Project Order

Proforma 2020

1. Short Project Title

Offsets for Life Cycle Greenhouse Gas Emissions of Onshore Gas in the Northern Territory

Long Project Title	Offsets for Life cycle Greenhouse Gas Emissions of Onshore Gas in the Northern Territory
GISERA Project Number	G.7
Proposed Start Date	13/07/2020
Proposed End Date	10/12/2021
Project Leader	Tim Baynes

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

This project seeks feasible options to offset life cycle greenhouse gas (GHG) emissions emitted in Australia associated with scenarios of onshore shale gas extraction in the Northern Territory (NT). Specifically, CSIRO will quantify technical scenarios[1] for offsetting Australian emissions from new production and Australian consumption of onshore gas extracted from the Northern Territory's Beetaloo Sub-Basin. This responds to **Recommendation 9.8** of the *Scientific Inquiry into Hydraulic Fracturing in the Northern Territory* (2018) hereafter, the "*Scientific Inquiry*". As part of the exploration of offset options, the project will investigate scenarios of developing hydrogen production in the NT that couple more broadly with the NT Government Gas Strategy.

Description

Currently, there is no natural gas production in the NT Beetaloo Sub-Basin. This project will therefore use scenario analysis to represent potential gas extraction, coupled with technical calculations on the GHG emissions implications of those scenarios. The purpose of this scenario analysis is to ask, "what is reasonably plausible" rather than to ask, "what is probable". The former is a technique usefully employed by extractive industries for some decades (Schoemaker 1993). The latter might feed into actuarial or risk calculations, which are not the aim here.

An important technical (and political) aspect of developing natural gas is the estimation of fugitive methane emissions from production scenarios. CSIRO has been actively conducting research on methane emissions for more than 30 years across a range of industries, and most recently, the same personnel identified in this Project Order have conducted a comprehensive life cycle GHG footprint assessment of coal seam gas (CSG) operations in the Surat Basin, Queensland (Schandl et al. 2019). CSIRO will build on that continuity, and knowledge and experience gained in the earlier work, and existing relations with industry and newly developed relations with NT government.

'Life cycle GHG emissions' consist of all GHG emission (including fugitive methane) from the various stages of development of a gas field - exploration, construction - through to final combustion. Calculation of those emissions in this project will be through a life cycle analysis (LCA). LCA looks at all inputs to a product (here that is natural gas) by representing all processes in the supply chain in detail, attaching to each an emissions intensity. CSIRO anticipate the life cycle approach of this project will work with the (currently draft) revision

[1] This research is predominantly a technical economic assessment. However, it should be noted some GHG offsets options may have socio-technical considerations that warrant deeper examination.

of NGER rules for estimating fugitive emissions from gas production and be able to offer the Commonwealth Government useful data for any future revisions.

Attribution of responsibility for life cycle emissions, of any activity, can be to the consumer of the final product (Ottelin et al. 2019) or, more rarely, entirely to the producer (Parra et al. 2019). This attribution problem affects the scope of what life cycle emissions CSIRO is including. Explicitly excluded from the scope of this project are emissions arising from combustion of exported gas. In this regard, refer to the conditions of Recommendation 9.8 of the *Scientific Inquiry*: that all emissions relating to production of gas in the NT and any local (Australian) consumption of gas, must be neutralized. A major part of the work is investigating options for offsetting those GHG emissions.

GHG emissions offsets, or 'carbon offsets' are accounting mechanisms to counteract emissions produced in one activity or location, with another activity that reduces emissions. For example, GHG emissions may be offset by tree planting, geosequestration, or by enabling industry in developing countries to switch to cleaner fuels. Carbon offset markets can be complex and, since the COP 21 Paris Agreement, there has been greater scrutiny on the governance and efficacy of carbon offsets (Blum and Lövbrand 2019).

Many jurisdictions are formalizing what has in the past been an unregulated approach to offsets. NT is currently drawing up a GHG offsets policy[2] and the general intent is that, under these policies and strategies, the environment in total will gain (or have no net loss) from a development proposal, even if the proposal will directly result in some 'acceptable' adverse impacts after all mitigation measures are taken. In Australia, GHG emissions offset actions include: re-forestation; avoided de-forestation, carbon capture and storage and; support of indigenous fire management in Northern Australia.

The project will simulate implementation of carbon offset options over the lifetime of the onshore gas production scenarios. CSIRO will survey and review potential GHG emissions offset actions based on technical feasibility and tractability of the carbon accounting, and particularly look at domestic options that engage with the Northern Territory Aboriginal Carbon Industry Strategy[3].

In summary, the project will assess life cycle GHG emissions mitigation and offsetting by first establishing the scale of the problem using a set of plausible production scenarios over coming decades, and then looking at opportunities for offsetting their respective contribution to climate change, measured in 100-year Global Warming Potential (GWP). CSIRO would assume that any production activity would adhere to other recommendations in the *Scientific Inquiry* and existing regulations.

Ultimately, the central technical output of the project would be a numerate visualization of production scenarios and the cumulative effect of offsets as indicated in Figure 1.

[2] https://haveyoursay.nt.gov.au/offsets-policy

[3] https://denr.nt.gov.au/__data/assets/pdf_file/0006/584439/Aboriginal-Carbon-Industry-Strategy_A4_Digital.pdf

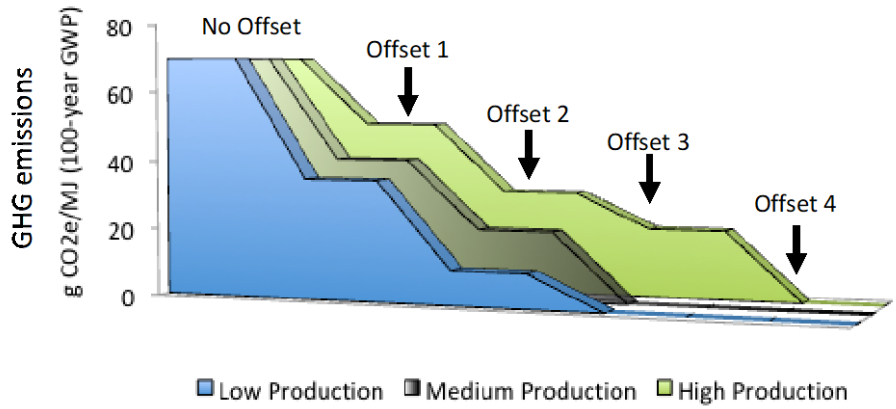

Figure 1 Indicative representation of outputs: gas extraction scenarios and emissions intensity reductions with successive application of a range of offset options.

The project necessarily deals with assumptions and hypothetical outcomes in scenarios and it will be important to have regular contact with regulatory, industry and community stakeholders. A key non-numerate outcome of the project would be consensus on the scenarios and the viability of the proposed offset measures. Outputs would likely partner with other GISERA projects such as the baseline assessment of fugitive emissions in the Beetaloo area (Ong et al. 2018).

Need & Scope

Anthropogenic GHG emissions have been identified as the key driver of climate change, and the recent effects of climate change are material and widespread in Australia and globally (IPCC 2014). In 2016 Australia ratified the COP 21 'Paris Agreements' - an international agreement signed by every nation on Earth (197 countries) to curtail GHG emissions in order to limit global warming below 2^0C.

There are valid concerns in the community and government that the life cycle GHG emissions from any new onshore gas project could challenge Australia's commitment to reduce emissions in line with COP 21 Paris Agreements (Parra et al. 2019; Climate Council of Australia 2019; Witt et al. 2018). Concurrently, the NT Government's gas strategy five point plan[4] has the aims of: supporting the development of onshore gas; establishing gas-based processing and manufacturing; and expanding the LNG hub in Darwin. This tension is resolved somewhat by **Recommendation 9.8** of the *Scientific Inquiry into Hydraulic Fracturing in the Northern Territory* (2018), which requires: "*That the NT and Australian governments seek to ensure that there is no net increase in the life cycle GHG emissions emitted in Australia from any onshore shale gas produced in*

[4] https://business.nt.gov.au/publications/strategies/northern-territory-gas-strategy

the NT." There is a need to respond to these concerns and this recommendation with quantitative analysis of the life cycle emissions and what measures can be taken to abate them in any scenario of gas extraction from the Beetaloo sub-basin going ahead. Within the control of industry, there is a range of options to mitigate direct and indirect emissions during production and, externally, to utilize the carbon offset industry. These options need to be planned in conjunction with production scenarios rather than being applied *ad hoc*.

Related to the aforementioned NT Government strategies, there are opportunities for the gas industry and NT Government to support new connections to the emerging Australian hydrogen industry (Bruce et al. 2018) and, thereby, potential processing and manufacturing industries and markets, for example, use of syngas from SMR for manufacturing fertilizers. The use of methane in this way allows more control over carbon capture and storage than the onshore gas industry could perhaps achieve, operating by itself.

NT Hydraulic Fracturing Inquiry Recommendations

This work seeks to address **Recommendation 9.8** "*That the NT and Australian governments seek to ensure that there is no net increase in the life cycle GHG emissions emitted in Australia from any onshore shale gas produced in the NT.*"

Methodology

Initially, government, industry and other stakeholders will be consulted to obtain perspective and understand the material issues of the onshore gas proposal in the Northern Territory. This includes scoping of the scale and duration of upstream and downstream activity and likely logistics regarding the particular geology and geography of the NT onshore gas project. There will also be a review of the recent peer-reviewed literature regarding onshore gas and GHG emissions.

Through this CSIRO will identify key challenges, uncertainties, develop process models, obtain data and perform a life cycle assessment (LCA) of GHG emissions relating to extraction, treatment, transport, liquefaction and Australian end-use of natural gas from the Beetaloo Sub-basin.

The project will proceed through 6 phases:

1. **Scoping**: The topic is potentially very complex and initially CSIRO would work with the gas industry, the NT government and potentially the panel of the *Scientific Inquiry* to establish the scope of the assessment in terms of the:
    - Physical scope – including questions on the scale, geography, infrastructure needs, and what exactly is the "life time" period when considering the life cycle of gas extraction?
    - Conceptual scope – it is important to clearly define what is meant by the boundary of Australian gas production and consumption to respond to the recommendations of the *Scientific Inquiry*, and

provide certainty to industry, and also to consider whether any emissions of offsetting technology is part of the 'life cycle' scope.

CSIRO can then develop scenarios of production for assessment within the agreed scope.

2. **Development of production scenarios** from the Beetaloo sub-basin and attendant GHG emissions from construction and operations, are dependent on anticipated scale and scheduling of extraction, and infrastructure needs. Information for this will come from existing government and industry reports and expert opinion. It is important that these scenarios are technically feasible and validated by consensus across stakeholders. A series of workshops (virtual and/or in-person) will iteratively refine parameters of the production scenarios that will include detailing:
   - Numbers of wells, drilling, finishing and operational emissions including fugitive emissions
   - Collection lines and pumping of gas
   - Energy and emissions for gas treatment facility
   - Energy and emissions relating to water treatment facilities
   - Pumping and pipeline transport
   - Liquefaction for export from NT
   - Consumption of gas in Australia

   Incorporated in these scenarios are contemporary mitigation activities by industry to reduce emissions in operation based on recent literature (Alvarez et al. 2018; Nisbet et al. 2020).

3. **A Life Cycle Assessment (LCA) of total GHG emissions** including stages of exploration, construction, operations, and final consumption in Australia[5] specific to the set of scenarios for onshore gas production from the Beetaloo Sub-Basin. This includes fate on non-combusted gas including fugitives (as much as comprehensively possible given the scenario nature of this work).

   LCA investigates environmental impacts with respect to a particular output from the processes studies, referred to as a 'functional unit'. For this project the functional unit will be 'a petajoule (PJ) of natural gas produced from the Beetaloo Sub-basin and any fraction thereof consumed within Australia'. Emissions from consumption will be based on the current Australian market for natural gas in different states and the relative change in population expected over the study period. The variety of possible domestic gas end- use processes and their efficiencies, prohibits a complete and detailed LCA of all consumption paths, but technical coefficients and emission factors from the Australian

[5] Accords with the scope and recommendations of the *Scientific Enquiry into Hydraulic Fracturing in the Northern Territory* (2018) Section 9.6

Greenhouse Emissions Information System[6] can inform calculations of aggregate emissions. The project will estimate emissions occurring within the Northern Territory consistent with the Northern Territory GHG inventory. As the inputs to the LCA of total GHG emissions involves assumed values for inputs (i.e. not data from actual operations), this stage will involve a sensitivity analysis on a set of inputs. The entire investigation rests on scenarios with inherent uncertainties, so there is limited value in a comprehensive sensitivity analysis over all inputs.

Part of this phase will be sub-contracted to an energy industry LCA specialist using Australian life cycle inventory databases, SimaPro™ software, and any data specific to shale gas production operations.

4. **Offset options,** including indigenous fire management, will be developed based on technical feasibility considering: maturity of technology; demonstrated effectiveness; application at scale; continuity over lifetime of onshore gas project; quality of governance and; indicative cost. The latter likely involve some economic analysis of the current position of options on the supply curve of GHG offsets.

   The scale of the GHG emissions from production and consumption of gas from the Beetaloo sub-basin could be many tens of megatonnes (Mt) of $CO_{2\text{-}e}$ annually. This quantity implies the GHG offsets required could shift the market price of land-based offsets and carbon farming. The CSIRO Land Use Trade-Offs (LUTO) model has been used in recent scenarios on carbon sequestration with vegetation in the Australian National Outlook (Brinsmead et al. 2019; CSIRO 2019). LUTO would be used to assess the land-use economics of offsets from vegetation in Australia.

   There is also potential for reducing emissions through steam methane reforming (SMR) in a scenario that would involve hydrogen production in the NT. This would utilize expertise from CSIRO's Hydrogen Future Science Platform[7] and would be a technical scenario coupled to one or more of the gas production scenarios. SMR is an established process with commercial application at scale[8].

5. **Combining Production Scenarios and Offsets**. Lastly, scenarios of Australian production and consumption from (2) and (3) will be matched with combinations of offset options from (4) according to relevant aspects of feasibility, with the aim of net zero increase in life cycle GHG emissions. This phase answers the question of the mix of offsets applicable to the different scenarios.

6. **Review of results and final reporting:** results and a draft report will be reviewed in a participatory fashion with industry, government and other stakeholders to ensure the usability of the report for the various needs, and also to position the findings within the context of responding to the

[6] https://ageis.climatechange.gov.au/

[7] https://research.csiro.au/hydrogenfsp/

[8] https://www.energy.gov/eere/fuelcells/fact-month-may-2018-10-million-metric-tons-hydrogen-produced-annually-united-states

recommendations of the *Scientific Inquiry*. The broad nature of the scope of this work makes it likely the final report will include findings that apply more generally for gas extraction beyond the specific situation of the Beetaloo sub-basin gas reserve.

5. Project Inputs

Research

There are life cycle assessments of the CSG to LNG industry from the Australian perspective of substituting for coal-fired electricity generation (Hardisty, P.E.; Clark, T.S.; Hynes 2012; Clark, Hynes, and Mariotti 2011). This project does not specifically compare fuels for electricity generation but it can update parameters of such work with more recent literature and data on emissions intensity of Australian energy use, updated data sets from AUSLCI[9], and making use of the recent peer-reviewed literature, reports and submissions to the NT Government *Scientific Enquiry into Hydraulic Fracturing in the Northern Territory* (2018) and elsewhere.

Researchers from CSIRO identified in this Project Order have conducted a recent assessment of the lifetime GHG emissions of onshore extraction, treatment, transport and liquefaction of gas from Queensland's Surat Basin (Schandl et al. 2019). This project will leverage off this experience and extend this earlier work through application to: a scenario exercise; different geographical and geological conditions, and; considering carbon offsets.

The genesis of the project came from explicit interest expressed by the NT Government and was further developed through feasibility conversations with domain experts on vegetation offsets, indigenous fire management and carbon capture and storage. The scale of the likely GHG emissions offsets raises a complex economics question on how this perturbs existing carbon offset markets. In addition to the land-use economist on the team, CSIRO has asked Stuart Whitten, Principal Economist of CSIRO's Land and Water, to join the Technical Reference Group.

CSIRO has used early consultation with industry and the NT Government on the potential connection to steam methane reforming and its products, in particular hydrogen. This was developed further with in conversation with lead authors of the *National Hydrogen Roadmap* (Bruce et al. 2018) and CSIRO's Hydrogen Mission to understand potential carbon offset pathways.

[9] http://www.auslci.com.au/

This project will complement the ongoing GISERA project (G5) looking at seasonal background levels of methane in the Beetaloo Sub-basin (refer to the interim report by Ong et al. (2018)). That work responds to Recommendation 9.3 of the *Scientific Inquiry* for measurement and monitoring of methane concentrations before the granting of exploration approvals. Combined with this project, perspective on the potential relative change in the local background methane due to the gas production scenarios will be provided. CSIRO is aware of critiques of the unqualified use of emissions intensities (Lafleur et al. 2016). Wherever possible this research will use Australian data from the most recent research into methane emissions from onshore gas production to apply in the scenarios.

A significant extension on prior research, and the impact or problem-orientated literature (Allen et al. 2013; Alvarez et al. 2018), is the exploration of the 'solution space' for onshore gas GHG emissions through options for mitigating emissions based on that same literature (this is in addition to the survey of carbon offsets). For example, Alvarez et al (2018) conducted an emissions survey of multiple onshore wells in U.S. natural gas supply chains and found that largest contribution to GHG emissions came from a small number of production wells that are referred to as "super emitters". They concluded that "*substantial emission reductions are feasible through rapid detection of the root causes of high emissions and deployment of less failure-prone systems*."(Alvarez et al. 2018). In a more recent review Nisbet et al. (2020) looked at general geophysical methods to reduce methane emissions and also promoted broad and frequent maintenance schedules for onshore gas to deal with leaks and other failures. Thus, before any consideration of carbon offsets, a mitigation scenario for industry would include the technical and financial commitment to less error prone equipment and maintenance schedules to identify and rectify high emissions sources for scenarios of large numbers of wells, spread over a wide area.

There are international carbon offset schemes with high levels of standards in governance e.g. the Gold Standard[10], and yet there remain doubts on credibility and sufficiency (Blum and Lövbrand 2019). It is exactly the aim of this research to explore production scenarios from a large onshore gas extraction development and to see if carbon offsets can be sufficiently ambitious and credible to counter the GHG emissions impact of production and local consumption.

[10] https://www.goldstandard.org

Resources and collaborations

Researcher	Time Commitment (project as a whole)	Principle area of expertise	Years of experience	Organisation
Tim Baynes (lead)	70 days	Scenarios, environmental impact assessment and industrial ecology	16	CSIRO (Land and Water)
Jim West	50 days	Data handling and modelling, material flows, exploration geologist	20	CSIRO (Land and Water)
Ray Marcos Martinez	40 days	Land use economics, vegetative offsets	7	CSIRO (Land and Water)
Nawshad Haque	55 days	Hydrogen from steam methane reforming	20	CSIRO (Energy)

Subcontractors (clause 9.5(a)(i))	Time Commitment (project as a whole)	Principle area of expertise	Years of experience	Organisation
Tim Grant	~ 4 months allowing for review of results	LCA of energy sector projects	25	Lifecycles

Budget Summary

Source of Cash Contributions	2020/21	2021/22	2022/23	% of Contribution	Total
GISERA	$257,414	$56,000	$0	75%	$313,413
- Federal Government	$234,624	$51,042	$0	68.36%	$285,666
- NT Government	$12,459	$2,710	$0	3.63%	$15,169
- Origin Energy	$4,393	$956	$0	1.28%	$5,349
- Santos	$4,393	$956	$0	1.28%	$5,349
- Pangaea Resources	$1,544	$336	$0	0.45%	$1,880
Total Cash Contributions	**$257,414**	**$56,000**	**$0**	**75%**	**$313,413**
Source of In-Kind Contribution	**2020/21**	**2021/22**	**2022/23**	**% of Contribution**	**Total**
CSIRO	$85,805	$18,667	$0	25%	$104,471
Total In-Kind Contribution	**$85,805**	**$18,667**	**$0**	**25%**	**$104,471**

Cultural Monitoring Program

The cultural monitor program is considered mutually beneficial, increases engagement and participation of the local traditional owners and provides additional safeguards against the research proponent or other fieldworkers inadvertently entering into a sacred site or other culturally sensitive area. Cultural monitors are engaged via the NLC whenever a company or operator goes out in the field.

In GISERA projects where CSIRO researchers are being escorted onto leases by company representatives who have organised permit access, those company procedures will apply.

For all other GISERA projects (particularly environmental and social projects) where CSIRO researchers are not being escorted by industry, CSIRO will work with the NLC to apply this practice.

6. Project Impact Pathway

Activities	Outputs	Short term Outcomes	Long term outcomes	Impact
A series of meetings or workshops (possibly virtual) and reports to accompany a literature review	Review of reports and literature, consultation with stakeholders	Awareness and consensus on the purpose of the project and the priority research questions for stakeholders	This project will enable the NT government, regulators and industry to make informed decisions on the environmental consequences and costs of gas extraction from the Beetaloo Sub-basin This work will improve community awareness about the economic, social & environmental effects of onshore gas development Improved capacity to forecast and negate environmental and commercial risks	*Environmental Impact* • Identified means to reduce GHG footprint directly from mitigation by industry and potential carbon capture, and indirectly through purchasing carbon offsets *Social Impact* • Specific inclusion of indigenous fire management in the set of carbon offsets can benefit the indigenous community *Economic Impact* • Support of Australian carbon offset economy
Define physical and conceptual scope and report	A scoping report outlining agreed terms of reference and parameters of the study in the context of local and international knowledge on GHG emissions from onshore gas	Defined quantitative and conceptual scope consistent with recommendations of the *Scientific Inquiry* (2018).		
Develop production scenarios	A dataset of technical scenarios that quantify levels of production from the Beetaloo Sub-basin, and any mitigation actions or practices that industry can reasonably commit to.	Credible information to support regulatory or investment decision making on gas extraction and mitigation of emissions from Beetaloo Sub-basin.		
LCA of production scenarios	A life cycle assessment of production scenarios. The functional unit will be 'a petajoule (PJ) of natural gas produced from the Beetaloo Sub-basin and any fraction thereof consumed within Australia'. Possibly a 'stand-alone' output of interest to researchers and the community.	More informed industry and government on the life cycle assessment of GHG impacts of onshore shale gas from latest data based on consensus scenarios		

Identify, quantify and assess GHG emissions offset options	A report on the survey of domestic and international carbon offset options based on: effectiveness; scalability; continuity; quality of governance and; indicative cost.	This quantitative and qualitative work outlines improvements in responding to recommendation 9.8 of the *Scientific Inquiry* (2018).		• Informing potential investment in emerging gas and chemical manufacturing industry in Australia and, more particularly, connected to the Northern Territory Gas Strategy.
Synthesize Production Scenarios and Offsets	A dataset combining the input assumptions of the production scenarios with the life cycle GHG impacts and the emissions offset options. Presentation of interim results to stakeholders in webinars or in person.	Provides a techno-economic pathway to resolving the concurrent strategic aspirations of developing gas from the Beetaloo Sub-basin and neutralizing GHG emissions impacts through improved industry practices.		
Report writing, review, Final Report	Draft report for internal peer-review and stakeholders. In view of the likely public interest in this work the Final Report will be accompanied by knowledge transfer sessions and factsheets.	Understanding of GHG environmental impacts from scenarios of production, and domestic consumption, of gas from Beetaloo Sub-basin. Abatement options assessed as matched to scenarios .		

7. Project Plan

Project Schedule

ID	Activities / Task Title (should match activities in impact pathway section)	Task Leader	Scheduled Start	Scheduled Finish	Predecessor
Task 1.1	Review of reports and literature and consultation with stakeholders	Tim Baynes/Jim West	13/07/2020	31/08/2020	*
Task 1.2	Define physical and conceptual scope and report	Jim West/Tim Baynes	13/07/2020	31/08/2020	*
Task 2	Develop production scenarios	Tim Baynes	14/08/2020	30/09/2020	Tasks 1,2,3**
Task 3	LCA of production scenarios	Tim Grant Lifecycles	01/10/2020	01/02/2021	Task 4
Task 4	Identify, quantify offset options	Jim West, Nawshad Haque	05/01/2021	31/03/2021	
Task 5	Synthesize Production Scenarios and Offsets	Tim Baynes/Nawshad Haque	05/01/2021	30/06/2021	Tasks 2, 3, 4
Task 6	Report writing, review, Final Report	Tim Baynes	01/07/2021	10/12/2021	Task 5

***** these tasks will depend on travel restrictions under COVID 19 though most elements of these tasks can be done in isolation

** note that there is some overlap with predecessor tasks

Task description

Task 1.1

TASK NAME: Review of reports and literature and consultation with stakeholders

TASK LEADER: Tim Baynes / Jim West

OVERALL TIMEFRAME: 1.5 months (13 July 2020 – 31 August 2020)

BACKGROUND: It is important to consult with government, industry and other stakeholders to obtain perspective and understand the material issues of the onshore gas proposal in the Northern Territory. There will also be a review of the recent (last 5 years) peer-reviewed literature regarding onshore gas and GHG emissions.

TASK OBJECTIVES: A knowledge base from peer-reviewed literature, expert submissions and industry to inform the scoping of the project and development of production scenarios

TASK OUTPUTS AND SPECIFIC DELIVERABLES: Series of workshops or online meetings with stakeholders and a literature review.

Task 1.2

TASK NAME: Define physical and conceptual scope and report

TASK LEADER: Jim West/ Tim Baynes

OVERALL TIMEFRAME: 1.5 months (13 July 2020 – 31 August 2020)

BACKGROUND: This task includes scoping of the scale and duration of upstream and downstream activity and likely logistics regarding the particular geology and geography of the NT onshore gas project.

TASK OBJECTIVES: Having consensus on the bounds of the project distributes ownership of the scope (and implications) beyond the research team to include multiple stakeholders

TASK OUTPUTS AND SPECIFIC DELIVERABLES: A scoping report outlining agreed terms of reference and parameters of the study in the context of local and international knowledge on GHG emissions from onshore gas.

Task 2

TASK NAME: Develop production scenarios

TASK LEADER: Tim Baynes

OVERALL TIMEFRAME: 1.5 months (14 August 2020 – 30 September 2020)

BACKGROUND: Working with industry, government and using the knowledge base of Task 1.1, these production scenarios are the main input assumptions that set the scope and scale of GHG emissions

TASK OBJECTIVES: Credible production scenarios that represent the specific conditions of the Beetaloo Sub-basin and industry commitments to mitigation practices over the life time of the hypothetical development

TASK OUTPUTS AND SPECIFIC DELIVERABLES: A dataset of technical scenarios that quantify levels of production from the Beetaloo Sub-basin, and any mitigation actions or practices that industry can reasonably commit to.

Task 3

TASK NAME: LCA of production scenarios

TASK LEADER: Tim Grant - Lifecycles

OVERALL TIMEFRAME: 4 months (1 October 2020 – 1 February 2021)

BACKGROUND: This task is the key link between the production scenarios developed in Task 2 and the objective of surveying potential GHG offset options in Task 4

TASK OBJECTIVES: Adding to and updating data on life cycle assessment of GHG emissions from onshore gas production scenarios cognisant of potential mitigation actions by industry

TASK OUTPUTS AND SPECIFIC DELIVERABLES: Report and data detailing the life cycle GHG emissions of production scenarios from Beetaloo Sub-basin.

Task 4

TASK NAME: Identify, quantify offset options

TASK LEADER: Jim West / Nawshad Haque

OVERALL TIMEFRAME: 3 months (5 January 2021 – 31 March 2021)

BACKGROUND: Key to the credibility of responding to the environmental impacts of gas development and Recommendation 9.8 from the Scientific Inquiry.

TASK OBJECTIVES: GHG Offset options, including indigenous fire management, will be developed and assessed based on technical feasibility considering: maturity of technology; demonstrated effectiveness; application at scale; continuity over lifetime of onshore gas project; quality of governance and; indicative cost.

TASK OUTPUTS AND SPECIFIC DELIVERABLES: A quantitative and qualitative appraisal of offset options available to the production scenarios of Task 2 that can effectively accommodate the GHG emissions impact identified in Task 3.

Task 5

TASK NAME: Synthesize Production Scenarios and Offsets

TASK LEADER: Tim Baynes / Nawshad Haque

OVERALL TIMEFRAME: 6 months (5 January 2021 – 30 June 2021)

BACKGROUND: This penultimate task matches the production scenarios with feasible carbon offsets and it is anticipated that in that matching exercise there may be some need for iteration between the tasks – hence this Task overlaps with its predecessors: Task 3 and 4.

TASK OBJECTIVES: A techno-economic pathway to resolving the concurrent strategic aspirations of developing gas from the Beetaloo Sub-basin and neutralizing GHG emissions impacts through improved industry practices

TASK OUTPUTS AND SPECIFIC DELIVERABLES: A dataset combining the input assumptions of the production scenarios with the life cycle GHG impacts and the emissions offset options. Presentation of interim results to stakeholders in webinars or in person.

Task 6

TASK NAME: Report writing, review, Final Report

TASK LEADER: Tim Baynes

OVERALL TIMEFRAME: 5.5 months (1 July 2021 – 10 December 2021)

BACKGROUND: Subsequent to the presentation of initial results in Task 5 and stakeholders' responses, this Task combines the output from different components of the project to a coherent final report. This task also includes preparation of a scientific paper for an international journal.

TASK OBJECTIVES: Communication of results and conclusions to immediate stakeholders, peers and the wider community

TASK OUTPUTS AND SPECIFIC DELIVERABLES: Draft report for internal peer-review and stakeholders. In view of the likely public interest in this work the Final Report will be accompanied by knowledge transfer sessions and factsheets. Preparation of scientific manuscript to international journal.

Project Gantt Chart

		2020-2021												2021-2022					
Task	**Task Description**	**Jul-20**	**Aug-20**	**Sept-20**	**Oct-20**	**Nov-20**	**Dec-20**	**Jan-21**	**Feb-21**	**Mar-21**	**Apr-21**	**May-21**	**Jun-21**	**Jul-21**	**Aug-21**	**Sept-21**	**Oct-21**	**Nov-21**	**Dec-21**
1.1	Review of reports and literature and consultation with stakeholders																		
1.2	Define physical and conceptual scope and report																		
2	Develop production scenarios																		
3	LCA of production scenarios																		
4	Identify, quantify offset options																		
5	Synthesize Production Scenarios and Offsets																		
6	Report writing, review, Final Report																		

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 most be composed of domain experts including:

- Stuart Whitten – Principal Economist at L&W
- Maartje Sevenstre – LCA Expert at CSIRO
- Northern Land Council and other specialists on indigenous fire management offset program
- Relevant NT Government representatives including from the Department of Trade, Business and Innovation
- Technical industry experts

9. Communications Plan

Stakeholder	**Objective**	**Channel** (e.g. meetings/media/factsheets)	**Timeframe** (Before, during at completion)
Traditional Owner communities	To pursue relations with Traditional Owner communities (via cultural monitors)	Engagement with TO communities – as a wider context as part of CSIRO communications (considered mutually beneficial)	Ongoing
Government and industry	To facilitate a deeper understanding of research findings and implications for policy, programs, planning, and other initiatives	Knowledge transfer sessions and through initial stakeholder consultation on scenarios and post-completion presentations and meetings.	From commencement of project and with updates as they come to hand.
Regional community/wider public	To communicate project objectives and key messages from the research	Fact sheets (including development of one at commencement of project which will explain in plain English the objective of the project – this will be updated periodically as project progresses). Project progress reported on GISERA website to ensure transparency for all stakeholders including regional communities. Participation in roadshows, community workshops and meetings and other engagements where appropriate.	From commencement of project and with updates as they come to hand. As required As required

Regional community/wider public, government, scientific community and industry	To report on key findings	Final Report	At completion
Scientific community	To publish results in international peer-reviewed journals	Manuscript for submission to journals	At completion

10. Budget Summary

Expenditure	2020/21	2021/22	2022/23	Total
Labour	$244,018	$74,666	$0	$318,684
Operating	$19,200	$0	$0	$19,200
Subcontractors	$80,000	$0	$0	$80,000
Total Expenditure	**$343,218**	**$74,666**	**$0**	**$417,884**

Expenditure per Task	2020/21	2021/22	2022/23	Total
Task 1.1	$42,403	$0	$0	$42,403
Task 1.2	$28,799	$0	$0	$28,799
Task 2	$45,020	$0	$0	$45,020
Task 3	$112,927	$0	$0	$112,927
Task 4	$55,346	$0	$0	$55,346
Task 5	$58,723	$0	$0	$58,723
Task 6	$0	$74,666	$0	$74,666
Total Expenditure	**$343,218**	**$74,666**	**$0**	**$417,884**

Source of Cash Contributions	2020/21	2021/22	2022/23	Total
Federal Government (68.36%)	$234,624	$51,042	$0	$285,666
NT Government (3.63%)	$12,459	$2,710	$0	$15,169
Origin Energy (1.28%)	$4,393	$956	$0	$5,349
Santos (1.28%)	$4,393	$956	$0	$5,349
Pangaea (0.58%)	$1,544	$336	$0	$1,880
Total Cash Contributions	**$257,414**	**$56,000**	**$0**	**$313,413**

In-Kind Contributions	2020/21	2021/22	2022/23	Total
CSIRO (25%)	$85,805	$18,667	$0	$104,471
Total In-Kind Contributions	**$85,805**	**$18,667**	**$0**	**$104,471**

	Total funding over all years	Percentage of Total Budget
Federal Government Investment	$285,666	68.36%
NT Government Investment	$15,169	3.63%
Origin Energy	$5,349	1.28%
Santos	$5,349	1.28%
Pangaea Resources	$1,880	0.45%
CSIRO Investment	$104,471	25%
TOTAL	**$417,884**	**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	Review of reports and literature and consultation with stakeholders	GISERA	Jul-2020	Aug-2020	2020/21	$31,802
Task 1	1.2	Define physical and conceptual scope and report	GISERA	Jul-2020	Aug-2020	2020/21	$21,599
Task 2	2.1	Develop production and consumption scenarios	GISERA	Aug-2020	Sep-2020	2020/21	$33,765
Task 3	3.1	LCA of production scenarios	GISERA	Oct-2020	Feb-2021	2020/21	$84,695
Task 4	4.1	Identify, quantify offset options with assessment of feasibility – interim report	GISERA	Jan-2021	Mar-2021	2020/21	$41,510
Task 5	5.1	Synthesize Production Scenarios and offsets	GISERA	Jan-2021	Jun-2021	2020/21	$44,042
Task 6	6.1	Report writing, review, Final Report	GISERA	Jul-2021	Dec-2021	2021/22	$56,000

11. Intellectual Property and Confidentiality

Background IP (clause 11.1, 11.2)	**Party**	**Description of Background IP**	**Restrictions on use (if any)**	**Value**
				$
				$
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		N/A	
	Origin Energy		N/A	
	Santos		N/A	
	Pangaea Resources		N/A	

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