

# ARENA INSIGHTS FORUM

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Australian Government  
Australian Renewable  
Energy Agency

**ARENA**  
10 YEARS

How good is this? The first in-person, ARENA INSIGHTS meeting ever, and the biggest ever. Following on the backdrop of a legislated emissions reduction target. And a government that sees ARENA as a guard dog instead of a wild dog. Enthusiasm is in the air!

But to be fair, we are building on a good base. Australia is the world leader in installed solar; our hydrogen strategy was adopted unanimously by all governments, we've seen record investment in solar and wind in recent years, and the solar and wind combined share of generated output nearly tripled in the last five years.

And now, with the clear direction and heightened ambition from the new government, Australia will be a leader in the clean energy transition.

To achieve that, there is a lot to get right.

I'm not going to talk to you today about the things ARENA has already done so well - tracking solar, rooftop solar, wind farms, behind the meter batteries, utility scale batteries for fast frequency control, distributed energy systems and hydrogen scale up. You are already expert at all that.

Instead, I plan to take you on a journey, by helicopter, for some aerial views of other low emissions technologies, with a focus on those where Australia has a competitive export advantage.

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Let's start with a passenger briefing to set the scene before take-off.

If you look at measured global outputs, the situation is not good. On a scale of 1 to 10, we are barely above 1. Emissions are increasing year on year and the atmospheric concentration of carbon dioxide is increasing without slowing.

Equally bad, the share of fossil fuels in the global energy mix is 84% - down just three percentage points from thirty years ago.

Unsurprisingly, the climate is measurably worse, as we were reminded in the State of the Climate report from the Bureau of Meteorology and the CSIRO last week.

In contrast, if you look at the *underlying technology* trends, the situation is exciting.

As exciting as the conquest of space in the 1960s.

- › Take electric vehicles. Sales are electric in both senses of the word. Globally, sales have doubled every year for the last two years.  
Predictions from just a few years ago are being blown out of the water. Norway is well on the way to 100% of new car sales being electric by 2025.  
Sales in China are stunning. In August this year, electric light vehicle sales in China were 29% of all new vehicles. That is a huge fraction of a huge market, and is the reason why total electric light vehicle sales in China are approaching 60% of the global total.  
Worldwide, it is expected that 13% of new cars sales this year will electric vehicles. Australia is a long way behind, just over 3%, but we have commenced an era of almost doubling every year and recently announced incentives will accelerate that trend.
- › On the global energy trend, deployment of solar and wind have reached warp speed.  
Thirty years ago, their contribution to electricity was zero. Today, globally it is 10% and in Australia it is nearly three times that.  
Most important, in the last decade solar and wind generation increased by a factor of four globally.  
If we can keep up that rate of increase, the decarbonisation of the global energy system will be achievable before 2050 even taking into account the need to produce extra electricity to replace fossil fuels across the economy.
- › In investment, money is pouring in, approaching US1 trillion globally per year, with talk of it tripling by the end of the decade.
- › Encouragingly, in 33 countries, the link between economic growth and increasing emissions has been severed, reversing the pattern of 100's of years.

In summary, I am confident that we will see a shift in global energy trade, from petrostates supplying oil and gas, to electrostates supplying energy transition materials. Australia will be a world-class electrostate, helping to lead the transition from the Industrial Age to the Electric Age.

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I promised you a helicopter flight. Take off. Five thousand feet.

Look, out the window on the left you will see one of the hottest low emissions technologies under discussion at the moment. You can see the smoke rising from the ground, it's so hot. Critical minerals.

Digging them out of the ground is probably beyond the present or even a future ARENA brief, but using zero emissions energy to process what we dig into higher value materials for export might be part of the brief, now or in future.

There are two drivers.

First, the majority of processing of hard rock lithium - spodumene - produced in Australia, and lithium brine produced in South America, is done in China. Same with rare earth elements. After the rising geopolitical tensions, purchasers want to diversify their supply chains.

Second, processing to the next step is energy intensive and must be decarbonised. In Australia we have abundant solar and wind, so we can do that, and there is an international market of for zero emission battery chemicals ready to be used in electric car batteries.

To understand the opportunity, we need some clarity about the subject matter. 'Critical minerals' is a well accepted term, and that is fine, but everybody has a different definition.

I tend to use the term Energy Transition Materials (ETM). BHP uses the term Future Facing Commodities. There are five groups within the energy transition materials:

- › Battery materials - lithium, manganese, nickel, cobalt and graphite
- › Solar materials - polysilicon and silver
- › Hydrogen materials - platinum and iridium
- › Motor and generator materials - mostly rare earths such as neodymium and samarium for permanent magnets,
- › Traditional materials - copper and aluminium

The demand is significant already and will increase dramatically by 2030:

- › On the Paris stated policies scenario, growth in battery materials will increase 5-7 times. On a sustainable development scenario, the increase will be between 11 and 17 times.
- › Copper might double in the next ten to fifteen years, off a huge base.
- › Rare earth element demand could increase 3-5 times.

Australia is already the largest exporter of lithium ore, but until last year it was from the quarry to the ship. Now, this year, three plants have opened in Western Australia to refine the hard rock spodumene into lithium hydroxide ready to be used in batteries.

And we have Lynas Rare Earths and Iluka Resources developing first-stage rare element processing in Australia, too.

And BHP is starting to refine its nickel ore into nickel sulphate, ready to be used in battery manufacturing.

Some commentators fear that we will run out of energy transition materials, but one thing that will never run out of is human ingenuity.

But human ingenuity needs to be nurtured.

That's where ARENA comes in.

By the liberal application of ingenuity, I am confident the world will never run out.

Eventually, much of future demand will be supplied by recycling, but we are too early on the growth curve for that to be significant now.

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Let's change altitude to seven thousand feet and travel a few nautical miles to the east. There, you can see lots of hot air rising and the occasional high-altitude balloon. That's the atmosphere above hydrogen valley.

It is worth stating publicly and for the record that hydrogen is an essential part of the clean energy transition. The basic rule is to use electricity to replace fossil fuels, and electricity is magic and can mostly do that. But all magic has limits. Where electrons are inadequate for the job, hydrogen steps up.

Much of the focus in Australia is on shipping sunshine. That is, hydrogen production for export, as hydrogen itself or as a derivative.

There will be demand, for sure. Our trading partners in Japan and Korea and other countries are clear on that.

Where my thinking has matured is that even more important than exporting hydrogen, there is a huge export opportunity in decarbonised products that use hydrogen as a key input to the manufacturing process.

That's a *use-it-where-you-make-it* approach.

The idea is to avoid the costs of handling and shipping. We will eventually get the cost of green hydrogen down to US\$1 per kilogram, but it is hard to see the cost of pipelining, conversion and shipping falling below \$2 per kg. The obvious conclusion is that it is much more sensible to use hydrogen at US\$1 per kilogram where it is produced rather than at US\$3 per kilogram in another country.

So, use it where you make it.

By building integrated plants. Giga scale solar and wind electricity generation, hydrogen electrolysis, and the end-product process, all on the one site.

Here are three examples that have enormous potential for Australia:

- › To start, green iron. Not green steel. Steel making takes place in two steps.

The first step is to reverse millions of years of rusting by converting iron ore into iron.

The second step is to create the steel alloy.

We can onshore the first stage because we have the iron ore, the solar electricity, the wind electricity and the low-cost hydrogen in Australia, at the one site. Thus, we can add value by using our abundant solar and wind electricity and emerging hydrogen expertise to ship green iron instead of shipping rust.

- › We can produce green nitrogenous fertiliser to feed the world. That depends on producing lots of green ammonia as the chemical feedstock.

Speaking of green ammonia, if you look out the starboard window of the helicopter you will see the Yara Engie plant in the Pilbara. Big congratulations to Yara and Engie for reaching financial close on their green hydrogen project.

In later stages of their project, they will have to address decarbonising the Haber Bosch process for ammonia synthesis.

All three steps – hydrogen production, nitrogen extraction and ammonia synthesis – must run on 100% renewable energy and nothing else.

- › We can produce green liquid fuel.

The most important will be synthetic aviation fuel to be used as a drop-in replacement for fossil aviation fuel. It will be fully synthesised from hydrogen derived from water and carbon captured from the air.

That's all you need to make synthetic jet fuel – the two elements hydrogen and carbon, and lots and lots and lots of renewable electricity.

All this hydrogen demand should create an opportunity for a home-grown industry in electrolyser manufacturing. The Fortescue gigafactory in Gladstone is well under way, and Hysata in Wollongong is in their scale-up phase. (I am an advisor to Hysata.)

The opportunities are large, but the competition is substantial. There is a *use-it-where-you-make-it* philosophy evident in the United States and Europe. There is shipping-sunshine export competition from Chile, Saudi Arabia and other countries.

Australia can compete because we have the experience in resource development, we are low sovereign risk, and we have a government that is providing policy vision and certainty.

But our salaries are high, so we must be smart. We have been smart in the iron ore industry. The production cost for Western Australian iron ore exports was US\$32 per tonne in 2021, well below the world average of US\$42 per tonne.

How have we been smart? By implementing artificial intelligence in the control rooms, driverless haul trucks and drilling machines, algorithmic process control for the crushing plants.

For the *use-it-where-you-make-it* philosophy to work, electricity must be ultra low cost. It is fantastic that ARENA is investing to drive the price of solar down and down. In the long term, it might get down to \$10 per megawatt-hour.

But that will not be a grid connected price. This will be at the solar farm level, integrated with green iron making and other decarbonised products.

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If you look out the window to the right you will see a vortex where millions of tonnes of atmosphere are assembling, ready to be pulled into future, direct air carbon capture facilities.

Some of the captured carbon will be used for producing synthetic aviation fuel, as we have discussed. Much of it will be stored deep underground.

Direct air carbon capture and storage is the absolute most credible form of carbon offsets, and international companies are willing to pay high prices. A tonne captured and stored underground is a tonne that is confidently sequestered essentially forever.

However, the energy efficiency is poor, for a fundamental reason. That reason is that the electrically powered fans in the direct air capture facility have to draw in 2,500 air molecules to bring in a single carbon dioxide molecule. That is, 2,499 molecules of oxygen, nitrogen and argon are brought along for a free ride for every carbon dioxide molecule ready to be captured.

Selling direct air removal offsets could be a huge international business for Australia. Tens of billions of dollars per year. But the costs today are too high.

Every aspect of the process needs to be refined and optimised.

This sounds to me like an ideal challenge for ARENA.

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Now settle in for a long cruise in our helicopter till we are in international space.

If you look outside the window to the northeast, you will see that one of the unexpected complications will be the so-called Inflation Reduction Act passed by the U.S. Congress in August.

What you see from up here as far as the eye can see are fields of orange covering the American landmass. The Inflation Reduction Act is all carrot and no stick. It is built on tax credits to subsidise construction and production in solar, wind, critical mineral processing, batteries, electric vehicles and hydrogen.

That's great for technology development and deployment. It's been estimated that the U.S. government will spend up to US\$800 billion over the next ten years, attracting perhaps another couple of trillion dollars of non-government money. It will accelerate the adoption of clean technologies and help to drive prices down. The planet will be better off.

However, it is very focussed on made-in-America. All the tax credits are linked to domestic production, regional locations and American jobs.

If we did the same in Australia, our own economists would cry foul and we would be chased through the courthouses of the World Trade Organisation.

The United States is the elephant in the room.

President Macron of France is angry. He fears an international subsidy war, with China subsidising its industries and America subsidising its industries. He called for Europe to do the same. And Germany has started. Last month they announced 200 billion euros in energy subsidies for German industry and consumers, a big package that Chancellor Olaf Scholz described as a "double ka-boom."

Nevertheless, the opportunities in the Inflation Reduction Act for Australia are large. Because the domestic sourcing provisions have some exceptions for countries with free trade agreements and deliberate exclusions directed against China and Russia, Australia should increasingly be able to become a preferred supplier for energy transition materials in their raw and their processed form.

The risks for Australia are the same as the risks to many other countries. The Inflation Reduction Act is already acting like a magnet for companies to set up new factories in the United States because of the massive financial incentives. Japanese, European and some Australian companies have already signed agreements.

America will increasingly be a magnet for global investment, and it will increasingly be a magnet attracting skilled workers.

I have been asked by the Minister to lead the development of advice to the Government on the implications and opportunities from the Inflation Reduction Act. That advice is in development, and we intend to be quick.

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Flying back to base, you can see some electric cars in the traffic. Not many, but more than we saw on a similar flight last year.

I hear lots of planning is underway about smart charging and vehicle to grid. Which is good. However, I have a concern. I fear that most of the planners have not owned an electric car and so their expectations of the level of cooperation they will get from drivers is perhaps overly optimistic.

One of the wonders of having an electric car is that it is hassle free. Every few days, perhaps once a week, you plug it in at home. Why would an electric car driver want to give up that luxury and plug in several times per day, whenever they are not driving? ARENA has lots of expertise in testing real-world applications of good ideas, particularly in distributed energy resource management, so I am confident that with ARENA's help the smart charging designers will work out approaches to smart charging that are acceptable to consumers.

On the other hand, hydrogen refuelling stations are heartbreaking. The rate of deployment is like watching molasses flow down a gentle slope. There needs to be a coordinated approach to get the price down from more than \$5 million for each refuelling station to much less than \$1 million each. And the real-estate footprint must shrink from more than 200 square metres to less than 20 square metres.

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Whoops, we are running low on fuel despite the helicopter being the latest hybrid battery and fuel model. We will land immediately at Macquarie Place Park and hoof it over to the Marriott Hotel to discuss the best way to make Australia a leading electrostate in the shift from the Industrial Age to the Electric Age.

Have many great discussions today.

May the Force be with you.

Thank you

Further information is available at  
arena.gov.au

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### Engage with us

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