SENATE ENVIRONMENT AND COMMUNICATIONS REFERENCES COMMITTEE

Inquiry into Oil and gas exploration and production in the Beetaloo Basin

Questions on notice

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Question 1: how do we replace all gas use with renewables?

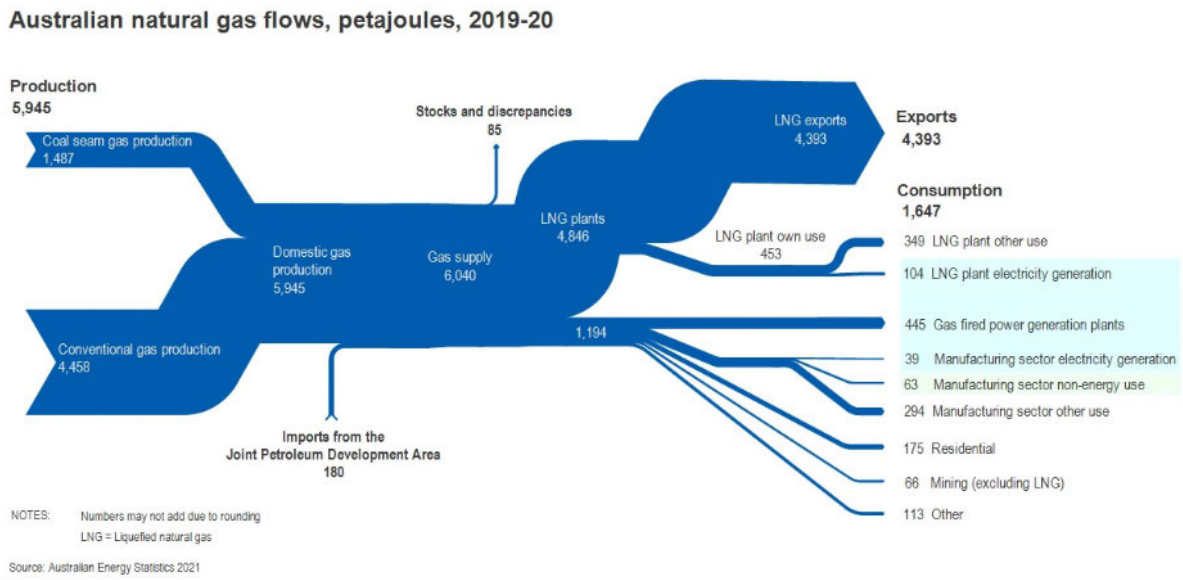
Fossil gas (methane, CH_4) is used for energy and as a source of carbon and hydrogen atoms for chemical synthesis. It can be completely removed from the Australian economy using existing technology. Figure 1 shows gas sources and end uses. Focusing on domestic consumption, the elimination strategy is as follows:

- LNG plant use (453 PJ): end gas exports
- Gas fired power plants (445 PJ): substitute solar & wind generation
- Manufacturing sector electricity generation (39 PJ): substitute solar & wind
- Manufacturing sector non-energy use (63 PJ): substitute green hydrogen
- Manufacturing sector other use (294 PJ): mostly heating; substitute electric furnaces
- Residential water & air heating (175 PJ): substitute heat pumps
- Mining (66 PJ): substitute solar & wind
- Other (113 PJ): substitute green hydrogen

Hydrocarbon synthesis also requires sustainable carbon, which can be sourced from (i) residual fossil fuel use (ii) biomass and (iii) direct air capture of CO_2

More detail is available at https://doi.org/10.1016/j.energy.2020.119678

Figure 2.3: Australian natural gas flows, petajoules, 2019–20



Source: Australian Energy Statistics

Question 2: How much water use to make green hydrogen?

Australian annual gas production (export + domestic) in 2019-20 was about 6000 Petajoules (PJ). The energy content of hydrogen is 120 MJ/kg. This 6000 PJ of fossil gas is equivalent to 50 Megatonnes (MT) of hydrogen.

Green hydrogen is made by splitting water using electrolysis powered by renewable energy (solar and wind). The fractional weight of hydrogen gas (H_2) in water (H_2O) is 2 parts in 18. Thus, 18 tonnes of water yields 2 tonnes of hydrogen gas. About 450 Mt (450 Gigalitres) of water is needed to produce 50 Mt of hydrogen. Seawater can be used.

Summary: to replace Australia's entire fossil gas production with hydrogen requires about 450 GL per annum. To place this in perspective:

- Annual Australian water consumption is 11,000 GL (24 times larger)
- Mining industry annual extractions are 1,100 GL of water (2.4 times larger) – a large fraction is used for gas extraction and would be eliminated by converting to green hydrogen

Question 3: How can hydrogen, plastics, urea, AdBlue be made without methane gas?

Hydrogen

As discussed above, hydrogen can be made with renewable electricity and electrolysers. An Australian company just announced a new world record for efficient hydrogen production. Seawater can be used to create hydrogen. Fortescue Future Industries is constructing a manufacturing plant

for hydrogen electrolysers in Gladstone, which will have an initial capacity of 2 GW per year, doubling the current global production.

Plastics

The principal elements in plastic are carbon, hydrogen, oxygen, nitrogen and sulphur – all very common elements that are widely available everywhere. Hitherto, fossil fuels have been a convenient source of elements for plastic. However, there are straightforward alternative sources: water, the atmosphere and biomass.

The Federal Government released a National Plastics Plan in 2021, which aims to reduce plastic waste and increase recycling rates, find alternatives to the plastics we don't need, and reduce the amount of plastics impacting our environment.

The CSIRO also released *A circular economy roadmap for plastics, tyres, glass and paper* in 2021, through which it hopes to lower total waste to landfill, and create a market for high value recycled commodities. Only 12% of plastics is currently recycled – the roadmap aims for an 80% recovery rate in 2030 with commercial scale feedstock recycling.

According to the CSIRO, local manufacturing currently produces 34% of Australia's plastic consumption. There are two major manufacturers, LyondellBasell Industries and Qenos. **Both support the reduction of plastic waste, and are already implementing plans to increase use of renewable feedstocks and recycled plastic as feedstock** (examples 1, 2, 3,).

In 2013, in response to a Senate Inquiry into Australia's Oil Refinery Industry, LyondellBasell Industries reported that their facilities use propylene and ethylene gas feedstock from local oil refineries and petrochemical plants.

Qenos uses ethane as a feedstock. Increases in the wholesale cost of methane gas when the LNG market opened in 2015 were a likely contributor to the closure of their two plastic production plants in Victoria. The ethane supply at Qenos' Victorian plants was a by-product of gas refining from the Bass Strait gas field, from which production is expected to fall in 2025. This field has a 15:1 ratio of methane to ethane. Different gas fields have different ratios, for example, coal seam gas has very little ethane in comparison. Ethane has been found in the Beetaloo Sub-basin.

APPEA may not be an appropriate source of information on the future need for methane gas mining to provide feedstock for plastic in Australia – rather, Qenos and LyondellBasell, and other plastic manufacturers, should be approached directly. Consumer demand may mean these companies prefer renewable and recycled feedstock in the near future rather than ethane from fossil mining. Many popular products are already being marketed as using "plant-based" plastic or using more recycled feedstock.

Fortescue Future Industries has also entered a long-term agreement with "Covestro, a world-leading Germany-based supplier of high-tech polymer materials" to supply green hydrogen and green ammonia. The CEO of Covestro said "Green hydrogen and its derivatives play a key role for the chemical industry, both as an alternative feedstock and a source of clean energy." Covestro has made a commitment to use only fossil-fuel free alternative raw materials, and renewable energy. In 2020, Covestro's sales were EUR 10.7 billion, and serves the automotive and transportation industries, construction, furniture and wood processing, electrical electronics and household appliance industries, sports and leisure, cosmetics, health and the chemical industry itself.

Ammonia

Ammonia is produced by combining nitrogen (from the atmosphere) and hydrogen. This can be achieved with renewable hydrogen derived from water rather than fossil gas. Proponents of the Asian Renewable Energy Hub proposed in the Pilbara region of WA hope to produce renewable hydrogen fuels and ammonia for export.

Urea

Urea is formed by combining ammonia and carbon dioxide. This can be done with renewable ammonia. Incitec Pivot has an ammonia, urea, and sulphate of ammonia manufacturing plant at Gibson Island in Brisbane. High methane gas prices meant that the plant would cease operations in December 2022, but the company has entered an agreement with Fortescue Future Industries to convert the existing plant to use renewable hydrogen, hopefully saving the existing 170 jobs. A favourable feasibility study has been competed, and an engineering and design study is underway and due later this year.

AdBlue

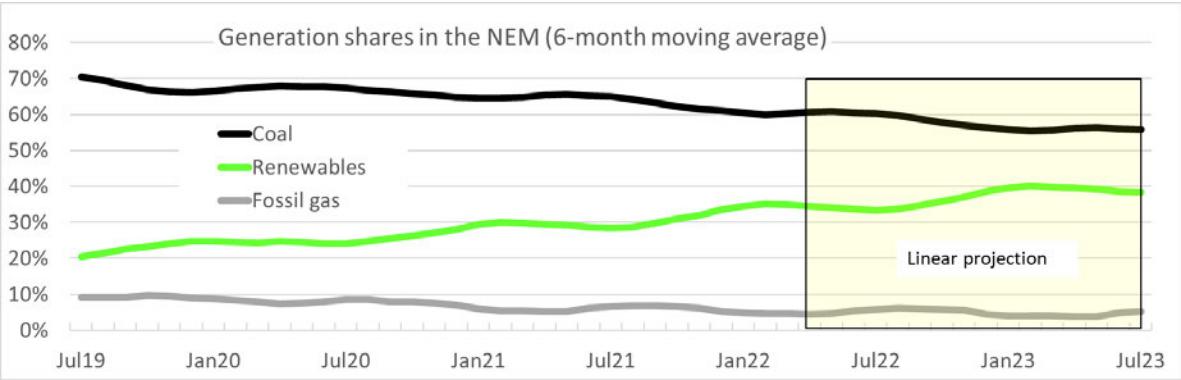
Battery electric trucks do not require AdBlue, and in many applications are already financially viable and should be used. Although these trucks have higher upfront costs, their fuel and maintenance costs are far lower. They also produce far less air pollution.

AdBlue can be made by combining renewable urea and deionized water.

Question 4: Cost curves of renewables and gas and how these might influence the NT's decision around Sun Cable and the Beetaloo? & Question 5: Expectations around prices over the next decade – LNG in Darwin or Gladstone from the Beetaloo or exported clean energy?

Solar and wind won the energy race because they are cheaper than energy from coal and gas. Prices of solar & wind continue to fall, and so their economic advantage will continue to grow.

The figure below shows the rise and rise of renewable share of electricity generation in the National Electricity Market (green curve, mostly solar & wind), and the fall and fall of coal and gas (black and grey curves respectively). These types of curves will appear in nearly every country in the world during the 2020s.



Gas has 5% of NEM generation, and steadily falling. Since most of the world has good solar and/or wind, the future of gas is bleak. The current price spike has accelerated interest in renewables. Read here.

We expect new solar to cost just $30/MWh in Australia in 2030 (for context, Origin Energy recently reported costs just above $40/MWh).

In the BP World Energy Outlook scenarios released last week, solar costs could fall between 43-54% by 2030. Wind costs could fall by 18-26%.

The BP Net Zero scenario has LNG trade to Asia peaking in 2030 and falling after this.

The IEA Net Zero report says "The energy transition envisioned in the NZE involves a major contraction of oil and gas production with far-reaching implications for all the companies that produce these fuels… This represents a clear threat to company earnings, but there are also opportunities. The resources and skills of the oil and gas industry are a good match with some of the new technologies needed to tackle emissions in sectors where reductions are likely to be most challenging, and to produce some of the low-emissions liquids and gases for which there is a rapid increase in demand in the NZE." These industries also include off-shore wind. The Victorian Government has announced a target of 9 GW of off-shore wind by 2040. Alinta Energy has announced off-shore wind projects to power industry in the Pilbara and on the east coast.

With the price spikes in Europe, green hydrogen and ammonia is now reportedly cost competitive with fossil hydrogen and ammonia in Europe, the Middle East, and China, according to Bloomberg New Energy Finance (a widely respected analyst group). A separate consultancy group called ICIS in Europe made this claim last year, and Rystad Energy independently published these findings in a report on the 21st March 2022.

Green ammonia can also be co-combusted with coal in coal-fired power plants, resulting in lower greenhouse gas emissions. Rystad Energy also report: "State owned utility giant China Energy successfully trialed a 35% ammonia mixing for a 40 MW coal-fired boiler. Japan and South Korea have set a target of 20% ammonia mixing by 2025 and 2035, respectively. If this were increased to 35%, then overall demand for ammonia could double to above 300 million tonnes as early as 2030."

The Ukraine war is expected to impact food prices and availability globally now and into the future. Staple food crops are not being harvested now, and cannot be transported. Seeds for sewing are not available. Fertiliser price rises and shortages around the world mean farmers are using less, which will likely impact future harvests. Producing green ammonia for fertilisers should allow for a more reliable system.

The cost comparisons for fossil and renewable hydrogen and ammonia do not include the cost of climate impacts, nor do they consider future increases in climate ambition – the next set of National Determined Contributions are expected in 2025.