



**Australian Government**  

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**Keynote address**

***Shipping sunshine at scale***

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Let's start today with a trip to Australia.

You drive to the airport, get on a plane and fly 10,000 miles to Sydney.

Then you swap planes and fly 2000 miles west to Perth, swap planes *again* and fly another 1000 miles north; and then you get hold of a four-wheel drive and follow the rail line into the desert for about five hours.

You're standing in the Pilbara.

You'll notice that it's very, very hot; it's very, very dry; and it's very, very remote.

But it's also home to the world's biggest robot.

And that's Rio Tinto's Mine of the Future.

It's a sophisticated mega-machine taking a million tonnes of iron ore from pit to port every day, with 1000 miles of rail running fully autonomous trains, and autonomous dump trucks the size of two storey buildings.

That mega-machine in the desert is one of the reasons we export more iron ore than any other country – with more than double the exports of Brazil.

If you drive back to the coast, then get on a helicopter and just keep going, you'll find yourself staring down at the Indian Ocean.

What you'll see out the window is a hundred miles of choppy water – maybe the occasional Great White Shark – and then, the largest offshore floating facility ever constructed.

A 600,000 tonne LNG production platform, manufactured in Korea and operated by Shell Australia.

We've been developing the gas-fields off the north-west coast of Australia for the past thirty years.

And last year we took the crown as the world's leading exporter of LNG.

Is it hard to run giant robots in the desert and floating gas platforms in the sea?

Yes.

And when you factor in that we're a high wage economy, that we're a long way from a lot of key markets, and that we're scrupulous on environmental

protections and safety – then the economics only work if you can operate at scale.

By “scale”, think big. Biggest-in-the-world scale. Biggest-ever-attempted scale.

That scaled up thinking is what I want to focus on today: a sense of the incredible opportunity in reach.

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So let’s start with the big picture: zero emissions energy everywhere, for everyone.

How do we get there? The answer, in a word, is *electrification*.

In a sentence: we replace the fossil fuels in electricity production with solar, wind and hydroelectricity, and possibly nuclear electricity; then we massively increase the production of clean electricity, and use it to replace the fossil fuels everywhere else.

That is, we build the *Electric Planet*.

Now electricity is incredibly versatile – but as you in the audience here today know better than anyone, it’s not enough.

We need a way to ship the sunshine internationally, we need seasonal storage, we need fuel for heavy transport.

And so we need the carrier, hydrogen: hydrogen for energy, at scale.

What does that look like come 2050?

McKinsey’s 2017 report for the Global Hydrogen Council set out a vision of 80 exajoules of hydrogen consumption per annum.

Let’s accept this figure, and further, for the sake of the discussion, let’s assume that the world exclusively uses solar photovoltaics, in good locations, to produce all of this hydrogen, and that the losses in production, compression and distribution are 50% in total.

On my calculations, acknowledging that the hydrogen replaces some of the electricity that would otherwise be used directly in the Electric Planet, we’d need just over 10,000 GW of additional solar electricity capacity to produce the 80 exajoules.

10,000 GW.

How many GW of solar capacity have we installed around the world thus far?

About 400 GW.

Wind and solar together are just over a 1,000 GW.

The most solar and wind capacity we've ever installed in a single year is 140 GW. Now, picture that, just for making hydrogen, 72 times.

If we continue to imagine that all that future electricity to make hydrogen comes from solar, then in terms of land area, using current technology, that's a solar farm the size of Wyoming.

A lot of effort! But a lot of value.

If that 80 exajoule vision is achieved, then we're looking at US\$1.3 trillion of global hydrogen sales come 2050.

An industry of this magnitude provides an extraordinary multiplier on return for effort. For instance, you might be the engineer who scrapes away for a decade for what looks on paper like a tiny improvement...

... but in a mega-scale market, *every increment counts*.

Let's say that all the 2050 hydrogen comes from electrolysis. A 1% efficiency gain in electrolysis saves US\$13 billion per year.

Or say that half the 2050 hydrogen is to be used in fuel cells. A 1% efficiency gain in fuel cells saves US\$7 billion per year.

That means that the work done by the world's best technologists – and I'm looking at *you*, right here in this room – will repay investors in spades.

And if you're excited by scale, Australia is excited by scale – because if any country is blessed with buckets of sunshine and years of producer experience, trust me, it's Australia.

On my calculations, if Australia were to export as much energy in the form of hydrogen as we currently export in the form of LNG, then we'd need 880 GW of new build solar, covering just over 4 thousand square miles.

In Australian terms, that's about half the size of our biggest cattle station.

So, yes, it's a big requirement – but we're used to thinking on that scale; and phased over thirty years, it's absolutely conceivable.

To fulfil the potential, we need commitment.

That's why I'm here: as the head of the national taskforce commissioned by every government in Australia, state and federal, to develop our National Hydrogen Strategy.

As it happens, we're currently in the midst of national elections.

It's the first time, to my knowledge, that either of our major parties has gone to an election talking about hydrogen. This time, it's both.

Our leaders are alive to the promise of this agenda.

So, there's the case for the affirmative: the reasons for optimism.

But what you really want to know is the case for the negative: what wakes me up at night.

I'd say there are three things.

The first is cost.

Japan has named the target: price parity with the landed cost of LNG.

That's tough – but then again, that's exactly what I would have said ten years ago if you'd asked me if new-build solar could get to parity with coal.

And in many places today, it's not at parity – it's already cheaper.

To meet the Japanese landed cost target for hydrogen, the electricity to produce it will have to be comfortably below US\$10 per MWh, without subsidies.

So yes, we have to keep that cost target for hydrogen firmly in mind – but like it's done before, the market will find a way. And I can go back to sleep.

The second thing that wakes me up at night is safety.

Hydrogen has to be safe, and be *seen* to be safe by consumers.

And that comes down to good regulations.

Good regulations aren't a constraint. Good regulations are a CEO's best friend!

If you've got clarity, and the community has comfort, then investors will have confidence.

Both the United States and Australia have outstanding safety records when it comes to handling natural gas.

The risks associated with hydrogen are different – not greater. And they can be managed.

So I can go back to sleep.

That brings me to the third thing that wakes me up at night.

I'll be honest... I close my eyes, and I see the Valley of Death.

The *Silicon Valley* Valley of Death.

On the far side of the valley I see the hydrogen economy of 2050.

Freeways lined with refuelling stations.

Half a billion hydrogen cars, buses and trucks.

Thousands of square miles of solar PV.

A million forklifts powered by Plug Power fuel cell systems.

Hundreds of hydrogen carrier ships criss-crossing the globe.

It's glorious.

And then I look at the terrain right in front of me.

And somehow, you, and I, and all of the pioneers who can see that brilliant future so clearly, have got to rally our people to hitch up the wagons... and trudge down that slope. And through the canyon. And up the other side.

Whichever way I look at it, it's daunting.

So, can I go back to sleep? I'm still deciding.

But there are two thoughts I'd invite you to consider.

The first is that the Valley of Death isn't a gap to be jumped in a single flying leap.

It's a journey to navigate on multiple paths.

That means being prepared to build out gradually, learning and recalibrating along the way.

For example: cracking the tough nut of moving hydrogen around the world.

Yes, we can build pipelines, but we can't easily build a 4000 mile pipeline under the ocean from Darwin, Australia to Tokyo, Japan. We need ships.

Now I'd be delighted if a big investor would wake up tomorrow morning and decide to drop US\$10 billion on a hydrogen port and liquefaction facility in Australia.

And maybe throw in another US\$50 billion for 200 liquid hydrogen tankers to improve on the current global total of zero.

Not going to happen.

But what we *can* do today is make and ship ammonia.

So we can start there, where regulators and investors have experience; and gradually open up the pathways for global trade.

We can take the same approach in the *other* big and interconnected systems we need to develop – be it systems and new technology for long haul trucking, or electricity generation, or hydrogen in the domestic gas mains.

It's a global effort.

It's still a race.

It's a race against time, and against each other.

But it's the sort of race that can generate the momentum to push everyone forward: if we build on the emerging vision among experts in the United States, Europe and Asia for a decarbonised energy supply; if we draw in private investment; if we collaborate as well as compete; if we develop the supply chains; and if governments make it a priority.

So that's my first thought for this audience: the trudge through the Valley may be gruelling – but you're not alone, there are many viable paths, and even your competitors are on your side.

My second thought is to encourage you to reach out to Australia.

What Australians see in America is a country that understands the challenges of scale.

A country that's almost incapable of starting small without a plan to go big.

So, when you look at Australia, I want you to see your at-scale laboratory.

We've got lots of space, lots of energy, and lots of expertise.

Talk to us early, at the demonstration phase: we'll take the call.

I also want you to look at Australia, and see a nation of early adopters. In no other country will you find a higher percentage of homes with rooftop solar.

So choose Australia for your pilot program – or look for opportunities to sell and support your products.

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And indulge me on just one more imaginary trip.

It's 2050. You're flying over the heartland of Australia. Who knows what sort of aircraft – but whatever it is, it's impressive.

And you look out over that great sunburnt country... and spread out before you is the world's biggest hydrogen farm.

Australian sunshine.

Global technology.

And I hope you're seeing it with me: the realisation of your ideas, at scale.

That's where we're headed – so reach out to us to find your path.

And, as Chief Scientists are allowed to say, at the end of every speech...

***May the Force be with you.***