# Project Order

Proforma 2020

## 1. Short Project Title

The role of gas in South Australia

| | |
|---|---|
| Long Project Title | The role of gas in securing energy supply, accelerating renewables, reducing emissions, and maintaining prices |
| GISERA Project Number | S.15 |
| Proposed Start Date | 12/10/2020 |
| Proposed End Date | 30/09/2021 |
| Project Leader | Luke Reedman |

## 2. GISERA Region

- ☐ Queensland
- ☐ New South Wales
- ☐ Northern Territory
- ☒ **South Australia**
- ☐ Western Australia
- ☐ Victoria

## 3. GISERA Research Program

- ☐ Water Research
- ☐ GHG Research
- ☒ **Social & Economic Research**
- ☐ Biodiversity Research
- ☐ Agricultural Land Management Research
- ☐ Health Research

## 4. Project Summary

**Objective**

The project will clarify the role of natural gas in meeting the state's renewable energy, security, emissions and energy pricing goals. South Australia is moving towards delivering electricity supply with greater than 50% renewable share and is also considering the potential for hydrogen consumption, production and exports. While in the very long term a zero emission approach might preclude natural gas, in the next decade or so, natural gas could potentially play an important supporting role in meeting the goals of decarbonising electricity and scaling up a broader hydrogen industry. High variable renewable shares can only be achieved with additional flexible generation technologies such as storage and natural gas as well as strong state interconnections. However, in the medium term, only natural gas may be capable of providing a cost-effective solution for extended periods of low renewable generation outputs (e.g. lasting several days). Similarly, in the long term, it would be ideal if all hydrogen is produced from zero emission sources. However, hydrogen produced from renewables is currently too high cost to be attractive. Gas with carbon capture and storage may be a more economically viable interim feedstock for hydrogen production to allow consumers to begin to incorporate lower emission hydrogen in their households and businesses.

**Description**

The research would define a least cost technical pathway towards 100% renewable electricity and a hydrogen industry which supports an eventual zero net emissions in South Australia consistent with *South Australia's Climate Change Strategy 2015-2050 – Towards a Low Carbon Economy*. In particular, the pathway would determine how higher variable renewable shares are supported by other flexible technologies, including natural gas, and how these technologies change over time. It will also consider how to provide the least cost hydrogen while also achieving a similar reduction in the emission intensity of hydrogen supply which is currently based on natural gas. Carbon capture and storage will be specifically considered as an option for decarbonising hydrogen supply as well as renewable electricity. It is likely that the linkages between these two pathways will change overtime. Now and over the medium term the hydrogen and electricity sectors will be competing for natural gas. Longer term, the decarbonisation of the grid will make electricity more attractive as a hydrogen feedstock while the increased availability of greener hydrogen will make it attractive as a flexible generation source to support variable renewable generation. As such the project is expected to identify strong synergies on the use of gas in the medium term, and long term convergence towards an integrated energy system. It might also identify technical or economic barriers towards realising these opportunities.

**Need & Scope**

South Australia has strong policies on renewable energy deployment and access to gas. This is reflected in *Climate Change and Greenhouse Emissions Reduction Act 2007, South Australia's Climate Change Strategy 2015-2050 – Towards a Low Carbon Economy*. It has also published its *Hydrogen Action Plan*. This project is designed to inform the implementation of those policies, providing insights on the role that gas can play in delivering high renewables shares with strong security and at least cost and in building a hydrogen industry that supports emissions reduction. Each of these policies has a broad goal but is not technologically or fuel prescriptive. The analysis to determine specifically what resources will be required is yet to be done. This project contributes by considering the role of gas against the backdrop of other fuel and technology options and consideration of both medium- and long-term horizons. The methodology will build on the growing but still infant body of work examining alternative hydrogen energy pathways (CSIRO, ARENA, Alan Finkel) and very high renewable generation systems (CSIRO, AEMO, Monash, Canberra University and various international groups). None of these existing works have sought to define when gas can best contribute to the process of decarbonising electricity and hydrogen production.

**Methodology**

CSIRO will use a combination of modelling approaches to determine least cost fuel and technology choices over the medium and longer term. The main tool for organising the work will be CSIRO's Aus-TIMES model which is a whole of Australian energy system model. That is, it simultaneously models the fuel and technology choices of the electricity, transport and commercial and industrial direct energy end-use sectors. This is an ideal framework for bringing together the topics that we need to explore in this project. Aus-TIMES is an Australian implementation of the TIMES modelling framework developed under the International Energy Agency's Energy Technology Systems Analysis Project.

We will also use three other specific task models. The first is model called STABLE which represents the National Electricity Market at the half hourly level and is designed to determine what additional supporting technologies should be deployed to meet different levels of renewables shares. This model will be run each 5 years and be used to inform TIMES which is a less granular model in annual time steps.

Both Aus-TIMES and STABLE have sub-state resolution for South Australia including the three electricity transmission zones (South East South Australia, Adelaide and Northern South Australia) and related Renewable Energy Zones (South East SA, Riverland, Mid-North SA, Yorke Peninsula, Northern SA, Leigh Creek, Roxby Downs, Eastern Eyre Peninsula and Western Eyre Peninsula) to identify regions where additional renewable and gas-fired generation may be needed.

The second specific modelling task will be to calculate the cost and location of alternative hydrogen feedstock and production supply chains. Aus-TIMES already includes some hydrogen production pathways (steam methane reforming (SMR), electrolysis), but we are anticipating the need to investigate these in more depth and potentially add additional pathways not yet included (SMR with CCS).The third specific modelling task will be to calculate the regional impacts on economic activity from changes in natural gas supply and hydrogen production. The KPMG-SD model will be used to estimate the impact on local gross regional product (GRP) and full-time equivalent employment (FTE) from changes in the demand for industries' outputs for regional economies in South Australia aligned to Statistical Area Level 4 (SA4) which includes areas of the South East.

## 5. Project Inputs

**Research**

There is a strongly emerging body of research on renewable integration which this project builds on and extends. As with all emerging research areas there are specific gaps we will be seeking to explore in more detail, particularly around the role of gas but also the context of using both renewables and gas as primary energy sources for a new hydrogen industry. We will complement existing work by extending the technological options for supporting renewables and integrating those issues with the challenges and opportunities involved with hydrogen production. We will also take greater account of system security and reliability constraints in our modelling framework. For the latter topic, we will take advantage of the various works published by AEMO over the last few years on the specific system security requirements. In regard to hydrogen and renewable integration, we will be able to build on the work of Alan Finkel in reviewing hydrogen supply pathways and potential demand for hydrogen exports. There is also an emerging body of work we can draw on in regard to the use of hydrogen in domestic industries such as steel and in the existing gas distribution pipeline at low blends.

**Resources and collaborations**

| Researcher | Time Commitment (project as a whole) | Principle area of expertise | Years of experience | Organisation |
|---|---|---|---|---|
| Paul Graham | 15 days | Renewable integration modelling | 20 | CSIRO |
| James Foster | 57 days | Renewable integration modelling and STABLE | 3 | CSIRO |
| Jenny Hayward | 34 days | Hydrogen production and demand | 9 | CSIRO |
| Luke Reedman | 47 days | Energy system modelling and Aus-TIMES | 16 | CSIRO |

| Subcontractors (clause 9.5(a)(i)) | Time Commitment (project as a whole) | Principle area of expertise | Years of experience | Organisation |
|---|---|---|---|---|
| KPMG | 20 days | Regional economic impact analysis | 20 | KPMG |

GISERA
Gas Industry Social and Environmental Research Alliance

**Budget Summary**

| Source of Cash Contributions | 2020/21 | 2021/22 | 2022/23 | % of Contribution | Total |
|---|---|---|---|---|---|
| GISERA | $159,419 | $82,328 | $0 | 75% | $241,747 |
| - Federal Government | $118,268 | $61,076 | $0 | 55.64% | $179,344 |
| - SA Government | $41,151 | $21,252 | $0 | 19.36% | $62,403 |
| **Total Cash Contributions** | **$159,419** | **$82,328** | **$0** | | **$241,747** |
| | | | | | |
| **Source of In-Kind Contribution** | **2020/21** | **2021/22** | **2021/22** | **% of Contribution** | **Total** |
| CSIRO | $53,140 | $27,443 | $0 | 25% | $80,583 |
| **Total In-Kind Contribution** | **$53,140** | **$27,443** | **$0** | **25%** | **$80,583** |

## 6. Project Impact Pathway

| Activities | Outputs | Short term Outcomes | Long term outcomes | Impact |
|---|---|---|---|---|
| Activity A: Preliminary modelling results | Preliminary results report quantifying the expected role of South Australia gas in renewable integration and hydrogen production<br>Output B: Communication of preliminary results and seeking feedback from industry and government through various forums | The opportunity for using gas in renewable integration and hydrogen production is starting to be defined | Knowledge of the economic & environmental impacts & opportunities of unconventional gas projects are enhanced | Supports electricity sector emissions reduction through high renewable generation.<br><br>Supports development of a hydrogen production industry which would have economic benefits for South Australia.<br><br>Provides more information about the likely future role of gas which would have economic benefits for the gas supply industry in the South East corner of South Australia. |
| Activity B: Final modelling results | Final results report quantifying the expected role of South Australia gas in renewable integration and hydrogen production<br>Output D: Communication of final results to industry, and government through various forums | The degree of opportunity for using gas in renewable integration and hydrogen production is more tightly defined | | |
| Develop fact sheets with key findings | A plain English factsheet at project commencement (outlining project objectives) and updated again towards completion of project (with key findings) for distribution via the GISERA website and at community engagement events. | Increased community awareness of potential environmental impacts & opportunities | | |

## 7. Project Plan

**Project Schedule**

| ID | Activities / Task Title (should match activities in impact pathway section) | Task Leader | Scheduled Start | Scheduled Finish | Predecessor |
|---|---|---|---|---|---|
| **Task 1** | Preliminary modelling results and engagement | Luke Reedman | October 2020 | May 2021 | None |
| **Task 2** | Final modelling results and engagement | Luke Reedman | June 2021 | September 2021 | Task 1 |

**Task description**

**Task 1**

**TASK NAME:** Preliminary modelling results and engagement

**TASK LEADER:** Luke Reedman

**OVERALL TIMEFRAME:** October 2020 to May 2021

**BACKGROUND:** The project is designed in two stages so that stakeholders have the opportunity to influence the study assumptions and results. In this first stage the research team will develop the initial scenarios, assumptions and modelling results and present them to industry and government.

**TASK OBJECTIVES:** Design appropriate scenarios, extend modelling frameworks as required, collect appropriate data and assumptions, produce a set of projections, capture the activity in a report and discuss results and findings with industry and government.

**TASK OUTPUTS AND SPECIFIC DELIVERABLES:** A report outlining the methodology, scenarios, assumptions and preliminary results and findings; Engagement with stakeholders on the preliminary report for the purposes of revisiting the scenarios and assumptions so that they are more closely aligned with stakeholder input.

**Task 2**

**TASK NAME:** Final modelling results and engagement

**TASK LEADER:** Luke Reedman

**OVERALL TIMEFRAME:** June 2021 to September 2021

**BACKGROUND:** The project is designed in two stages so that stakeholders have the opportunity to influence the study assumptions and results. In this second stage the research team will revise the scenarios and assumptions and produce a final set of results to communicate to industry and government.

**TASK OBJECTIVES:** Revise scenarios and assumptions collecting improved data as required, produce a revised set of projections, capture the activity in a final report and present results and findings to industry and government.

**TASK OUTPUTS AND SPECIFIC DELIVERABLES:** A report outlining the methodology, scenarios, assumptions and final results and findings; Engagement with stakeholders on the final report for the purposes of increasing their knowledge on the potential role of gas in meeting the state goals in relation to renewable integration and hydrogen production.

GISERA
Gas Industry Social and Environmental Research Alliance

**Project Gantt Chart**

| | 2020-21 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Item | Oct-20 | Nov-20 | Dec-20 | Jan-21 | Feb-21 | Mar-21 | Apr-21 | May-21 | Jun-21 | Jul-21 | Aug-21 | Sep-21 |
| Scenario design | | | | | | | | | | | | |
| Data collection and revision | | | | | | | | | | | | |
| Model testing | | | | | | | | | | | | |
| Model runs | | | | | | | | | | | | |
| Report writing | | | | | | | | | | | | |
| Industry & government engagement | | | | | | | | | | | | |
| Stakeholder feedback received | | | | | | | | | | | | |

## 8. Technical Reference Group

The project will establish a Technical Reference Group (TRG) aimed at seeking peer-to-peer technical advice on contextual matters and to discuss research needs as well as outputs as the project progresses. The TRG will include the project leader and a group of different stakeholders as appropriate.

## 9. Communications Plan

| **Stakeholder** | **Objective** | **Channel** (e.g. meetings/media/factsheets) | **Timeframe** (Before, during at completion) |
|---|---|---|---|
| Government & Industry | Improve knowledge and seek feedback on research | Meetings and preliminary results summary information | During (Midway) |
| Government & Industry | Improve knowledge | Meetings and final results summary information | At completion |
| Regional Community/Wider public | Communicate project objectives and key findings from the research | Fact sheets (including development of one at commencements of project which will explain the objective of the project – this will be updated towards completion<br><br>Project progress reported on GISERA website to ensure transparency for all stakeholders including regional communities. | From commencements of project and with an update towards completion<br><br>Periodically |

## 10. Budget Summary

| Expenditure | 2020/21 | 2021/22 | 2022/23 | Total |
|---|---|---|---|---|
| Labour | $170,559 | $71,771 | $0 | $242,330 |
| Operating | $7,000 | $3,000 | $0 | $10,000 |
| Subcontractors | $35,000 | $35,000 | $0 | $70,000 |
| **Total Expenditure** | **$212,559** | **$109,771** | **$0** | **$322,330** |

| Expenditure per Task | 2020/21 | 2021/22 | 2022/23 | Total |
|---|---|---|---|---|
| Task 1 | $187,241 | $0 | $0 | $187,241 |
| Task 2 | $25,318 | $109,771 | $0 | $135,089 |
| **Total Expenditure** | **$212,559** | **$109,771** | **$0** | **$322,330** |

| Source of Cash Contributions | 2020/21 | 2021/22 | 2022/23 | Total |
|---|---|---|---|---|
| Federal Government (55.64%) | $118,268 | $61,076 | $0 | $179,344 |
| SA Government (19.36%) | $41,151 | $21,252 | $0 | $62,403 |
| **Total Cash Contributions** | **$159,419** | **$82,328** | **$0** | **$241,747** |

| In-Kind Contributions | 2020/21 | 2021/22 | 2022/23 | Total |
|---|---|---|---|---|
| CSIRO (25%) | $53,140 | $27,443 | $0 | $80,583 |
| **Total In-Kind Contributions** | **$53,140** | **$27,443** | **$0** | **$80,583** |

| | Total funding over all years | Percentage of Total Budget |
|---|---|---|
| Federal Government Investment | $179,344 | 55.64% |
| SA Government Investment | $62,403 | 19.36% |
| CSIRO Investment | $80,583 | 25% |
| Total Other Investment | | |
| **TOTAL** | **$322,330** | **100%** |

| Task | Milestone Number | Milestone Description | Funded by | Start Date (mm-yy) | Delivery Date (mm-yy) | Fiscal Year Completed | Payment $ (excluding CSIRO contribution) |
|---|---|---|---|---|---|---|---|
| **Task 1** | 1.1 | Preliminary modelling results and engagement | GISERA | Oct-2020 | May-2021 | 2020/21 | $140,431 |
| **Task 2** | 2.1 | Final modelling results and engagement | GISERA | Jun-2021 | Sep-2021 | 2021/22 | $101,316 |

## 11. Intellectual Property and Confidentiality

| | | | | |
|---|---|---|---|---|
| Background IP (clause 11.1, 11.2) | **Party** | **Description of Background IP** | **Restrictions on use (if any)** | **Value** |
| | CSIRO | Model software research tools | None | $ Not Applicable as BIP will not be embedded in deliverables |
| | | | | $ |
| Ownership of Non-Derivative IP (clause 12.3) | CSIRO | | | |
| Confidentiality of Project Results (clause 15.6) | Project Results are not confidential. | | | |
| Additional Commercialisation requirements (clause 13.1) | Not Applicable | | | |
| Distribution of Commercialisation Income (clause 13.4) | Not applicable | | | |
| Commercialisation Interest (clause 1.1) | **Party** | | **Commercialisation Interest** | |
| | CSIRO | | Not applicable | |
| | Other | | | |

## 12. References

Bruce, Sam; Temminghoff, Max; Hayward, Jenny; Schmidt, Elizabeth; Munnings, Christopher; Palfreyman, Doug; Hartley, Patrick. *National Hydrogen Roadmap*. Australia: CSIRO; 2018. https://doi.org/10.25919/5b8055bc08ac

Campey, Tom; Bruce, Sam; Yankos, Thomas; Hayward, Jenny; Graham, Paul; Reedman, Luke; Brinsmead, Thomas; Deverell, James. Low emissions technology roadmap. Melbourne: CSIRO; 2017. https://doi.org/10.4225/08/59b6dd4eb41d4

COAG Hydrogen Work Group 2019, *Australia's National Hydrogen Strategy*, COAG Energy Council.

Graham, Paul; Hatfield-Dodds, Steve. Electricity sector. In: Amandine Denis, editor/s. *Pathways to prosperity in 2050: How Australian can thrive in a low carbon world: Technical report*. ClimateWorks Australia; 2014.

Ju, HyungKuk; Kaur, Gurpreet; Kulkarni, Ani; Munnings, Christopher; Giddey, Sarb. *Technologies for Australia's renewable energy export. In: Asia-Korea Conference on Science and Technology* 2018; 22-23 November; Brisbane. Korean Academy of Scientists and Engineers in Australiasia (KASEA); 2018. 62. http://hdl.handle.net/102.100.100/86232?index=1