Innes Willox: Address to the 2022 Australian Hydrogen Forum

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Good morning, and it's a pleasure to talk about hydrogen and industry with you at what is a critical moment for the world.

These are not usual times.

The world, and the world order, are changing before our eyes.

For the last thirteen thousand years, humanity enjoyed a mild and relatively stable global climate. That is now giving way to a hotter, harsher world where records for heat, fire, flood and drought tumble all too often. With sustained policy, investment and innovation we can still meet the Paris temperature goals. But even in the best case we will still have to live with substantially higher temperatures, extremes and disasters.

For more than 70 years, a trend towards ever freer and deeper trade sped economic development and boosted the affordability, quality and quantity of goods and services. But while that free trade regime remains vital, it faces a backlash from those left behind by economic change, and security challenges to economic integration.

In the three decades since the end of the Cold War, great power competition was muffled. Now there is war in Europe. And US allies clearly see a renewed need to make large security investments and take hard security decisions to match a more dangerous geopolitical environment.

What, you may ask, does all this have to do with hydrogen?

It has everything to do with hydrogen.

Hydrogen has long been seen by many as a solution in search of a problem. Hydrogen from fossil fuels was of interest in refining and fertilisers and rocketry. But in the old world with cheap and secure fossil fuels, and no apparent consequences from burning them, why would you bother with hydrogen for any other purpose? And why would you go to the expense and trouble of making it cleanly?

That sentiment is recent. But subjectively it now feels quite distant. Today climate, economic and security problems are urgent and glaring. Hydrogen is clearly one of the most scalable and broadly relevant solutions, even if it will not solve everything.

Today I want to talk about five key aspects of the hydrogen opportunity:

- First, the state of play on hydrogen as a solution. Where is it looking credible, and where is it unlikely to succeed?
- Second, the path to cheap hydrogen. What is "cheap" and how does it happen?
- Third, the size of the potential hydrogen opportunity – and the importance of uncertainty.

- Fourth, the tools available to Australia to realise the potential of hydrogen and other solutions.
- And fifth, the implications of Russia's invasion of Ukraine and the international response.

I'm going to start at the end, because the Ukraine situation is an earthquake for energy, as it is for so many other topics.

UKRAINE

I want to be duly cautious about the evolving situation around Ukraine because it shifts day by day.

Some major consequences are already clear, however.

Russia's role as an energy supplier is under intense immediate pressure from sanctions, but is also facing much deeper challenge over the medium term from Europe's push to wean itself from Russian energy. That has lasting global consequences.

Russia was the largest exporter of natural gas in 2020. They were the second largest exporter of oil that year. They were the third largest exporter of coal in 2018. Russia makes a difference. In the past their various fallings-out and make-ups with OPEC have caused oil prices to plunge and to recover. Slackening in their gas supply to Europe was one of the big factors in the 2021 run-up of spot gas prices.

Sanctions are now having an impact on that supply. Financial sanctions make it harder to export energy even where they are notionally designed to avoid energy disruption. Western businesses are self-sanctioning in their haste to disassociate from Russian energy. The United States, the UK and Australia are formally banning energy imports from Russia. And while both Europe and Russia would suffer from an acute stop to their energy trade, rumblings and threats are rife. If the pipelines are shut off – at either end – it would not be the first time in human history that nations chose to harm themselves.

It would not even be the first time this year.

Existing disruption, and the fear of more to come, has seen fossil energy prices soar.

After spending much of the past decade around US$50 per barrel, and briefly dipping below zero during the pandemic, oil prices are back over US$100 per barrel.

Spot gas prices in Europe and Asia were high even before the invasion. Now Europe is looking at the equivalent of AUD$50 per gigajoule and Japan-Korea Marker futures are above AUD$40 for the rest of 2022. In Eastern Australia we've thought of AUD$10/GJ as "high".

High gas prices are driving high demand for coal which, along with supply impacts, has sent coal prices leaping from US$60 per tonne a year ago to more than US$400 per tonne in early March.

These are volatile markets and what has soared may sink. But Europe now sees energy trade with Russia not as a path to peaceful integration but a source of unacceptable European weakness and Russian leverage. They are muscling up for an immense and sustained effort to reduce their dependence, especially with respect to Russian gas.

The European Commission is developing a plan to reduce EU imports of Russian gas by two thirds in 2022 and entirely by 2027. Member states are debating the pace, but not the direction, and it looks likely that some version of this plan will be pursued.

- The long term elements of the plan are to shrink demand for fossil gas by building up Europe's access to renewables, boosting energy efficiency, and deploying a mix of electrification, hydrogen and biogas to meet different energy users' needs.
- The medium term elements of the plan are to avoid gas demand growth by delaying the retirement of existing nuclear and coal power plants. The idea of a coal-to-gas switch as a bridge to renewables appears dead, at least in Europe – though the flexibility of gas is not something that coal can easily match.
- The biggest immediate tool in the European kit bag is to suck up all the LNG they possibly can from global markets. The International Energy Agency estimates Europe can buy up around 1,000 extra petajoules of LNG this year, equivalent to just under a quarter of Australia's total exports.

Little of Europe's LNG buy will be new gas. Production will respond only slowly, partly for financial reasons and partly for physical ones. Some may be freed up by worldwide price and policy responses on the demand side. But most will represent European buyers outbidding others.

That means sustained higher gas prices around the world. It is hard to believe that Australia can be immune from this. Our status as a major gas exporter makes it all the more likely that local prices will be impacted by international price expectations, even if they don't track every twitch of LNG spot markets.

Price pressure will last for years. European efforts on efficiency, electrification and gas substitutes will take time to build up, though they are likely to be huge in the long term.

We can expect prices and policy to drive demand-side change in other economies too, though with less strategic urgency behind it.

Meanwhile it would take years to build new infrastructure to redeploy Russian gas to neutral customers. Denial of Western skills and supply chains might mean even longer delays.

Oil and coal exports may be less inflexible over time. But world gas markets now look tight for years to come.

There are big human consequences to all this. European cost of living pressures will be intense, of course, but there are likely to be even more serious effects on the global middle class, and on the prospects for reducing energy poverty – at least in the near term.

But there are also consequences for the prospects of hydrogen.

Hydrogen will receive two very big boosts.

The first is to its immediate cost competitiveness. Whether hydrogen is "cheap" or "pricey" was always a question of context. Now, with sky-high prices for coal, gas and oil, the context has changed:

- On a fuel cost basis new green hydrogen now looks cheaper than spot gas overseas.
- Green hydrogen has gone from three quarters of the price of diesel to half the price.

Yes, it takes significant capital outlays for end users to switch fuels. Yes, prices will surely move again. But these relativities change the game.

The second boost is to the speed of long-term hydrogen cost decline. The cost of making hydrogen is not fixed, nor is the rate of cost decline. It's about deployment. Every doubling of global installed electrolysis capacity slashes the cost of the next doubling as manufacturers and supply chains learn and scale up. So as Europe and others deploy more hydrogen in response to high fossil energy costs, we should expect cost reduction goals to be hit earlier than past forecasts.

On the other hand, it won't all be plain sailing for hydrogen.

One hitch is that, while green hydrogen faces boomtime, blue hydrogen has a big problem. The main argument for it was that it was a relatively cheap and scalable way to start a hydrogen economy while green hydrogen costs came down. But newly pricy and scarce feedstock means that blue hydrogen made from natural gas or black coal generally won't be attractive on cost or security. The rare exceptions may be where there are stranded gas resources that can't be exported, but can host a hydrogen-intensive activity.

By contrast, brown coal is not easily exportable or subject to international price pressures and the prospects of blue hydrogen from brown coal may be brighter post-Ukraine. But it will be essential to establish the technical and regulatory credibility of the high carbon capture rates required if any projects are to move forward.

A second hitch is that hydrogen will not only be competing with coal, gas and oil. Biofuels, electrification and efficiency will also get a boost, and the most scalable and manufacturable solutions will also exhibit strong learning effects.

A third problem is that hydrogen will face supply chain pressures of its own in the near term. Electrolysis is capital intensive, and the costs of labour, materials and money have been rising worldwide. A major economy scramble for hydrogen and other solutions should reduce costs in the medium term but it may well drive costs higher in the near term until resource and supply chain bottlenecks are overcome by new investment.

In short, the invasion of Ukraine accelerates the growth of hydrogen. But it also brings some growing pains.

PUTTING HYDROGEN TO BEST USE

Let's keep the Ukraine situation in mind as we turn to the other issues I flagged.

As we all know, hydrogen has many possible uses. Some have called it the "Swiss Army Knife of energy".

The thing about Swiss Army Knives, though, is that while you can do a lot of things with them, you mostly don't. You may use the corkscrew every so often, while the hoof cleaner and the marlinspike gather dust. Some jobs don't come up much, and most jobs are best done with a specialised and convenient tool.

So what end uses for hydrogen are most likely to prosper in the long term?

But also, does it matter much right now?

Hydrogen has enough uses in a world striving for net zero emissions, and its competitors have enough limitations, that it is likely to be at least big, if not colossal. However, the biggest immediate barrier to most potential hydrogen applications is cost.

One possible view is that scarce and expensive clean hydrogen should be carefully directed only to those uses that make the biggest difference for emissions or make the most long term sense.

Another is to say: who cares where the hydrogen goes today? Cost declines with deployment. The relative value of hydrogen in all contexts will be very different when cost is lower. The overwhelming priority should be to deploy, deploy, deploy. On this view, near and medium-term demand only matters to soak up early expensive supply.

The Ukraine-driven shift in cost relativities is likely to help reconcile these views a fair bit.

If natural gas is available for $9 per gigajoule and green hydrogen costs $30 per gigajoule, substituting hydrogen to reduce greenhouse emissions costs more than $300 for each tonne abated.

But if gas rises to $25 per gigajoule – far below current international spot prices, but consistent with oil price equivalency – that abatement cost drops below $80 per tonne. That's well within the range of the more ambitious carbon pricing schemes in Europe and Canada.

And if green hydrogen costs fall to $20 per gigajoule, the abatement cost of gas substitution goes negative. Indeed, at current thermal coal and coking coal prices, substituting those with hydrogen would cost the equivalent of $23 per tonne of emissions abated, or less. That's within the range of a lot more carbon pricing schemes worldwide, including Australia's idiosyncratic Emissions Reduction Fund market.

That said, the urgency of substituting away from high-cost, high-emissions and highly insecure energy does impose some discipline. Solutions have got to be deployable at a scale that makes a difference in the real world, not just look good in a spreadsheet.

Which leads us back to the question: how do different uses stack up, particularly for Australia?

Chemistry, steel, peakers and heavy transport look like the best bets, though they all have question marks.

Production of essential chemicals is the main source of demand for grey hydrogen today and will surely use green hydrogen tomorrow. Cost competitiveness has been a serious barrier. A sustained global surge in gas prices will not completely solve that; some global chemicals sector players will be less affected than others – whether because of market structure, long term feedstock contracts or public policy.

Using green hydrogen in the chemical industry also requires substantial process changes and capital upgrades. Making those investments in Australia is not easy, but there are advantages for customers and nations from strong and trustworthy supply chains. Suppliers, customers and governments need to collaborate if we are to take the plunge.

Steel is a similar story. There are other competing solutions here for primary steelmaking. But the global momentum in the past year has been with direct reduction of iron oxide with hydrogen – or with natural

gas as a stepping stone to hydrogen. The latter may now have to be reconsidered. But in any case we are talking new facilities to replace blast furnaces, not minor upgrades. That is a big deal for companies and communities.

A power grid increasingly built around cheap bulk energy from wind and solar needs flexibility too – lots of it, and different kinds. Peaking generators, burning a blend of gas and hydrogen, and eventually just hydrogen, are cheap to build but would be too expensive to run for everyday needs. But they seem like a good fit for renewables droughts, which might occur only once in several years but last for days or weeks when they do happen. Think of hydrogen peakers as an insurance policy with a low premium and a high excess.

However, peakers can only be as flexible and reliable as their fuel supply. That means either access to sufficient fuel storage to sustain rare extended periods of full output; or the ability to dip into a broader fuel market for days or weeks at a time. This is a challenge for hydrogen today, but it may increasingly become a problem for gas-fired peakers too as other gas users substitute away from fossil methane. These dependencies have to be convincingly answered before power system planners can assume peakers resolve renewables droughts.

Heavy transport also looks like fertile ground for hydrogen, though the specifics differ markedly across road freight, shipping and aviation, and battery electric options are looking more relevant to more niches than many would have thought a few years ago.

Those are the probable hydrogen winners. There's also a likely hydrogen loser - light transport. Never say never, but the global car industry momentum is overwhelmingly with battery electric – albeit little of that in Australia so far.

Finally, in between the winners and the losers are the maybes. Heat is the big one, though again there are many different contexts under that heading. Hot showers, rare steaks and bricks are very different products and we should not be surprised if the best pathways for their transition from natural gas are different too.

Arguments are particularly intense over the solutions for household gas use. Is it better to migrate household heating, water heating and cooking to efficient and smart electric appliances? Or would that have higher overall costs than migrating to 100% hydrogen appliances, once we take account of the relative costs to augment energy networks to meet peak loads in each scenario?

Ai Group does not know the right answer. But the development of the Victorian Gas Substitution Roadmap is bringing this fight to a head, and the Ukraine situation is making it clear that we need to move at a brisk clip. Appliance makers, builders, energy suppliers, regulators, tradies and trainers all need a clear steer on what to prepare for. With the status quo becoming intolerably expensive, playing for time to keep future options open is no longer a no-regrets strategy.

THE ROAD TO CHEAP HYDROGEN

I've already noted that hydrogen gets cheaper with faster deployment. I want to unpack some implications.

Most importantly, and I've said this before, the road to cheap hydrogen lies through lots of expensive hydrogen. Many gigawatts of relatively expensive early electrolysis has to be deployed worldwide for supply chains to learn how to make electrolysis cheap. This is not a job that can be delegated to white-coated boffins in a lab somewhere, or a plucky pilot project here and there. Big stuff has got to be built, and somebody's got to pay for it.

Most Australian hydrogen strategies to date are largely export-oriented – governments are saying "If someone is mad enough to buy, we'll be ready to sell." Some may see that as responsible caution, others as irresponsible coasting while others do the heavy lifting. But I think it's just a bit short-sighted. Exports of hydrogen or hydrogen-intensive products are potentially a very large opportunity for Australia. We have a lot to gain in a faster transition, and global clean hydrogen demand is small enough today that Australian demand decisions can meaningfully expand it. Why wouldn't we be in the forefront on the demand side as well as on supply?

Learning rates should encourage us to stop taking technology cost estimates as a given. Modelling exercises are much easier when the model is simply told "hydrogen will cost X in year Y". But the cost outcome we get will be a function of local and global policy choices about the pace of change. There have been many positive signs over the past year that the rate of public and private investment worldwide will deliver faster deployment and faster cost declines. Ukraine is going to accelerate that further.

Learning rates are most marked for technologies that are modular and manufacturable and may be disappointing or even negative where every project is its own unique saga. That would give green hydrogen the edge over blue in the long term, even if fuel costs were not in such flux.

Finally, learning rates create a risk for the supply side. I've heard people object to blue hydrogen projects by saying they'll be stranded when future green hydrogen projects undercut them. For gas and black coal-based projects that day may be here. But actually, <u>every</u> early hydrogen project, green included, is likely to be undercut by every later hydrogen project. Long term contracts or long term policy supports will be important to every project that goes ahead.

HOW BIG IS BIG?

Before I turn to public policy, I want to say a few words on how big hydrogen could be – and the uncertainty involved.

How big global clean hydrogen gets depends on:

- how fast the world heads for net zero emissions;
- how well hydrogen performs against other solutions, including existing fossil fuels.

However big that global market is, Australia's opportunities within it depend on:

- how attractive and scalable we are versus other would-be hydrogen exporters; and
- how attractive hydrogen trade is for current energy importers, versus making hydrogen locally or moving hydrogen-intensive activities.

You can be very positive about hydrogen and still see a yawning spread of scenarios for how all that plays out!

Total global demand for hydrogen in recent years has been around 90 million tonnes per annum, nearly all of it high-emissions grey hydrogen. Specific demand for clean hydrogen has been so scarce that the announcement of just 200 tonnes a year of demand from the Tallawarra B power station was considered exciting.

Three years ago, the most ambitious scenario in Australia's National Hydrogen Strategy projected 156 million tonnes per annum of global clean hydrogen demand by 2050.

Last year, the International Energy Agency's Net Zero by 2050 scenario projected 520 million tonnes per annum of hydrogen demand in 2050.

Bloomberg New Energy Finance foresees between 190 million and 1.3 billion tonnes of annual demand by 2050.

Goldman Sachs' "Bear" case is 220 million tonnes per annum by 2050, and their "Bull" case is 540 million tonnes.

Ai Group has done our own simple estimates. Suppose hydrogen turns out to be the whole answer to decarbonisation of steel and ammonia making, a partial answer to heavy transport, a small part of total heating needs and 1% of electricity supply. Ignoring global demand growth, that would mean at least 245 million tonnes of demand for clean hydrogen.

These are all big numbers compared to the world we live in today.

Even so, between Big and Behemoth lies a lot of uncertainty and risk. If you invest for a billion-tonne market and you get a 500 million tonne one, you could lose your shirt despite epic growth. But rational caution about that risk might make it harder to get the global investment levels that we do need.

Cooperation and clear messages between buyers, sellers and governments is essential. Committed demand from leading global businesses for clean steel, clean shipping and clean aviation in the First Movers Coalition, announced on the margins of the Glasgow climate summit last November, is a very positive development.

WHAT TO DO NEXT

So let me close with some thoughts on what Australia can do to realise the opportunities and manage the risks in hydrogen development.

Ahead of the upcoming Federal Election, Ai Group recently launched policy statements setting out industry priorities for Australia's next Government, whoever forms it. I'll single out a couple of recommendations from the Energy paper, but you can find the rest at www.aigroup.com.au.

National policy needs a sharper focus on gas transition and the demand side. The States are taking the lead here at the moment, including through Victoria's Gas Substitution Roadmap. But gas has national implications for the economy, emissions and security.

Managing these risks only on the supply side, and without an eye to the net zero destination, is like trying to fly a plane with a missing wing – blindfolded.

A big push on all the options for gas transition – hydrogen, biogas, electrification and efficiency – is essential. Different tools and different solutions will be appropriate for different users.

For large industry, changes to the Safeguard Mechanism to gradually lower emissions baselines would help make hydrogen and other solutions more investable. Care will be needed to ensure uneven policies don't compromise competitiveness. But with investors and customers expecting deep emissions cuts, and major economies developing carbon border adjustments, there are also competitive risks in being left behind.

The Safeguard Mechanism also presents a possible solution to the social license and credibility questions around blue hydrogen. High carbon capture rates are physically possible, but what will motivate their achievement? In addition to baselines for existing facilities, the Safeguard contains a latent system of best practice benchmarks for new facilities. Nothing has yet been done with it. But a technology-neutral benchmark for hydrogen production – most logically, zero tonnes of emissions per tonne of hydrogen produced – would provide a strong regulatory motive to capture as much carbon from blue hydrogen projects as possible, and to offset any residual emissions.

Other tools will be relevant too. The New South Wales Government has opened a new Australian policy frontier by legislating a green hydrogen target that ramps up to 8 petajoules by 2030. Similar to previous renewable energy targets, the scheme requires gas retailers and large gas customers to buy certificates from accredited green hydrogen producers. The cost of buying those certificates will depend both on the evolving cost of producing hydrogen, and the price that physical customers for that hydrogen are willing to pay given the alternatives in each context for its use. Scheme costs will be passed through to gas users, with some exemptions still to be finalised.

This kind of scheme could be extremely promising for underpinning hydrogen expansion. 8 petajoules is not much in a net zero world, but it is a hell of a lot more guaranteed demand than existed beforehand.

Ai Group has tried to calculate the cost of the NSW scheme. Every time we run the numbers it looks cheaper. Pre-Ukraine, assuming a long-term natural gas price of $12 per gigajoule the target looked like it might add 23 cents per gigajoule to the cost of using gas in NSW for unexempted users. Post-Ukraine it will be cheaper, as hydrogen costs fall faster and methane prices rise higher. How much cheaper? Who knows? If natural gas is $25 a gigajoule in 2030, the scheme costs nothing. And that eye-watering gas price would be cheap in Berlin or Tokyo right now.

Cheaper schemes could potentially be pushed harder and faster. And the technology-specific NSW scheme is not the only option. The broader energy savings schemes in NSW, Victoria and SA can boost gas transition in a more technology-neutral way.

But the costs of any of these schemes need to be better understood and fairly distributed. Trade exposed industry needs a pathway to net zero – but they need to stay alive on the way there. And vulnerable households will also need help with the cost of living and transition, whether that is delivered through energy-specific arrangements or the broader social safety net.

The thought I want to leave you with is urgency. The invasion of Ukraine has unleashed immense upheaval in energy, trade and global security. Geopolitical, economic and climate factors are now lined up to require an accelerated transition from oil and gas starting in earnest this decade. Hydrogen is well placed to provide big chunks of that transition. But both the supply and demand sides need to get on with it – and government needs to play its part.

Thank you.