SOCIAL AND ECONOMIC IMPACTS

GISERA | Gas Industry Social and Environmental Research Alliance

The role of gas in South Australia

This project seeks to clarify the role of natural gas and hydrogen in helping South Australia to secure its energy supply, accelerate renewables, reduce emissions, and maintain price.

South Australia (SA) is transitioning to net zero emissions - gas and hydrogen will be part of this transition.

CSIRO's Gas Industry Social and Environmental Research Alliance (GISERA) has completed a study for the SA Government that defines the least cost technical pathway towards 100% renewable electricity and a hydrogen industry, and the role of natural gas and hydrogen in that transition.

Key points

- SA is moving towards a zero net emissions future, with strong policies of renewable energy and access to gas.
- There is a need for information on when gas can best contribute to the state's process of decarbonising electricity and hydrogen production.
- This report provides an analysis of the outlook for the SA energy industry and its economic implications, with a particular focus on the role of natural gas and hydrogen.
- Researchers considered (and modelled) three alternative future scenarios, each with a target of 100% of the gaseous fuels used by 2050 being hydrogen (not natural gas).
- The results show the impacts of the three scenarios on: economies, industries, the demand for gas, hydrogen exports, the technology mix in the power sector, and on greenhouse gas emissions.
- This project provides technical insights into how gas can help deliver a higher share of power from renewable energy in SA, with strong security and at least cost.
- All findings are publicly available in a GISERA report.

Research objectives

A long-term pathway to zero emissions might exclude natural gas, but over the next decade or so, natural gas could play an important supporting role. Natural gas could help to meet the goals of decarbonising electricity and scaling up a broader hydrogen industry.

As such, more research is needed to pinpoint when and how gas can best contribute to the process of decarbonising both electricity and hydrogen production.

This study provides a technical, least cost pathway towards SA's goal of 100% renewable electricity alongside a hydrogen industry that is eventually net zero.

The study brought together new knowledge on integrating renewable energy sources, especially the role of gas, but also using renewables and gas as primary energy sources for a new hydrogen industry. The study compared three scenarios out to the year 2050. GISERA researchers used a combination of modelling approaches to determine SA's best, least-cost fuel and technology choices to the year 2050.

How did researchers look at future scenarios?

CSIRO researchers used a combination of modelling approaches to determine SA's best, least-cost fuel and technology choices to the year 2050.

Researchers used a CSIRO model called AusTIMES. It models Australia's entire energy system-simultaneously modelling the fuel and technology choices of the electricity, transport, commercial and industrial sectors.

Researchers also used an economic model that estimates the impact of different scenarios on the local economy and local employment.

Building on previous research

This study is the second and final of two reports for GISERA's project, the 'Role of Gas in South Australia' undertaken in 2021-2022 by CSIRO.

Researchers drew on research by the Australian Energy Market Operator (AEMO) on specific energy system security requirements. On hydrogen and renewable integration, researchers built on the work of Alan Finkel (in reviewing hydrogen supply pathways and potential demand for hydrogen exports) and other research on the use of hydrogen in domestic industries (such as steel) and in the existing gas distribution pipeline at low blends.

South Australia and its renewable energy policies

South Australia has strong policies on renewable energy deployment and access to gas. The state is moving towards delivering electricity supply with greater than 50% renewable share, and has considered the potential for hydrogen consumption, production and exports. This is set out in *South Australia's Climate Change Strategy 2015-2050 - Towards a Low Carbon Economy and the Hydrogen Action Plan*. These policies have a broad goal but is not technologically or fuel prescriptive.

Findings from this study can inform the implementation of these policies, providing insights on the role of gas in delivering high renewables shares (with strong security and at least cost), and in building a hydrogen industry that supports emissions reduction.

The role of gas and hydrogen

Long-term, because of the variable nature of renewable energy, we can only achieve a high share of renewable energy with more technologies like storage, and better interconnection between each state's energy markets. So, in the medium term, natural gas may have a role to play as a cost-effective solution for extended periods (e.g., several days) of low renewable generation outputs.

Hydrogen produced from renewables is currently too high cost to be attractive. But, in the long term, all hydrogen may be produced from zero emission sources, instead of hydrogen produced from coal or natural gas.

So, three scenarios assumed hydrogen production to be 100 per cent from renewable electricity by 2050. One additional 'sensitivity scenario' allowed hydrogen production from methane or coal by 2050 as long as it was accompanied by Carbon Capture and Storage (CCS).

The three transition scenarios for South Australia

In order to find potential future pathway for SA to transition towards 100% renewable electricity, the researchers developed three different scenarios:

1. **Blue Hydrogen**
   'Blue' hydrogen is hydrogen produced using natural gas. This process produces greenhouse gases, but CCS technologies capture and store those emissions. This transition scenario assumes:
   - A relatively rapid decline in the costs of hydrogen production from natural gas, and
   - Low opportunities for electrification.
2. **High Electrification**
   The second transition scenario for SA includes:
   - Extensive electrification,
   - Higher costs of hydrogen production from natural gas, and
   - Lower costs of renewable generation technologies, such as wind and solar.
3. **Hydrogen Exports**
   The third transition scenario considers a strong role for hydrogen as part of an Australian export industry, including both:
   - The direct export of hydrogen, and
   - The export of Direct Reduction Iron (DRI) processed steel for which hydrogen represents a significant energy input.

Project results: what did the models show?

Overall, the findings demonstrate a range of potential pathways for SA to secure its energy supply, accelerate renewables, reduce emissions, and maintain price.

Impacts of scenarios on SA economies, by region

For metropolitan Adelaide region, the outlook for economic growth across all three transition scenarios is similarly small; this is because the services sector dominates this region. One exception is the 'Hydrogen Export' scenario, which will have a positive impact on metropolitan Adelaide area, as the production of hydrogen/steel will occur close to the port.

Across all SA regions, the greatest impacts will be for metropolitan Adelaide, followed by the Barossa, York, and mid-North regions.

Impacts of scenarios on different SA industries

Future energy transitions will affect SA's industries in various ways. The study found that, for each industry, the impacts across the scenarios relative to the baseline are broadly similar.

The most positively affected industries are:

- Electricity transmission and distribution sector
- Other chemicals (which includes the hydrogen production industry), and
- Other non-ferrous metals (with the largest positive increase under 'Hydrogen Exports'), with a cumulative impact between 1-5% to 2050
- Construction had minor positive impacts.

The most negatively affected sector is mining (including natural gas production and coal mining) which are both approximately a cumulative 10% smaller relative to a baseline scenario of no change to the energy mix.

Impacts of scenarios on the demand for gas

In all scenarios, demand for gas in the electricity generation sector is projected to decline reasonably quickly. The total demand for gas (both natural gas and hydrogen) in other industries remains reasonably steady up to 2050 due to energy efficiency and fuel switching measures compensating for increasing production. After this, increasing production will require a modest increase in demand for gaseous fuels.

The demand for natural gas versus hydrogen in industry follows the assumptions from each scenario on the rate of overall average uptake of hydrogen in the gas transmission network. Demand for hydrogen fuel in transport increases steadily but remains a reasonably small component of total demand for gas fuels.

Impacts of scenarios on demand for gas as an end-use-fuel

Not only can natural gas be used as a 'primary' fuel for electricity generation or hydrogen production, it can alternatively be used directly by the end-user as a 'end-use' (or 'final') fuel. Demand for natural gas as an end-use fuel declines reasonably rapidly from 2040 in most scenarios, and even earlier in the 'Hydrogen Exports' scenario.

The extent to which the demand for natural gas as an end-use fuel is replaced by demand for natural gas as a primary fuel (for use as a feedstock in hydrogen production) depends on whether methane produced hydrogen (steam-methane reforming with carbon capture and storage - SMR-CCS) is allowed as part of the energy mix.

In SA, the relatively low cost of electricity means that hydrogen continues to be produced by electrolysis even in the sensitivity scenario that permits non-electrolysis hydrogen production in the long term.

Impact of scenarios on hydrogen exports

The 'Hydrogen Exports' scenario describes a future where export demand for Australian hydrogen and steel, produced via the direct reduction iron route, increases significantly. In this scenario, the capacity for SA to meet this additional demand is limited by existing port capacity (and not by workforce skills).

Under this scenario, SA's hydrogen and steel exports increase to the limit of the port capacity, exporting about twice as much hydrogen as steel (in tonnage), creating only a modest increase to SA's current steel production. Because they are not limited by existing port capacity, Queensland and Western Australia supply most of the demand for Australian exports in these energy intense commodities.

The model is limited in that it assumes that there will be no additional investment in capacity expansion of SA's ports throughout the projection period. Infrastructure upgrades may well take place in the next 40 years.

Impacts of scenarios on technology in the power sector

The technology mix in the power sector is similar in all scenarios, with a slight difference between the national electricity market (NEM) in general and SA in particular.

There is a consistent shift to renewable solar and wind generation, supported by battery storage. The NEM shifts away from black coal generation and some gas; SA shifts away from existing gas generation. The assumed trajectories of customer side generation (rooftop solar) have a higher uptake in under 'Hydrogen Exports', and more customer side batteries are taken up under the 'High Electrification' scenario.

Impacts of scenarios on greenhouse gas trajectories

The greenhouse gas emissions trajectories are similar across all scenarios. Results show emissions reduced by a half (nationwide) between 2020 and 2050, and by about two-thirds in SA. Power generation is the sector that reduces emissions most rapidly and deeply, followed by the transport sector.

Industry is the most challenging sector for emissions reduction. However, in all scenarios, despite industrial output continuing to grow in real and nominal economic terms, emissions remain fairly flat or decline slightly.

This shows a decline in emissions intensity due to energy efficiency measures, fuel switching to hydrogen and biomass, and electrification. Hydrogen production only makes a minor, reasonably short lived, contribution to total emissions via production from natural gas (SMR), as electrolysis ultimately becomes the dominant production process, even under the sensitivity scenario.

More information

The study is available as a report on the GISERA website.

Read about other GISERA projects in SA.

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