Project Order, Variations and Research Progress

Project Title: Whole of life cycle greenhouse gas assessment of the exploitation of the Surat Basin gas reserve: global benefits and risks

This document contains three sections. Click on the relevant section for more information.

1 Original Project Order

Project Order
Proforma 2015

1. Short Project Title (less than 15 words)

Whole of life cycle greenhouse gas assessment of the exploitation of the Surat Basin gas reserve: global benefits and risks

Long Project Title	Whole of life cycle greenhouse gas assessment of the exploitation of the Surat Basin gas reserve: global benefits and risks
GISERA Project Number	
Proposed Start Date	1 February 2016
Proposed End Date	31 January 2017
Project Leader	Dr Heinz Schandl

2. GISERA Research Program

☐ Biodiversity Research	☐ Marine Research	☐ Land Research
☐ Water Research	☐ Social & Economic Research	☒ GHG Research

3. Research Leader, Title and Organisation

(Include time commitment to project by the Research Leader)

Heinz Schandl, Dr, Commonwealth Scientific and Industrial Research Organisation (CSIRO)
10% time commitment

4. Summary (less than 300 words)

This project assesses the whole of life cycle greenhouse gas emissions of the exploitation of the Surat Basin natural gas reserve including extraction, transportation and usage. The analysis of GHG emissions will include domestic and offshore usage of the gas including for

electricity generation in Asia. The project employs a novel hybrid approach of environmentally extended input-output (EEIO) analysis and life cycle analysis (LCA) to measure direct and indirect (embodied) emissions related to the gas reserve. It then compares the emissions of gas use for electricity generation to emissions of other forms of generation to report on the benefits and risks including emissions, climate and health impacts. The project uses I-O tables with a high geographical and sector resolution that are now available through a new research infrastructure, the Industrial Ecology Virtual Laboratory (IE Lab) of which CSIRO is a partner. I-O analysis will establish hot spots of GHG emissions which will be further analysed using LCA. Results from both analytical tools are integrated in one hybrid analytical framework which utilises the strengths and corrects for the weaknesses of each approach. The analysis of GHG emissions follows international accounting standards that have been applied for nations, cities, businesses and products. Whole of life cycle emission accounting for a whole natural resource reserve is a novel application, however, which puts GISERA partners in a unique leadership position in coherent and comprehensive reporting for the complete greenhouse gas emissions, climate and health impacts of utilising a gas reserve in Australia and offshore. The knowledge base established through this research is relevant for business decisions and policy formulation in the context of energy security and global efforts for moving toward a low carbon energy system. It will assist GISERA to establish the merit of natural gas as a transition fuel especially in the context of energy needs in developing and emerging economies and the associated benefits and risks.

5. Budget Summary (From Excel Budget Pack worksheet "Project Plan Summary")

Expenditure	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	Total
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	
Labour					81,568	127,140		206,708
Operating					16,500	16,500		33,000
Total Costs					**98,068**	**143,640**		**241,708**
CSIRO					98,068	143,640		241,708
Total Expenditure					**98,068**	**143,640**		**241,708**

Expenditure per Task	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	Total
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	
Task 1					98,068	143,640		241,708
Task 2								
Task 3								
Task 4								
Task 5								
Task 6								
Total Expenditure					**98,068**	**143,640**		**241,708**

Cash Funds to Project	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	Total
Partners	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	
CSIRO					84,000	56,000		140,000
Total Cash to Partners					**84,000**	**56,000**		**140,000**

Source of Cash	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	Total
Contributions	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	
GISERA					84,000	56,000		140,000
Total Cash Contributions					**84,000**	**56,000**		**140,000**

In-Kind Contribution from	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	Total
Partners	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	
CSIRO					14,068	87,640		101,708
Total In-Kind Contribution from Partners					**14,068**	**87,640**		**101,708**

	Total funding overall years	Percentage of Total Budget
GISERA Investment	140,000	58%
CSIRO Investment	101,708	42%
Total Other Investment		
TOTAL	**241,708**	**100%**

Task	Milestone Number	Milestone Description	Funded by	Participant Recipient	Start Date (mm-yy)	Delivery Date (mm-yy)	Fiscal Year	Fiscal Quarter	Payment $
Task 1	1.1	Establishing the study boundaries and data sources and concordances for the analysis	GISERA	CSIRO	Feb 16	Mar 16	15/16		14,000
Task 2	2.1	I-O analysis of GHG emissions to identify hotspots and priorities	GISERA	CSIRO	Apr 16	Jul 16	15/16		35,000
Task 3	3.1	LCA analysis of selected priority areas	GISERA	CSIRO	May 16	Oct 16	15/16 - 16/17		35,000
Task 4	4.1	Integration of I-O and LCA results into one hybrid analysis	GISERA	CSIRO	Aug 16	Oct 16	16/17		28,000
Task 5	5.1	Reporting of main results	GISERA	CSIRO	Sep 16	Oct 16	16/17		14,000
Task 6	6.1	Review of results and final reporting	GISERA	CSIRO	Nov 16	Jan 17	16/17		14,000

6. Other Researchers (include organisations)

Researcher	Time Commitment (project as a whole)	Principle area of expertise	Years of experience	Organisation
Tim Baynes	25%	Systems modelling, input-output analysis, industrial ecology, climate change	15	CSIRO Land and Water
Nawshad Haque	25%	Life cycle analysis, mining and energy, industrial ecology	15	CSIRO Mineral Resources
Arne Geschke	20%	Economically extended input-output analysis	10	University of Sydney
Karin Hosking	5%	Research assistant, editor	15	CSIRO Land and Water

7. GISERA Objectives Addressed

Carrying out research and improving and extending knowledge of social and environmental impacts and opportunities of CSG-LNG projects for the benefit of the CSG-LNG industry, the relevant community and the broader public.

Informing government, regulators and policy makers on key issues regarding policy and legislative framework for the CSG-LNG industry.

8. Program Outcomes Achieved

The GISERA research alliance aims for an improved understanding of the environmental, health, and social and economic impacts of the Australian gas industry in Australia and offshore to provide a knowledge base to industry, the policy community and other stakeholders. This research achieves the program's desired outcome by developing a novel greenhouse gas emissions analysis and assessment which is comprehensive, reliable and robust and covers the whole life cycle of the gas resource. It establishes environmental and health benefits and risks of the Surat Basin gas reserve exploitation and helps understand the potential importance of gas as 'transition fuel'. The research establishes a tool and approach that will be applicable for other natural resource extraction activities and can be easily expanded to a whole sustainability (triple bottom line) analysis. The project demonstrates the leading example of GISERA in the resource industry internationally.

9. Program Outputs Achieved

Outputs of this research will include a comprehensive report, publication in the peer-reviewed literature, and workshops with industry representatives and other stakeholders. They may also include, as required, targeted briefs for specific audiences and events, and conference presentations.

10. What is the knowledge gap that these research outputs will address?

Research on GHG emissions has reached maturity over the past couple of decades including for direct, indirect and embodied emissions of national economies, cities, businesses, products or certain industrial processes. This has included research on life-cycle GHG emissions for different fossil energy sources (Burnham et al. 2011, Clark 2011) including the analysis of data gaps (Zoran et al. 2014) and quantification of uncertainties (Hauck, et al. 2014). There is much less research focusing on the exploitation of a natural resource body (see Laurenzi and Jersey 2013 for an exemption) across its whole life cycle, including extraction, transport and power generation, which is the aim of this research. There is a lack of knowledge of the benefits and risks of natural gas to be used for electricity generation, especially in developing and transitional economies, to satisfy development and economic growth needs whilst reducing carbon emissions.

This research will explore the specific benefits and risks related to the Surat Basin gas reserve and its use for energy generation with respect to overall GHG emissions and in comparison to other generation technologies with a special focus on electricity generation in Asia where most of the Surat Basin gas is sold. GHG emissions are the most significant environmental issue from the usage of natural gas. The industry is largely export driven hence emissions at the point of use for electricity generation need be included in the analysis and will be compared to emissions from other electricity generation with using coal fired electricity generation as a baseline. The scientific insight created in this research will inform the gas industry in Australia with regard to the specific reserve and will allow general conclusions to be drawn on the potential of natural gas to be utilised as a transitional fuel towards a low carbon energy system.

While research into whole of life cycle greenhouse gas emissions of gas fields and comparative research on emissions from different electricity generation is growing this research employs an innovative approach by linking environmentally extended I-O analysis to standard life cycle analysis. In doing so, the strength of each approach will be utilized and weaknesses will be compensated for. Using this hybrid methodology prepares for a broader assessment of environmental, social, and economic which are not the focus of this study.

11. How will these research outputs and outcomes be used in State Government and industry?

Project insights will enable industry and business planning and decision making to be based on a sound analysis and knowledge base about the full (whole of life cycle) greenhouse gas emission impact of Queensland (Australian) gas extraction and gas usage for energy generation abroad. This becomes more important as gas exports will increase in the near future now that the transportation infrastructure has been completed. The project will provide assessments of overall benefits and specific risks related to the extraction, transport and usage of gas in terms of their GHG emission footprint and will recommend strategies for emission reduction if such potential is revealed by the analysis. Project insights hence will help in making business decisions and support policy formulation based on scientific research and will improve the ability of the energy industry to formulate the environmental (carbon emission reduction) benefits of gas usage over other primary energy sources.

12. Project Development (1 page max.)

This project proposal was developed to address an information gap that exists with regard to the full carbon emission benefits and risks of natural gas in the extraction in Australia, transport to the centres of demand of Australian gas in Asia and its use for mainly electricity generation. There is renewed high-level international policy interest in reducing carbon emissions of economic activity, as demonstrated by the recent statement of the Group of 7 leading economies at their meeting in Germany in June 2015 and the recent meeting of ministers and environmental authorities in Asia and the Pacific in Bangkok in May 2015. It is important to know what role the Australian gas industry can play to achieve these high-level regional goals and what risks may be related to the usage of gas as a transitional fuel in energy generation between now and 2050.

13. Project Objectives and Outputs

The aim of this project is to assess the whole of life cycle greenhouse gas impacts of the exploitation of the gas reserve in the Surat Basin over the whole extraction period and to relate this assessment to the potential greenhouse gas savings that are achieved at the point of usage especially in Asia of the gas. The assessment of greenhouse gas in the process of the exploitation of the reserve will include all direct and indirect (embodied) greenhouse gas emissions that are related to the extraction and transport of the gas to the point of usage (i.e. upstream and downstream carbon emissions will be included in the analysis).

Accounting for emissions across the whole life cycle of a product, sector or process is a standard field of inquiry in environmental engineering and industrial ecology and can rely on well-established concepts, methods and tools. For carbon emissions they apply international standards which include direct (Scope 1), indirect (Scope 2) and embodied emissions (Scope 3). The scientific novelty of this research is the application of standard methods to the exploitation and usage of a whole reserve of a specific natural resource – in this case natural gas – which require adaptation of methods to the specifics of the case to assess the benefits and risks of gas exploitation and use.

The assessment will use a hybrid approach of life cycle analysis (LCA) and environmentally extended input-output analysis (EEIO). This combination of tools within one hybrid framework will enable a thorough analysis of all greenhouse gas emissions that can be attributed to the extraction and use of the Surat Basin gas and will guarantee robust and reliable results. The project will answer how much direct and embodied GHG emissions occur in the extraction phase, in transporting the gas and in the final use of the gas. The results will be compared to other primary energy sources and other forms of electricity generation to compare the relative benefits and risks of natural gas as an energy resource. Establishing the comparative data will mainly rely on available case studies but will also require some genuine data analysis.

In the context of renewed international efforts to reduce the carbon intensity of the global energy systems (especially the electricity generation sector) the relative merits of natural gas over other primary energy sources will be demonstrated. This will enable policy makers and business leaders to assess the merit of natural gas as a transitional primary energy source in the context of transitioning global energy systems to a much lower overall carbon intensity.

The research would benefit from an analysis of the economic and employment impacts of the gas exploitation and use which is not part of this research proposal. The analytical framework is constructed in such a way that analysis of social and economic (and additional environmental) impacts can be integrated at a later point.

14. Project Plan

1. **Project initiation**

In an initial phase of the project, the study team will engage with APLNG representatives to establish the boundaries of the study, tailor the study objectives to the specific needs of the client, review data availability and the international literature and establish concordances between existing data and the standard industrial classification used in I-O and LCA analysis. Adapting the study design to the specifics of the Surat Basin situation and the client's needs will require a participatory approach to ensure applicability of the knowledge created for business decisions.

2. **I-O analysis of GHG emissions to identify hotspots and priorities**

The Industrial Ecology Virtual Laboratory (IE Lab) Input-Output (I-O) analytical capacity will be employed to establish a full Greenhouse Gas accounting of the exploitation, transportation and final use of the whole Surat Basin gas reserve. This analysis will include assumptions about different levels of fugitive emissions informed by the literature to assess the impact of different levels of fugitive emissions for the assessment of benefits and risks. The IE Lab is a world-leading research capacity of geographically disaggregated input-output tables that provide a very detailed picture of inter-industry relationships in the Australian economy and allow the attribution of GHG to an economic activity, sector or product. For this project the IE Lab will be utilised to attribute all direct and indirect emissions that stem from the whole gas reserve over the full life cycle from extraction, to transport, to use. I-O analysis provides a comprehensive account of all GHG emissions but may lack granularity with regard to specific processes in the life cycle of the gas extraction, transport and usage. It will hence be complemented by an LCA analysis to explore in greater depth the main sources of GHG emissions over the life cycle. The analysis of GHG emissions will be guided by international accounting standards and will include Scope 1, 2 and 3 emissions.

3. **LCA analysis of selected priority areas**

The LCA analysis will be undertaken using Sima Pro, a world-leading analytical tool, and will focus on such processes as the extraction, transport and use of the gas which have the highest carbon emission intensity. This analysis will provide additional data to be reviewed in comparison to the I-O results. The process character of LCA will allow identifying process technology and optimisation options that would reduce the carbon footprint of the gas extraction and usage. The LCA capability will also be used to compare electricity generation using Surat Basin gas mainly in Asia to other generation technologies including fossil fuel based and renewable generation to establish the GHG emission merits of gas compared to other primary energy sources. It is expected that substantial savings in GHG emissions will occur compared to coal fired electricity generation which currently is the dominant energy source in Asian developing countries. The LCA approach also allows for an uncertainty assessment with regard to current technology and including assumptions about future improvements in technology but focussing on incremental technological change.

4. **Integration of I-O and LCA results into one hybrid analysis**

Full integration of I-O and LCA results will require a separate step in the analysis to make necessary adjustments and avoid double counting. The final results will therefore be based on a hybrid analysis which will include elements of I-O and LCA employing both analytical strategies to their strengths and avoiding biases. In this respect the study will extend the current knowledge base which is based on our LCA analysis and will avoid shortcomings of this methodology such as for instance the limited depth in production layers that can be analysed using LCA.

5. **Reporting of main results**

The study team will prepare a comprehensive report which will explain the analytical techniques used for establishing the direct and indirect GHG emissions of gas extraction and final usage for electricity generation predominantly offshore in a language accessible to non-experts. The report will discuss the benefits and risks related to gas exploration and usage for electricity generation across the whole life cycle and will position the results within the broader international literature on GHG emissions and the assessment of the role of natural gas as a transitional fuel on the way to a low carbon energy system with special focus on energy needs in developing and transition economies. It will evaluate the benefits of natural gas as an energy source for electricity generation over coal across the whole life cycle of the gas use.

6. **Review of results and final reporting**

Project results and the draft report will be reviewed in a participatory fashion with representatives of APLNG to ensure the usability of the report for the needs of the client and also to position the findings within the context of practice of the mining and energy sector. This will enable the study team to prepare a final report that will serve the requirements of the client whilst at the same time adhering to highest scientific quality and credibility. The final report will include findings that apply more generally for gas extraction beyond the specific situation of the Surat Basin gas reserve.

14.1 Project Schedule

ID	Task Title	Task Leader	Scheduled Start	Scheduled Finish	Predecessor
1	Establishing the study boundaries and data sources and concordances for the analysis	Heinz Schandl	Month 0	Month 2	
2	I-O analysis of GHG emissions to identify hotspots and priorities	Tim Baynes	Month 3	Month 6	
3	LCA analysis of selected priority areas	Nawshad Haque	Month 4	Month 6	
4	Integration of I-O and LCA results into one hybrid analysis	Tim Baynes	Month 7	Month 8	
5	Reporting of main results	Heinz Schandl	Month 8	Month 9	
6	Review of results and final reporting	Heinz Schandl	Month 10	Month 12	

TASK 1

TASK NAME: Project initiation

TASK LEADER: Heinz Schandl

OVERALL TIMEFRAME: 2 months

BACKGROUND: In this initiation phase a project reference group will be established which will assist the project team to tailor the research to the needs of the business, establish system boundaries for the analysis, and identify relevant data bodies.

TASK OBJECTIVE: Achieve all preparatory steps required to run the subsequent analysis.

TASK OUTPUTS: Datasets, concordance matrixes, specific research interest of client established.

SPECIFIC DELIVERABLES: Project inception report (5–10 pages).

TASK 2

TASK NAME: I-O analysis of GHG emissions

TASK LEADER: Tim Baynes

OVERALL TIMEFRAME: 4 months

BACKGROUND:

TASK OBJECTIVE: Perform whole of life cycle GHG emission analysis (Scope 1–3) using IE Lab.

TASK OUTPUTS: Emission profiles of all relevant steps in the gas extraction, transport and usage.

SPECIFIC DELIVERABLES: Dataset (Excel) and technical report (10 pages).

TASK 3

TASK NAME: LCA analysis of selected priority areas

TASK LEADER: Nawshad Haque

OVERALL TIMEFRAME: 3 months

BACKGROUND: A fine-grained analysis using LCA techniques will be run for priority areas identified by the I-O analysis. GHG emission reduction potential will be identified and other forms of energy provision will be compared to gas energy provision.

TASK OBJECTIVE: Perform whole of Life Cycle LCA analysis using Sima Pro for selected priorities to complement I-O analysis.

TASK OUTPUTS: Emission profiles for selected priority areas.

SPECIFIC DELIVERABLES: Dataset (Excel) and technical report (10 pages).

TASK 4

TASK NAME: Integration of I-O and LCA results

TASK LEADER: Tim Baynes

OVERALL TIMEFRAME: 2 months

BACKGROUND: I-O and LCA results need to be harmonised in one hybrid analytical framework to correct for biases related to each approach and establish the best achievable results.

TASK OBJECTIVE: Integrate results of the two analytical approaches employed.

TASK OUTPUTS: Integrated whole of life cycle emission analysis.

SPECIFIC DELIVERABLES: Dataset (Excel) and technical report (10 pages).

TASK 5

TASK NAME: Reporting of main results

TASK LEADER: Heinz Schandl

OVERALL TIMEFRAME: 2 months

BACKGROUND: The project team will write a comprehensive report which includes a generally accessible description of methods and results and interpretation of results as well as a technical annex to enable reproducibility of results.

TASK OBJECTIVE: Prepare the main study report based on the analysis undertaken in tasks 2 to 4.

TASK OUTPUTS: Comprehensive draft report, technical annexes and dataset.

SPECIFIC DELIVERABLES: Draft report.

TASK 6

TASK NAME: Review of results and final reporting

TASK LEADER: Heinz Schandl

OVERALL TIMEFRAME: 3 months

BACKGROUND: The draft report will be discussed and reviewed with the client and all questions that the client may have will be answered. This will ensure maximum impact of research for client decision making. Edit and layout of the final report.

TASK OBJECTIVE: Sharing of study results with the client, reviewing the presentation and interpretation of results.

TASK OUTPUTS: Reviewed, and edited report.

SPECIFIC DELIVERABLES: Final study report, technical annexes and dataset.

15. Budget Justification

CSIRO's in-kind contribution is calculated as 30% of the total project cost. The project leader, Dr Heinz Schandl is a world-leading scientist in the domain of industrial ecology and has more than 15 years of experience in leading large, complex, international projects. He leads the Sustainable Consumption and Production (SCP) team at CSIRO Land and Water. Dr Tim Baynes is a senior systems modeller and very well published in the area of emissions accounting. He is a member of the IE Lab team and a leading expert in integration of different analytical approaches including I-O and LCA. Dr Nawshad Haque is a senior LCA modeller and experienced with the Sima Pro tool and applications to the mining, resources and energy sector. Dr Arne Geschke is an experienced I-O modeller and a key member of the IE Lab team. He has run both global and Australian I-O models. Sydney University is the world-leading centre for environmentally extended I-O analysis and will be subcontracted for Dr Geschke's contribution. Karin Hosking is an experienced science editor. Travel budgets are necessary to engage with industry representatives for project initiation and in a comprehensive review process of project results. The joint capacity of CSIRO's SCP team and University of Sydney's I-O team (led by Professor Manfred Lenzen) is a world-leading research outfit.

16. Project Governance

The project leader is very experienced and has a track record of delivering research within time and budget and to the satisfaction of clients. Progress meetings will occur every two weeks and task leaders are experienced scientists who have worked with the project leader before. A project reference group will be established at APLNG to help set up the project, ensure swift exchange of data and knowledge and review project results at several stages of project implementation. The project reference group will help tailor the research to the needs of the company and interpret results within the broader context of APLNG's operation and business model. The reference group will include industry representatives and leading CSIRO senior scientist Paul Graham.

17. Communications Plan

General communication will be managed by GISERA.

18. Risks

There are no specific risks identified for this project which go beyond standard risk management. The research teams in CSIRO Land and Water and CSIRO Mineral Resources would be able to backfill in case of staff departures. Data availability is considered to be good and research analytical frameworks are well established and have been tested in previous projects. Application to this research should be straightforward despite the novelty of the application. There is residual reputational risk because of the politically contested nature of the research topic. This will be managed by high level technical review through Paul Hardisty and Paul Graham of all project outputs. Research results will be published in the peer-review literature which will demonstrate their high scientific credibility.

2 Variations to Project Order

Changes to research Project Orders are approved by the GISERA Director, acting with authority provided by the GISERA National Research Management Committee, in accordance with the National GISERA Alliance Agreement.

The table below details variations to research Project Order.

Register of changes to Research Project Order

Date	Issue	Action	Authorisation
9/11/16	Delays in data exchange with industry	Milestone 2.1, 3.1, and 4.1 pushed back to Jan-17 Milestone 5.1 pushed back to Feb-17 Milestone 6.1 pushed back to Mar-17	
28/3/17	Due to delays in obtaining data, milestones 2.1, 4.1, 5.1 and 6.1 have been pushed back by 3 months	Milestone 2.1 pushed back to Apr 17, milestone 4.1 pushed back to Apr 17, milestone 5.1 pushed back to May 17, milestone 6.1 pushed Jun 17.	
19/6/17	Due to delays in obtaining data, milestones 2.1, 4.1, 5.1 and 6.1 have been pushed back by 3 months	Milestone 2.1 pushed back to Jul 17, milestone 4.1 pushed back to Jul 17, milestone 5.1 pushed back to Aug 17, milestone 6.1 pushed back to Sept 17.	

3 Progress against project milestones

Progress against milestones are approved by the GISERA Director, acting with authority provided by the GISERA National Research Management Committee, in accordance with the National GISERA Alliance Agreement.

Progress against project milestones/tasks is indicated by two methods: Traffic Light Reports and descriptive Project Schedule Reports.

1. Traffic light reports in the Project Schedule Table below show progress using a simple colour code:
   - Green:
     - Milestone fully met according to schedule.
     - Project is expected to continue to deliver according to plan.
     - Milestone payment is approved.
   - Amber:
     - Milestone largely met according to schedule.
     - Project has experienced delays or difficulties that will be overcome by next milestone, enabling project to return to delivery according to plan by next milestone.
     - Milestone payment approved for one amber light.
     - Milestone payment withheld for second of two successive amber lights; project review initiated and undertaken by GISERA Director.
   - Red:
     - Milestone not met according to schedule.
     - Problems in meeting milestone are likely to impact subsequent project delivery, such that revisions to project timing, scope or budget must be considered.
     - Milestone payment is withheld.
     - Project review initiated and undertaken by GISERA Research Advisory Committee.

2. Progress Schedule Reports outline task objectives and outputs and describe, in the 'progress report' section, the means and extent to which progress towards tasks has been made.

Project Schedule Table

ID	Task Title	Task Leader	Scheduled Start	Scheduled Finish
1	Establishing the study boundaries and data sources and concordances for the analysis	Heinz Schandl	Feb 16	Mar-16
2	I-O analysis of GHG emissions to identify hotspots and priorities	Tim Baynes	Apr 16	Jul-17
3	LCA analysis of selected priority areas	Nawshad Haque	May 16	Jan-17
4	Integration of I-O and LCA results into one hybrid analysis	Tim Baynes	Aug 16	Jul-17
5	Reporting of main results	Heinz Schandl	Sep 16	Aug-17
6	Review of results and final reporting	Heinz Schandl	Nov 16	Sep-17

Project Schedule Report

Task 1

TASK NAME: Project initiation

TASK LEADER: Heinz Schandl

OVERALL TIMEFRAME: 2 months

BACKGROUND: In this initiation phase a project reference group will be established which will assist the project team to tailor the research to the needs of the business, establish system boundaries for the analysis, and identify relevant data bodies.

TASK OBJECTIVE: Achieve all preparatory steps required to run the subsequent analysis.

TASK OUTPUTS: Datasets, concordance matrixes, specific research interest of client established.

SPECIFIC DELIVERABLES: Project inception report (5-10 pages).

PROGRESS REPORT:

This task is fully completed.

A kick-off meeting of the project team took place in March 2016 and a literature review was undertaken and preliminary decisions for the study boundaries were established. The definition of the study boundaries, and assessment of the process flow of gas, for the well to the user and review of available data sources had to be established with industry representatives.

A first meeting with the reference group for the project took place on 8 April 2016 in Brisbane and Origin Energy (through Matt Kernke) and QGC (through Graeme Starke) were represented. Together with the industry representatives a full process flow was developed, system boundaries for the analysis were established and a mode of interaction between the study team and the industry representatives decided. In follow-up meetings the process flow was refined and finalised. This was important for commencing tasks 2 and 3 and also for developing a good understanding of data availability and limitations in data sharing.

One of the objectives of task 1 was developing concordance between the expenditure accounts of the industries involved in gas extraction and the sector/product structure of the Australian and global I-O tables. Sharing of expenditure data is usually a sensitive issue and establishing concordance can be a time consuming process. The concordance has been developed and the team is ready to start the data analysis. A visit to the gas fields is envisaged for July 2016 and that will enable the research team to have meetings with finance and engineering personnel to establish data needs and data sharing procedures.

The industry partners were asked to define how they would judge whether the project was successful at the end of project and the study team took note of the industry expectations.

Task 2 of the project has commenced: based on the concordances, the I-O frameworks are adjusted and this work has been started.

Task 3 of the project has commenced: the study team has started a review of available LCA datasets for life cycle analysis of gas extraction, transportation and usage in different receiving countries and for different technologies. The process flow established in task 1 has been refined to match the data availability and system boundaries for the LCA have been reviewed.

In an overall assessment, the project is well underway and on course for delivery within the agreed timelines.

TASK 2

TASK NAME: I-O analysis of GHG emissions

TASK LEADER: Tim Baynes

OVERALL TIMEFRAME: 4 months

BACKGROUND:

TASK OBJECTIVE: Perform whole of life cycle GHG emission analysis (Scope 1-3) using IE Lab.

TASK OUTPUTS: Emission profiles of all relevant steps in the gas extraction, transport and usage.

SPECIFIC DELIVERABLES: Dataset (Excel) and technical report (10 pages).

PROGRESS REPORT:

This task is now 100% complete.

TASK 3

TASK NAME: LCA analysis of selected priority areas

TASK LEADER: Nawshad Haque

OVERALL TIMEFRAME: 3 months

BACKGROUND: A fine-grained analysis using LCA techniques will be run for priority areas identified by the I-O analysis. GHG emission reduction potential will be identified and other forms of energy provision will be compared to gas energy provision.

TASK OBJECTIVE: Perform whole of Life Cycle LCA analysis using Sima Pro for selected priorities to complement I-O analysis.

TASK OUTPUTS: Emission profiles for selected priority areas.

SPECIFIC DELIVERABLES: Dataset (Excel) and technical report (10 pages).

PROGRESS REPORT:

A full LCA analysis of whole of Life Cycle Greenhouse Gas emissions of the Surat Basin gas reserve has been undertaken based on a detailed description of the process of gas extraction, transport, liquefaction, shipping, regasification, and burning for electricity generation in China. GHG emissions have been reported per tonne of LNG and per MWh of electricity generated and compared to coal fired electricity generation. The project team has produced detailed process flow diagrams and Excel data sheets that support the report and are available for task 4 where the information from task 3 is integrated with the information generated in task 2 in a hybrid analysis framework.

The report finds that close to 40% of GHG emissions result from the operation of the gas process and close to 50% from combustion. LNG proves beneficial when compared to coal mainly because of a much lower GHG intensity of the combustion process but with a higher GHG intensity for construction and operation. For the final report we plan to extend the comparison to renewable generation and aim to list saving potential of GHG emissions in construction and operation.

TASK 4

TASK NAME: Integration of I-O and LCA results

TASK LEADER: Tim Baynes

OVERALL TIMEFRAME: 2 months

BACKGROUND: I-O and LCA results need to be harmonised in one hybrid analytical framework to correct for biases related to each approach and establish the best achievable results.

TASK OBJECTIVE: Integrate results of the two analytical approaches employed.

TASK OUTPUTS: Integrated whole of life cycle emission analysis.

SPECIFIC DELIVERABLES: Dataset (Excel) and technical report (10 pages).

PROGRESS REPORT:

This task is now 100% complete.

TASK 5

TASK NAME: Reporting of main results

TASK LEADER: Heinz Schandl

OVERALL TIMEFRAME: 2 months

BACKGROUND: The project team will write a comprehensive report which includes a generally accessible description of methods and results and interpretation of results as well as a technical annex to enable reproducibility of results.

TASK OBJECTIVE: Prepare the main study report based on the analysis undertaken in tasks 2 to 4.

TASK OUTPUTS: Comprehensive draft report, technical annexes and dataset.

SPECIFIC DELIVERABLES: Draft report.

PROGRESS REPORT:

The draft report has been delivered.

TASK 6

TASK NAME: Review of results and final reporting

TASK LEADER: Heinz Schandl

OVERALL TIMEFRAME: 3 months

BACKGROUND: The draft report will be discussed and reviewed with the client and all questions that the client may have will be answered. This will ensure maximum impact of research for client decision making. Edit and layout of the final report.

TASK OBJECTIVE: Sharing of study results with the client, reviewing the presentation and interpretation of results.

TASK OUTPUTS: Reviewed, and edited report.

SPECIFIC DELIVERABLES: Final study report, technical annexes and dataset.

PROGRESS REPORT:

The final report "Whole of Life Greenhouse Gas Emissions Assessment of a Coal Seam Gas to Liquefied Natural Gas Project in the Surat Basin, Queensland, Australia" is available on the GISERA website.