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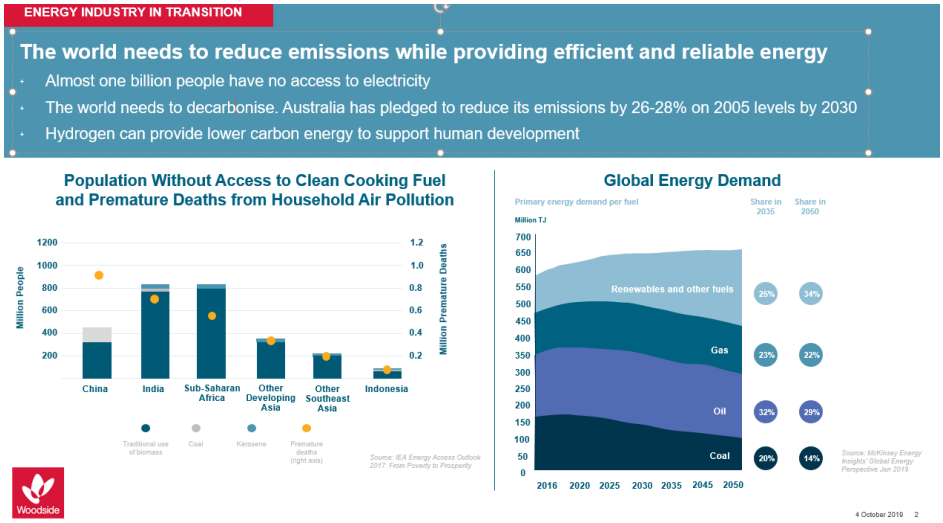
I would like to begin by acknowledging the traditional owners of the land we are meeting on today, the Gadigal people, of the Eora nation, and pay my respect to their Elders past, present and emerging.

Thank you to the AFR for convening an energy summit that covers the breadth and depth of challenges and opportunities confronting energy producers and consumers in Australia.

I'm pleased to be talking about one of the biggest opportunities – the opportunity for Hydrogen. But first, let me give some context around why Woodside is actively pursuing this opportunity.



This summit has heard from Australian manufacturers how vital energy is to them – the strength of our economy depends on industry being able to secure reliable and affordable energy supply.

Globally, extending access to energy can lift millions of people out of poverty.

Almost a billion people still lack access to electricity. Nearly 40% of the world's population have no clean cooking fuels, and instead burn wood, straw or dung. Household air pollution, mostly from cooking smoke, was linked to 2.6 million premature deaths in 2017.

Our world needs extra energy. And our world also needs to decarbonise.

The scientists are telling us the world needs to decarbonise. Some of our investors are telling us this. And our kids are telling us this.

This is the dual challenge – delivering more energy to the world whilst reducing the planet's carbon. The challenge is a big one, but it's one we must tackle. Let me outline to you, Woodside's part in this journey, and the role of Hydrogen in the dual challenge.

Woodside's core business is delivering energy in bulk to customers. We do this today in the form of Liquefied Natural Gas, one of the lowest emission fuels available and one which is incredibly dense in energy. One cargo of LNG can power tens of millions of homes – or to look at it another way, one home for 30,000 years.

And under all future scenarios, natural gas will continue to play a significant role for many years to come, delivering the energy the world needs and displacing higher emission fuels. So Woodside will continue to invest in gas, to ensure LNG can fulfil its role in the energy mix.

But we also know that our industry needs to get serious about managing its emissions.

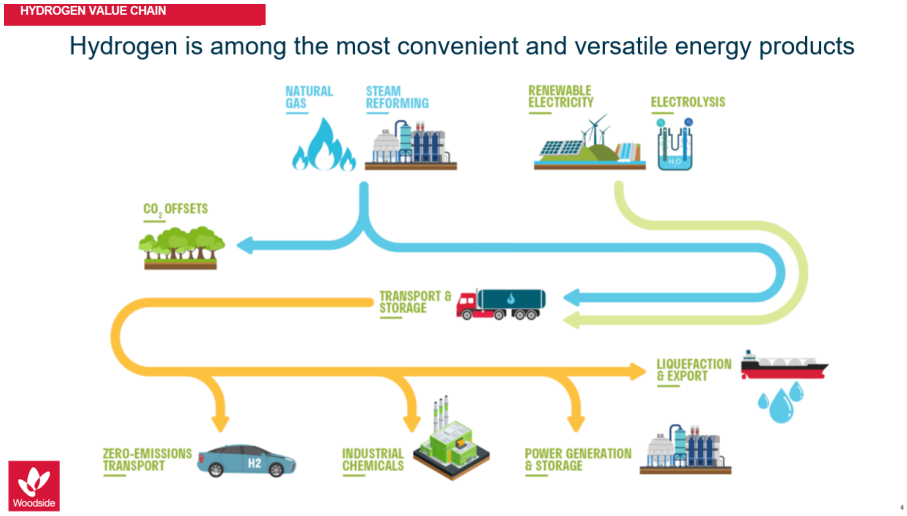
Woodside does this under four themes:
…in the design of our facilities;
…in how we operate them;
…in our efforts to offset emissions;
…and by diversifying into lower-carbon energy options.

I'll give you just a few examples:

- We have reduced emissions from one of our offshore platforms, the Goodwyn A platform, by installing a 1-megawatt hour battery, to remove the need for a spare generator to be constantly spinning in reserve.
- As part of our growth plans in northern WA, we are looking to integrate renewable and gas-fired generation to power our onshore facilities.
- A key theme of our Technology strategy is Carbon – exploring turning emissions into a product, such as feedstock for synthetic fuels.
- And, with respect to emission offsets, we have established an internal business to generate and acquire carbon offsets, including through our strategic partnership with environmental enterprise Greening Australia.

We are also considering how the skills and experience we have built up over decades as a gas producer can be used to develop and deliver lower carbon energy and support human development, in a commercially sustainable way.

It's in that context that we are looking at Hydrogen.



So, why Hydrogen? Simply put, it is a way to store energy that when consumed produces only water. That's why it's sometimes referred to as the Holy Grail.

Hydrogen can be used in a wide variety of applications including power generation, transportation and industrial processes, making it one of the most convenient of energy products.

You may wonder why we haven't done this already. Essentially – cost. The cost of production is not currently commercially sustainable, and the infrastructure to utilise Hydrogen is not in place. But things are changing rapidly.

We see great potential for Australia to grow a Hydrogen export industry, which may in time reach equivalence with LNG exports. But to get there, it's going to take big investment from industry and a smart and agile policy framework.

We've seen a number of "false dawns" for Hydrogen before; this time, the world has to get it right: And Australia has to get it right, as one of the countries with the most to gain from growth in the Hydrogen economy globally.

Let's talk about three key challenges we need to overcome:
1. Scale
2. Transition
3. Collaboration

Firstly, Scale (Challenge 1)

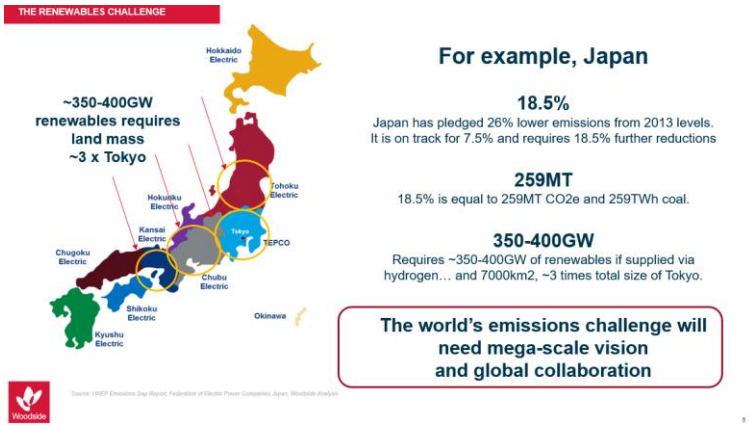
It's tempting to assume our sunburnt country has everything that's needed to support the immediate scale-up of solar-powered Green Hydrogen.

But let's consider the scale of power that's required to produce it.

At the July 2019 Clean Energy Summit, Australia's Chief Scientist Dr Alan Finkel said that Australia could in 20 to 30 years export 30 megatonnes of Hydrogen annually. This would match the energy exported in the 70 Mt of LNG the country shipped in 2018, as Hydrogen has 2.4 times the energy density of LNG.

However, Dr Finkel pointed out that it would take 1,980 TWh to produce that Hydrogen, if solar power drives the electrolysis.

That's eight times more than Australia's *total* electricity generation today.



Let's think about that in the context of one of our most important energy export markets, Japan. Japan has set itself the goal of reducing emissions by 26% from 2013 to 2030, and reaching carbon neutrality as early as possible in the second half of the century. The latest figures show that Japan still needs to achieve 17.6% in reductions. That gap amounts to approximately 250 MT CO2 emissions per annum – or roughly 250 TWh per annum of coal-fired generation.

Consider for a moment how much solar capacity would be required to produce that much hydrogen from renewables. It would require a land mass much bigger than Tokyo, in fact roughly three times Tokyo's land mass.

Renewable energy has undergone dramatic growth in Australia – and will continue to grow - but that is a very steep increase indeed. To date, renewable energy has been solely for domestic use – if it is also to support Hydrogen exports, we'll need to build extra capacity dedicated to that purpose.

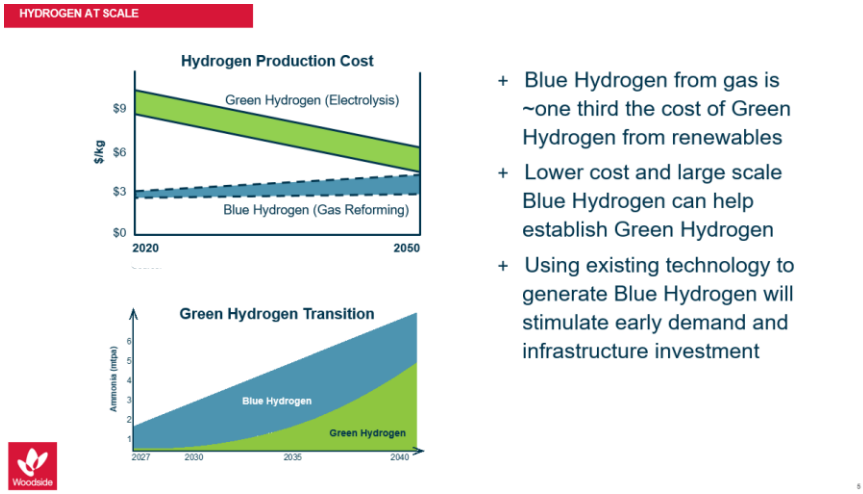
In addition, there could be challenges such as land access rights, transmission lines, or climate change impacting weather conditions that underpin renewable power.

Scale applies not only to the hard infrastructure of pipelines, terminals, trucks, power stations and vehicles, but also to the soft infrastructure of regulatory standards, a trained and certified workforce, consumer acceptance and trading relationships.

So how to do we address this challenge?

1. Using existing technology is a great starting point: For example, generating Blue Hydrogen from natural gas can stimulate early demand and investment in infrastructure.
2. Adapting existing technology for a new use also plays a role: For example, using ammonia as a Hydrogen carrier, and injecting 10 to 20% of ammonia into coal-fired boilers for power.
3. Finally, let's invest in prototypes that help with scaling. I'm not talking about proof of concepts to demonstrate that we can produce Hydrogen; we need prototypes that address the challenges of scale, and ultimately reduce costs. These may not be as sexy or headline grabbing, but they represent core science work that needs to be undertaken.

I'll move onto **Challenge 2 – Transition**



Transition comes in two forms – transitioning from pilots to production at global scale, and from Blue Hydrogen to Green.

The former – from pilots to scale, will ultimately take care of itself. Capability and capital are already available, meaning that if the pilots are successful, and if there is sufficient demand– scale is inevitable.

What about Blue to Green Hydrogen? For now, the cost of producing Green Hydrogen is approximately 2 to 4 times the cost of producing Blue Hydrogen from natural gas.

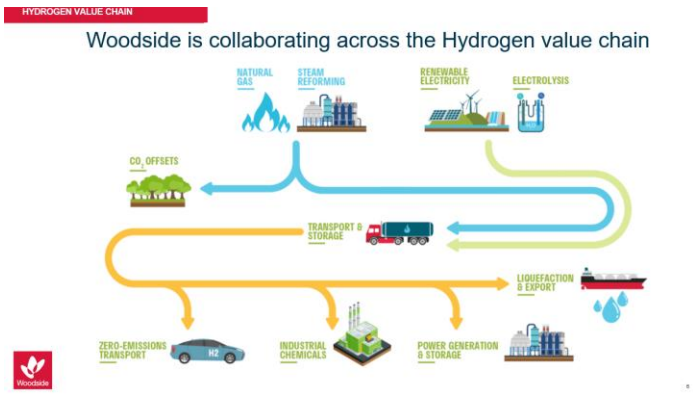
Australia has ample potential sources of renewable power, but there is still a long way to go before those sources are developed to a scale to support mass Green Hydrogen production for export.

We must address this transition, and we must make energy cheaper. There's a number of ways we can do this.

1. Let's encourage all technology efforts to manage carbon. Whilst carbon sequestration has a role, it would be far better if we could turn emissions into a valuable product whilst still reducing the world's carbon. Don't rule out the capacity for human ingenuity; consider carbon utilization, not simply storage.
2. Let's also ensure technology pilots are focussed on addressing bottlenecks in processes to improve efficiency and bring costs down, making energy increasingly competitive.
3. Finally, we need to take advantage of those areas where Hydrogen is already cost competitive, or where a premium would be paid, to drive early adoption and support both scale and infrastructure development.

Woodside is working with research institutions to explore these opportunities. These are not easy challenges: if they were, they would have already been solved; importantly they offer a tremendous opportunity for Australia to take a world-leading position in the Hydrogen export market.

Finally, **Challenge 3 – Collaboration**



We must not overlook a key point – what do our customers want?

Our customers want energy that is (1) affordable (2) low emissions (3) reliable (4) at scale. Power, transport and manufacturing customers all want Hydrogen delivered in different forms, produced at different scale. We need to work with them to tailor solutions to meet their needs.

Woodside has decades of experience exporting LNG to Japan and Korea – both of which are showing keen interest in the emerging Hydrogen economy. We have seen signals from the Japanese Government this year that, faced with the emissions challenge I discussed earlier, decarbonisation is urgent. We are talking to our customers in both countries about their needs, as well as considering Australia's domestic requirements.

Perhaps an example here helps. What form does Hydrogen take?

- Power companies want Ammonia;
- The transportation industry is seeking pure Hydrogen, shipped in liquid form; whilst
- Manufacturers want the form of Hydrogen which is most efficient for heating.

My point is this – there are many options in the Hydrogen economy, and the end-use or customer is vital to each investment decision. So how to address this? Collaborate, and collaborate deeply.

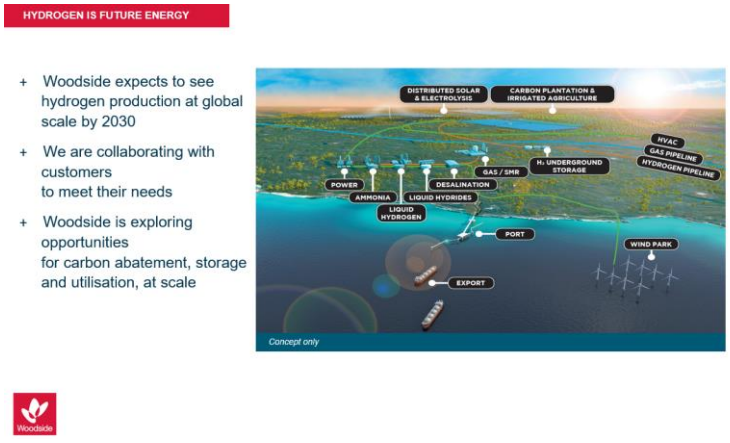
We have agreements with several universities and other research organisations, both here in Australia – including Monash, Curtin, the University of Western Australia and CSIRO – and abroad.

Last month, Woodside and Korea Gas Corporation signed an agreement to jointly study the technical and commercial feasibility of a green hydrogen pilot project.

Woodside is in active discussions with major Japanese partners and utilities regarding the potential for export of commercial scale carbon-free hydrogen and related technologies for power generation and other applications in Japan.

We believe it is not a race to be first: it is a marathon to do it right and sustainably. And the best way to get there is to work with others – with customers, researchers, even competitors.

Conclusion



At Woodside, we believe in thinking big, starting small with prototypes, and then scaling fast. We are forming partnerships now to facilitate this. And our customers are seeking to transition as well. By 2030, we expect to see large-scale Hydrogen production around the world – and we intend to be part of that.

There are many commonalities between the traditional LNG industry and a future Hydrogen industry – the potential for complex, large scale project development, products at low temperatures and high pressure, long transport distances to export markets, safety

and reliability requirements, and the need for partners with significant operational capability and financial wherewithal.

In short, Australia has a rich resource endowment, from minerals and gas, to sunshine and wind. But we need to proactively address the issue of transitioning both to Hydrogen-at-scale, and to increased usage of renewables in Hydrogen production. Importantly, this must be in conjunction with a broad technology approach to managing carbon.

We are not starting from scratch; rather, we are building on our existing skills and capabilities. Australia's experience as a leading exporter of LNG gives us a firm basis to leverage in developing a successful Hydrogen economy for Australia.

Delivering more energy to the world whilst reducing carbon emissions is a global challenge, one in which Hydrogen will play a key role. Australia is well-placed to capture these opportunities, and both Woodside and I are incredibly excited to be part of it. ENDS