impact on water** - Under the *Energy of the Future* scenario, hydrogen product would use 200,000MLpa, approximately 1/3 of the average annual water consumption in the current mining sector.
- **Impact on land** - Under *Energy of the Future* scenario the solar farm land requirement by 2050 would be 9,000km², equivalent to 3/4 the size of metropolitan Sydney.

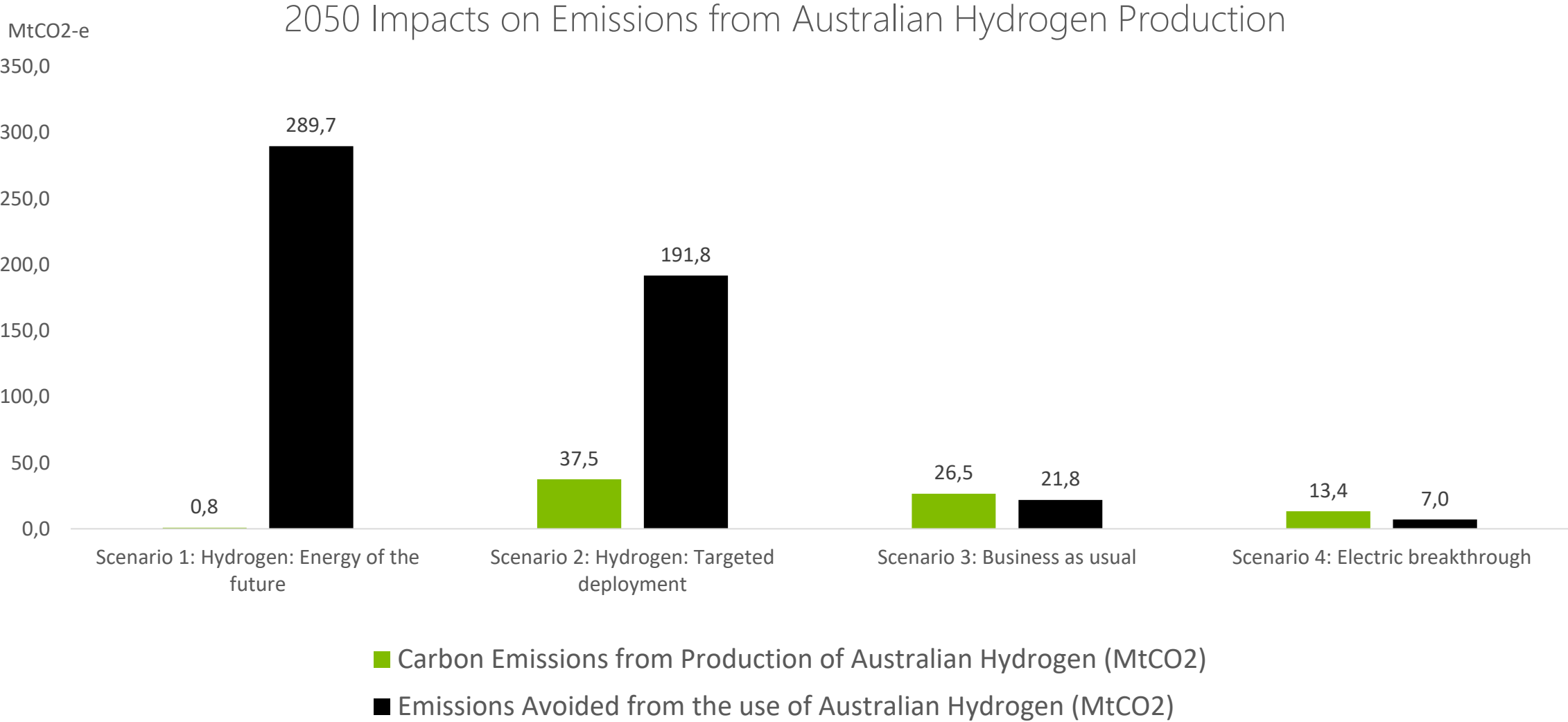
Source: COAG Energy Council – National Hydrogen Strategy Taskforce 2019, Australian and Global Hydrogen Demand Growth Scenario Analysis. Available from: <https://www2.deloitte.com/content/dam/Deloitte/au/Documents/future-of-cities/deloitte-au-australian-global-hydrogen-demand-growth-scenario-analysis-091219.pdf>

The report also examined the impact on water and emissions

National Annual Water Consumption of Hydrogen Produced in Australia



The report also examined the impact on water, land and emissions



Australia is well positioned to play a world-role as exporter in the hydrogen market. This is primarily driven by it's abundant natural resources, substantial experience in exporting energy, geographic location and relationships to key potential trading partners

Economic

Trade relations – Australia has **strong existing trade relationships** (including natural and energy resources export) **with the growing Asian markets** including both Japan and South Korea who have made hydrogen commitments.

Access to finances – high ratings with the World Bank and both State and National government funding.

Ease of doing business – Australia has proven itself a trusted energy trading partner and that reputation will be leveraged in a hydrogen export marketplace.

Environmental

Ports and other infrastructure – Australia is in a good position to leverage strong maritime infrastructure and experience in developing LNG infrastructure and its experience in exporting fuels.

Feedstock for generation – Australia's large tracts of land, together with its **ample natural gas, sun, wind** and general water access enables hydrogen production at scale.

Access to electricity for hydrogen production – several energy market reforms are currently underway which is likely to increase reliability of Australia's energy supply.

Political

Government stability and support – there is broad government support for the development of settings that will be needed for Australia to capture a portion of any future hydrogen export market.

Government transparency – the government has remained transparent and both national and state strategies and industry development plans have been developed.

Regulatory and policy settings – Australia is in a position to announce targets and policies to encourage the rapid expansion of renewable and hydrogen production.

Technical

Experience in delivering similar technologies – as a **global leader in energy exporting**, and the **largest exporter of LNG**, Australia is able to leverage its experience to enable the country to easily pivot to exporting hydrogen.

Availability of human technological resources – Australia has shown ability to innovate and develop new technologies and the workforce is highly skilled.



Signals and signposts

It is necessary to monitor which scenario pathway is most likely to play out and what, if any steps, can be taken to aid development of the pathway to align with Australia's aspirations

The following signals and signposts for 2025 and 2030 were developed:

- Global government / corporate investment in hydrogen
- Cost competitiveness
- Australia's market share
- Light transport
- Heavy transport
- Pipeline gas
- Industrial heat
- Steel making
- Feedstock use



Signpost – an example

Cost Competitiveness		2025	2030
PEM – Upstream CAPEX plus midstream CAPEX (lagging indicator)	Scenario 1: Energy of the Future	\$1.34/kgH2	\$1.06/kgH2
	Scenario 2: Targeted Deployment	\$1.41/kgH2	\$1.17/kgH2
	Scenario 3: Business as Usual	\$1.48/kgH2	\$1.29/kgH2
	Scenario 4: Electric Breakthrough	\$1.42/kgH2	\$1.20/kgH2

Enabling the potential of hydrogen to be realised

Three key market enablers

01

Take the Long View

Establish apolitical goals that provide clear director for industry over the next decade

02

Domestic Hydrogen Industry

To benefit from export markets we require a domestic market to be developed.

03

Widespread Value Streams

Need to examine the role of hydrogen allow the value chain and to leverage various end-uses.

Requires a stable policy framework built on:

- long-term commitment;
- building support, capability and capacity within the community;
- driving cost reductions through scale and emerging technologies; and
- developing early demand through industry partnerships.

There is a spectrum of policy tools that could be used by governments to promote hydrogen development:

Hydrogen Deployment Targets –

for example, setting a goal for the number of FCEV by 2050

Mandated Use-Cases – for example, hydrogen blended gas up to 50 per cent by 2030

Incentives for deployment – for example, tax breaks for hydrogen transport options



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