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Employment scenarios in Queensland CSG regions 2014–2034

A report of the *Economic Assessment and Forecasting of Future Impacts on Regional Economies and how Local Businesses can Respond* project (Milestone #8 report)

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Executive summary

This report presents the findings of a research project on forecasting the potential economic effects of the Coal Seam Gas industry to 2034. The demand for this project stems from the need to prepare for the likely economic effects of this sector over the course of the operations phase of the CSG industry in the Surat Basin.

The modelling presented in the report is based on econometric analysis, guided by an earlier report into the strengths and weaknesses of different modelling approaches. Based on the findings of that report, and discussions with stakeholders from industry, academia and government, econometric modelling provided the best option for this research.

The report forecasts the likely changes to employment across different sectors of the economy according to different scenarios. The 'Business As Usual' scenario presents the likely changes to indirect employment (i.e. job spill-overs) that flow from direct CSG employment forecast estimates prepared as part of the CSG Industry workforce plan developed by Energy Skills Queensland (Energy Skills, 2015). As such 'Business As Usual' refers to the flow-on effects to employment in other sectors based on the estimated labour demand put forward by the industry for the period 2014 to 2034. This period is used to match the most up-to-date CSG projections for direct employment prepared by the CSG industry (Energy Skills, 2015).

The second 'Slow Down' scenario was prepared after consultation with the project reference group and a review of trends in energy market conditions. It presents the likely effects for indirect employment, adjusted by the project team for reduced direct employment in the CSG industry in response to declining commodity prices and technological change. The scenario has three variations for different magnitudes of reduced employment. The third scenario presents the findings from decreased direct employment combined with reduced indirect employment multipliers in three variations.

Across the scenarios, and the variations within scenarios, there are some important points of comparison and some key similarities. Across all combinations, total employment is forecast to increase in the Surat Basin up until 2024. For 2024 to 2034, total employment is forecast to decrease across all scenarios. The pace of these increases and decreases varies according to each scenario. For the majority of the scenarios, total employment declines to a level in 2034 that was below the level for 2014, but higher than 2006.

The findings of this report are intended to provide input into the broader process of regional planning for local, State and national stakeholders in addition to providing insight for local businesses seeking to respond effectively to the operations phase of the CSG industry.

1 Introduction

In 2013, GISERA stakeholders asked that research be conducted to provide insights into how the coal seam gas (CSG) industry will continue to affect the local economies of the Surat Basin in the coming decades as it moves from a strong construction phase into an operational phase, including continued development at a slower rate. This project has evaluated different economic options (models) available to simulate potential future economic impacts of the CSG industry across regions. In designing the scenarios, the project draws on a substantial review of literature presented in previous reports (Fleming et al., 2016) and on insights from a project reference group composed of industry stakeholders, researchers and economists from the office of the Chief Economist in the Department of Industry, Innovation and Science.

From the review conducted, the research team established that the most appropriate approximation of the potential economic effects of the CSG industry in coming years, at *local* levels, can be appraised with a combination of quantitative and qualitative analysis fed by outputs obtained from regression models aiming to capture job multipliers from the CSG industry to other industries across regions.

A distinguishing feature of coal seam gas is the nature of the shift from the construction to operational phases of projects. For conventional energy (e.g. a coal mine), the shift from construction to operation occurs distinctly, in the form of a single large event. Conversely, a basin of CSG wells involves multiple smaller events – the pace of construction may slow but wells continue to be drilled as others progressively start producing gas, one by one – such that the shift from construction to operation in a region is more like a wave that progressively spreads across a landscape (Measham et al., 2016).

Due to the extended nature of construction processes – e.g., installing compression stations and pipeline manifolds, which span into the operational phase, economic effects that accompany ongoing drilling for unconventional gas are more prone to be affected by commodity price fluctuations. This may potentially affect the pace of well expansion programs throughout the operations phase (Jacquet and Kay, 2014). In addition, the positive initial income effects reflected in a resource boom may diminish over time, such that regions with long-term involvement in the energy sector may see declining levels of income effects over several decades (Haggerty et al., 2014) as labour supply adjusts to meet demand. These dynamics complicate processes for forecasting the economic impacts of CSG projects beyond the initial peak construction phase because commodity price volatility (which is difficult to predict) may cause variations in local economic activity and labour markets can change as a product of in (or out) migration and the entry (or exit) of new industries.

This report summarises and discusses the main findings obtained from the forecasting analysis. Its appendix describes the methods used and the empirical caveats to consider when obtaining and interpreting results.

2 Summary of main results and discussion

As presented in the methodological appendix, this forecast analysis comprises two main components: econometric modelling to estimate job spillovers and scenario analyses to consider different CSG industry trajectories in the forecasting evaluation. All analyses were conducted using the Australian Bureau of Statistics (ABS) defined regions given by SA1 areas within the SA4 regions of 'Darling Downs – Maranoa' (Surat region) and 'Toowoomba' (Toowoomba region). See map A1 at the end of this document for a visual reference.

2.1 Multiplier results from econometric models

The first component, given by the construction and estimation of econometric models to estimate the job multiplier effects of the CSG industry across the Surat and Toowoomba regions, produced several key results. These results, available in tables A1 and A2 in the methodological appendix, are highlighted in the following points:

- Between 2006 and 2011 the employment generated directly by the CSG industry generated statistically significant job spillovers to the construction, electricity, accommodation, recreational, administrative and other services sectors in the *Surat region* – all other sectors do not have a statistically significant multiplier, implying no major effect of the CSG industry over them within the Surat region.[1]
- The multipliers found when including the Toowoomba region in the analysis were different, with statistically valid results in the construction, electricity, accommodation, retail, transportation, rental and other services sectors.[2]
- In total, the creation of one new local job in the CSG industry between 2006 and 2011 generated a total of three new jobs distributed across the aforementioned impacted services in the Surat region, and a total of eight new jobs across the five impacted services when considering the Surat *and* Toowoomba regions together.
- In agreement with previous studies of CSG impacts, negative effects on agricultural employment were observed in the Surat region, although these were not included in the forecasting analysis as the multiplier coefficient is not statistically significant at the five percent level – we decided to consider only multipliers with p-Values below 0.05 to produce robust results, as done in Fleming and Measham (2015).

[1] The formal names for these industry sectors according to the Australian Bureau of Statistics are provided in Table A3 of the technical appendix of this report. The Surat region in this report is given by SA4 of 'Darling Downs – Maranoa' as shown in map A1 in the technical appendix.

[2] Formal names for these two sectors are shown in Table A3 in the technical appendix.

- Construction is the sector that obtained the higher multiplier during the CSG expansion between 2006 and 2011; however, this should be viewed with caution as the construction phase of the industry has been winding down in recent years as the CSG industry enters a more productive stage. This consideration is analysed in scenario 3 below.

Although not exempt from empirical caveats, the results obtained from the econometric models provide robust estimates of the employment effects across local economies as consequences of the CSG expansion between 2006 and 2011. Thus, highlighting that all of the econometric analyses were performed using 'place of residence' data, the results capture local effects of the CSG industry on the regions hosting the activity, controlling for fly-in fly-out employment (sourced from beyond the Surat and Toowoomba regions) that could misguide the *local* economic benefits (and costs) of the CSG industry expansion across the Surat and Toowoomba regions.

2.2 Forecasting employment growth from multipliers using scenarios

Considering the results derived from the econometric modelling shown in tables A1 and A2 in the appendix, the second component of this work projected the likely indirect employment changes that the CSG industry may generate across regions – that is, the economic impact of the continuing presence of a maturing CSG industry across the region from the perspective of the number of jobs generated and/or destroyed in non-mining sectors. In doing so, we use different scenarios and plot the main results below for the Surat region and for the Toowoomba and Surat regions together. Table A4 in the technical appendix describes in detail the names and assumptions used to construct each of the analysed scenarios described below.

It is important to mention that all of the forecasting charts provided below, as described in the technical appendix, are derived from the econometrically calculated job multipliers *and* from the most conservative CSG jobs forecast that the industry has provided for coming decades, published in the report by Energy Skills (2015). The numbers for these CSG employment projections can be seen in Figure A2 in the technical appendix.

Scenario 1: Considering the 'business as usual' (BAU) case, we derived employment growth across non-CSG sectors based on adjusting industry-provided CSG job estimates as described in the technical appendix. By considering data provided in Energy Skills (2015) in terms of projected CSG jobs, we adjusted (as shown in the appendix) numbers to control for industry location and fly-in fly-out labour. Figure 1 and Figure 2 show the forecast job growth across non-CSG sectors for this scenario in both regions – the Surat region alone and the Surat and Toowoomba regions.

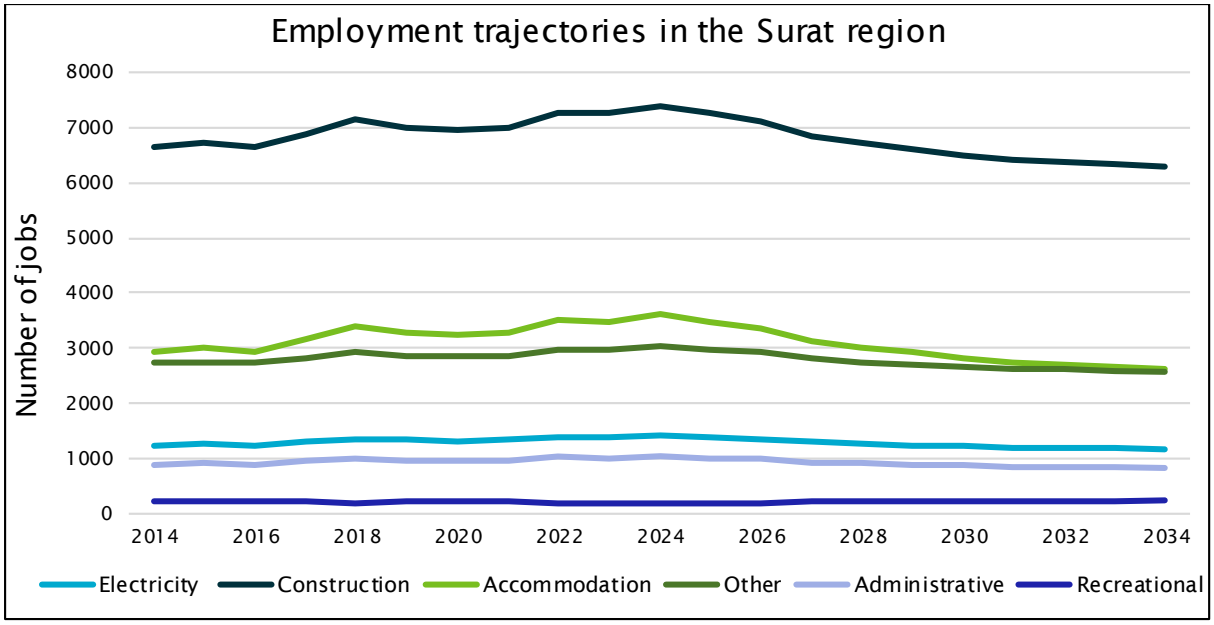


Figure 1. Employment trajectories across sectors forecast for scenario 1 in the Surat region

The charts in Figure 1 and Figure 2 only provide numbers for the respective sectors shown because, as mentioned above, our econometric estimation did not capture statistically significant effects of the CSG industry on other industry sectors in terms of local workers in the Surat region. So, if in the past (in the period 2006–2011) there was no clear link between CSG industry employment growth and other sectors' employment growth, it is assumed that future impacts, on average, are unlikely as well. The same assumption applies to charts in figures 3, 4, 5, 6 and 7.

Figure 1 shows employment patterns in coming years in the Surat region. As can be seen, the construction sector is likely to have the largest increases in numbers in the BAU scenario. Thus, starting from an initial level in 2014 of around 6,600 people employed in construction services across the Surat region, by 2024 there would be around 800 additional jobs.[3] The accommodation sector would also have important initial gains in employment, with around 600 new jobs created to 2024, while the 'others' sector would grow by around 300 jobs.

However, after 2024 the number of jobs in these three sectors drops to reach a low point in 2034, reflecting a slower rate of development during the operations phase as shown in CSG employment projections provided by industry; in three cases, the job numbers in 2034 are actually lower than initial levels in 2014. This finding is important to consider as employment will tend to move in parallel to CSG industry employment, which means that after its peak, total employment numbers will decrease to even lower levels than 2014, other things remaining equal. In the case of recreational, administrative and electrical services, job growth is not considerable, with each presenting a relatively flat line over time reflecting minimal employment gains. In any case, important to note here is that our

[3] It is important to highlight that the baseline employment levels to 2014 correspond to figures reported at SA4 levels by the ABS (available at: http://www.abs.gov.au/ausstats/abs@.nsf/mf/6202.0).

forecasting analysis starts in 2014, therefore 'net gains or loses' forecasted in this report do not consider the indirect job increases or decreases generated by the CSG before 2014. In any case we provide a reference table at the end of section 2 that highlight employment levels data in 2006, 2011, 2014 and select forecasted scenarios for comparison.

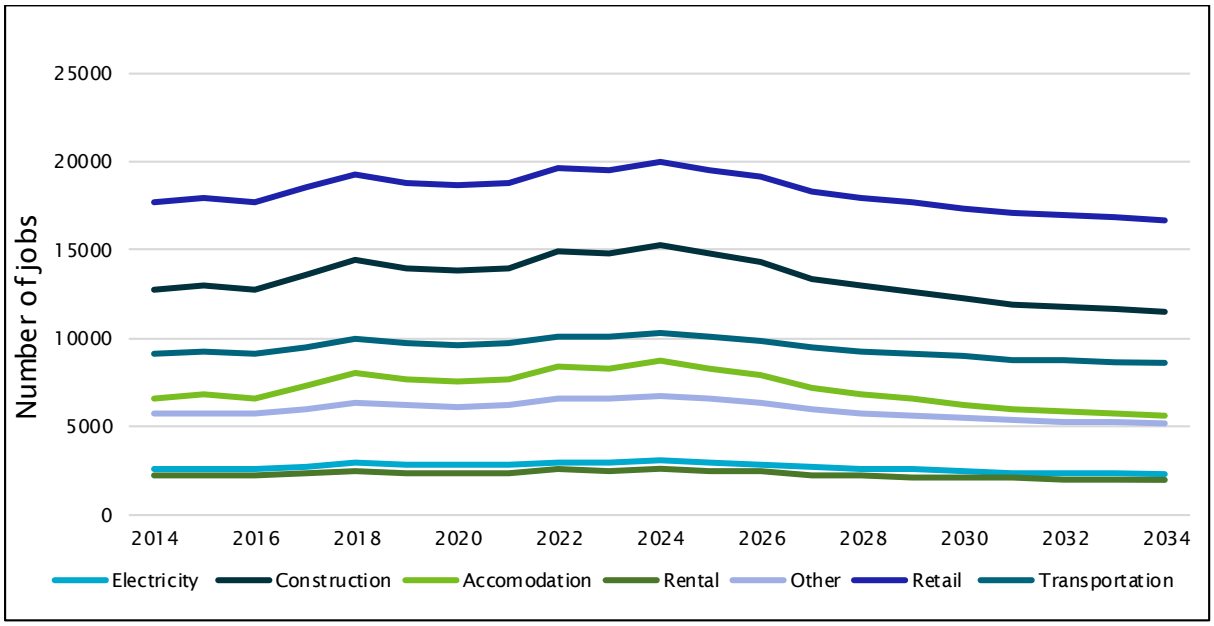


Figure 2. Job trajectories forecast for scenario 1 in the Surat and Toowoomba regions

Figure 2 plots the sectors that have significant job gains when analysing the Surat and Toowoomba regions together. The chart in this case shows higher total absolute numbers of jobs, as this is a much larger area (see the appendix), where construction numbers are projected to peak at around 15,000 (from a baseline of 12,750) in 2024, which implies more than 1,000 extra jobs in each region. However, the sector presenting the most absolute gains is the retail sector, which gains over 2,000 jobs to 2024. The accommodation sector behaves similarly to the Surat region with a peak in 2024 and numbers to 2034 below levels in 2014.

However, as discussed previously (and with more details in the technical appendix), it is important to further scrutinise the case of the construction sector. This clearly gained a relatively higher multiplier in the period 2006 to 2011 because the industry was in the midst of its initial expansion and therefore investing considerably in putting infrastructure in place (pipelines, collection hubs, roads). Therefore, the construction multiplier will drop in future years, which we consider in the analysis of scenario 3.

Scenario 2: This scenario adjusts the BAU case by reducing, in different proportions, the industry-provided projected CSG job growth – the 'slow down' (SD) scenario. Given the recent drop in international oil prices, natural gas companies' caution about expanding as rapidly as they did in the past decade, and the potential for technological change to improve CSG industry development and labour productivity, we plot in this scenario the different trajectories that employment in the construction and accommodation services sectors would take, in each region, if the CSG industry employment projections were reduced in

three different ways: by 25% (scenario SD1), 50% (scenario SD2) and 75% (scenario SD3) less CSG jobs.

The assumptions made here for the three scenarios (SD1, SD2 and SD3) were made to provide insight on how employment levels might change if the CSG industry reduces its labour demand due to reduced activity or productivity gains. It is important to note that this forecasting study is accompanied by a spreadsheet where alternative assumptions can be substituted and tested. In other words, the research provides a dynamic tool where different scenarios can be projected based on changes in many of the underlying assumptions and parameters used in this work.

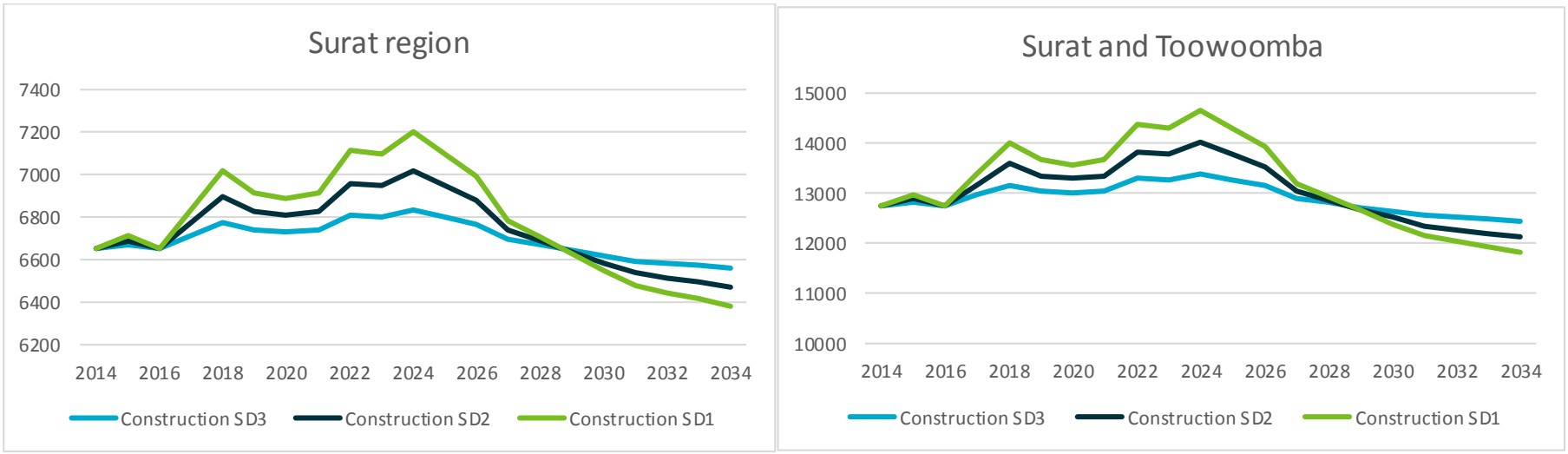


Figure 3. Trajectories for Construction sector across SD scenarios

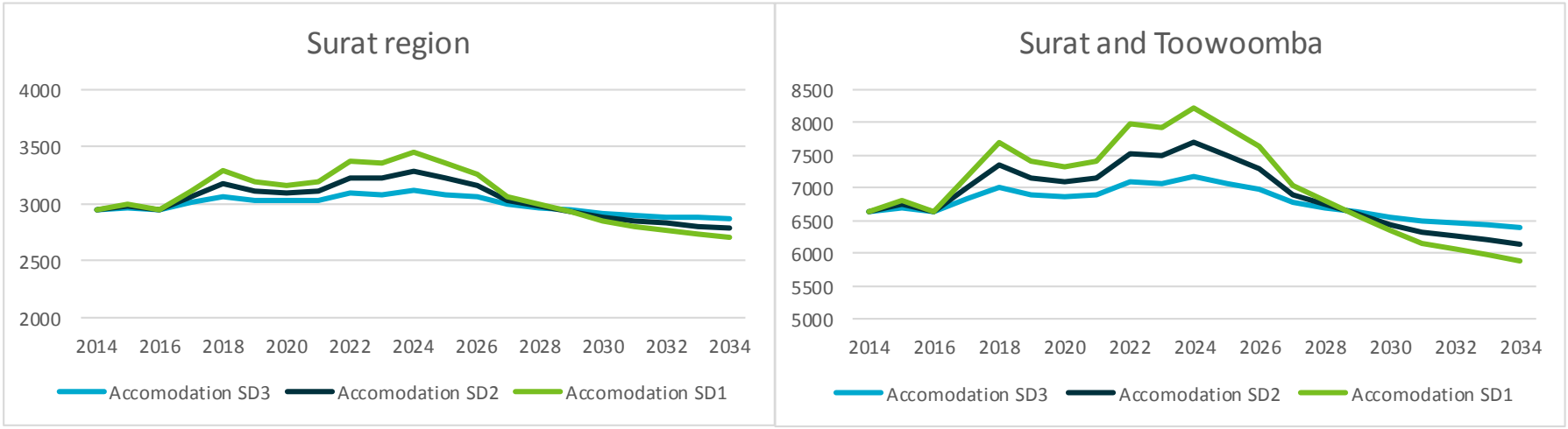


Figure 4. Trajectories for Accommodation sector across SD scenarios

In scenario 2, indirect employment continues to rise until around 2024. However, a 50% reduction in direct CSG employment projections (SD2 scenario) reduces the spill-over jobs in the construction sector (relative to BAU) by around 5% at its peak in year 2024 for the Surat region, and 10% for Surat and Toowoomba combined. In the case of Accommodation services, a 50% reduction in direct CSG employment projections translates to around 20% fewer jobs than in the BAU scenario in 2024. It is also worth noting in scenario 2 that jobs for the decade beyond 2024 are forecast to decline for construction and accommodation services, dropping to below 2014 levels by 2034.

Scenario 3: Finally, scenario 3 includes analysis of projections considering changes in the multipliers derived from the econometric models. As the economic structures across regions are likely to change due to industry efficiency gains and technological development, it is likely that the job multipliers will also change over time. This case is especially relevant for the construction and electricity multipliers, which were relatively high between 2006 and 2011 given the rapid construction to meet project timeframes and establish market advantage across southern Queensland. Considering this, we provide three options after changes in the multiplier coefficients:

Option a) Scenarios BAU or SD2 considering a 50% decrease in construction multipliers over time (every 5 years). See Figure 5 for results

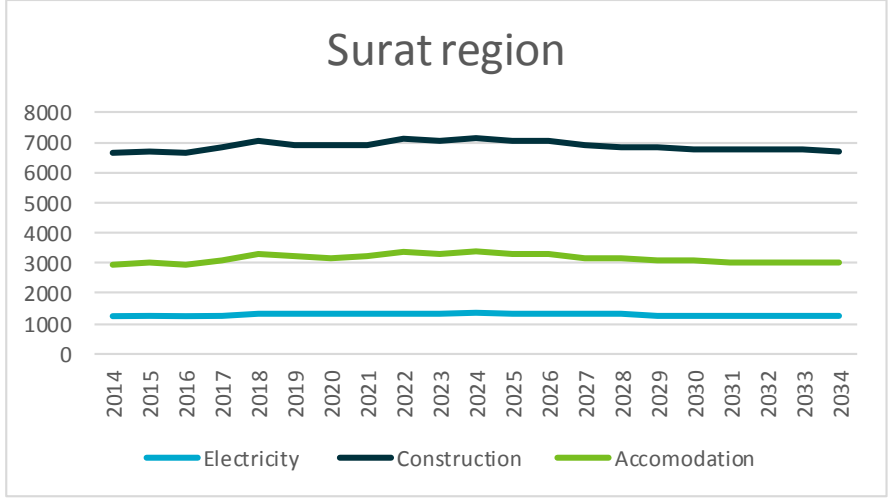
Option b) Scenarios BAU or SD2 considering a 25% decrease in all multipliers over time (every 5 years), except for 'Recreation' and 'Administration'.[4] See Figure 6 and 7 for results.

Option c) Scenarios BAU or SD2 considering a 75% decrease in construction over time, but a 20% increase in other sectors, except for 'Recreation' and 'Administration'. See Figures 8 and 9 for results.

Similar to the case of scenario 2, the assumption made here for the changes across multipliers were chosen by the research team to mainly provide insights on how employment levels might change if structural changes in the economy occur and multipliers change over time. Option a) considers the likely minor effect of CSG activity on the construction sector as the industry enters a more operational phase (considering other things equal). Option b) considers a gradual decline of the CSG industry impacts across all other sectors of the economy over time, considering that as the industry matures, the economies of the Surat and Toowoomba regions could tend to depend less on changes in CSG activity. Finally, option c) considers a more abrupt de-link between CSG and construction and considers a shift on employment towards other sectors of the economy.

[4] These two sectors have the lowest total employment numbers across the analysed sectors, so we opted not to include them in the analysis for this scenario.

Figure 5. Scenario 3 under option a) using BAU and scenario SD2. Scenarios BAU and SD2 (Sc. 2.2) are also added for comparison. Scenario 3 under option a) is described as Sc 3.1 (multiplier changes over BAU scenario) and Sc 3.11 (multiplier changes over Scenario SD2) in legend



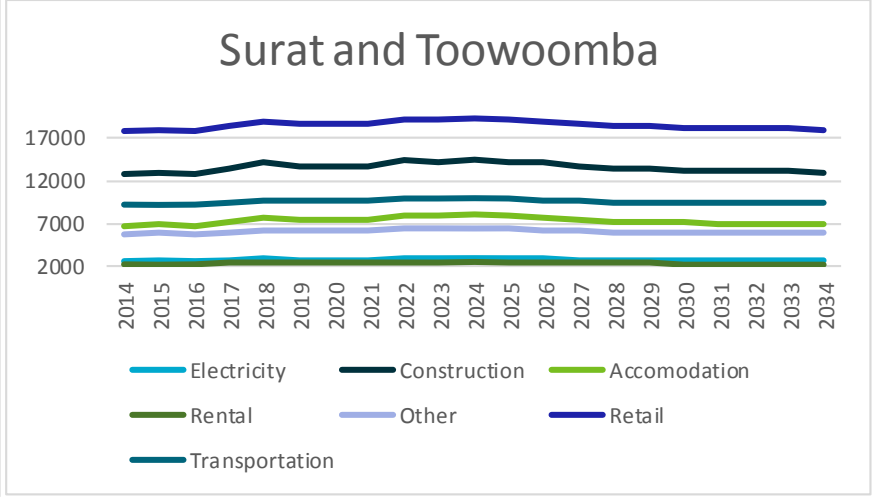
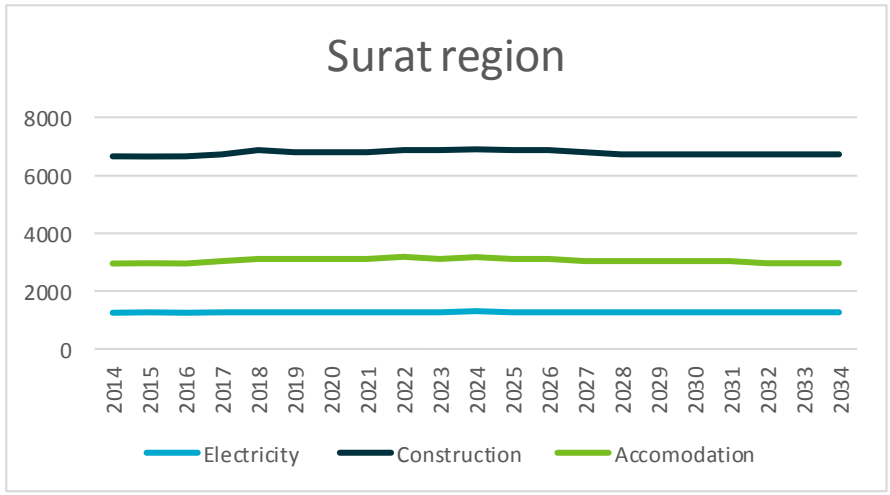


Figure 6. Scenario 3 under option b) and BAU [Scenario 3.2 in legend of figure 10]



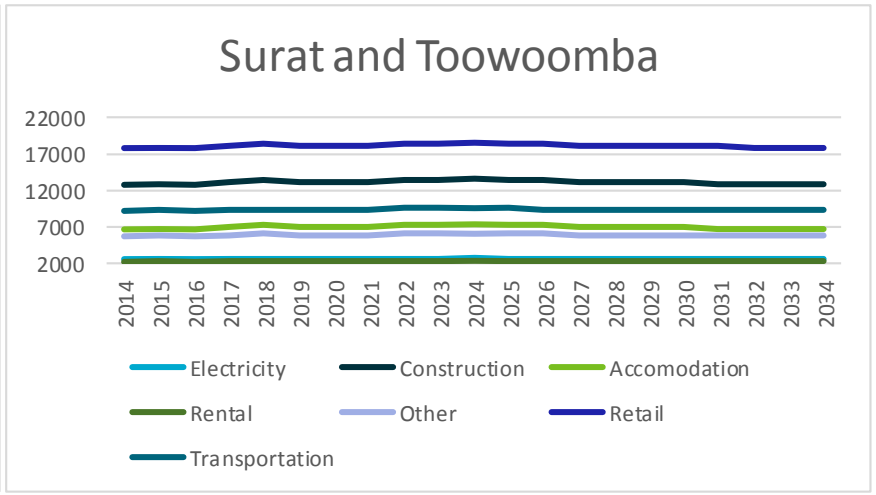
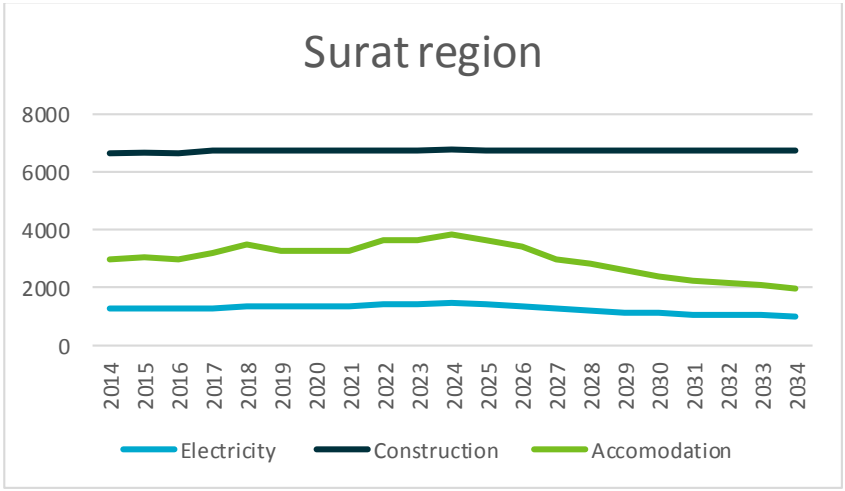


Figure 7. Scenario 3 under option b) and scenario SD2 [Scenario 3.21 in legend of figure 10]



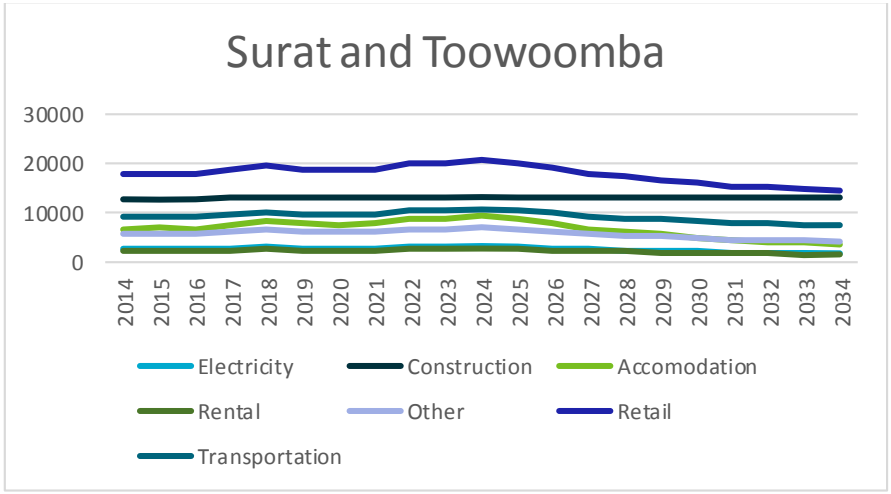
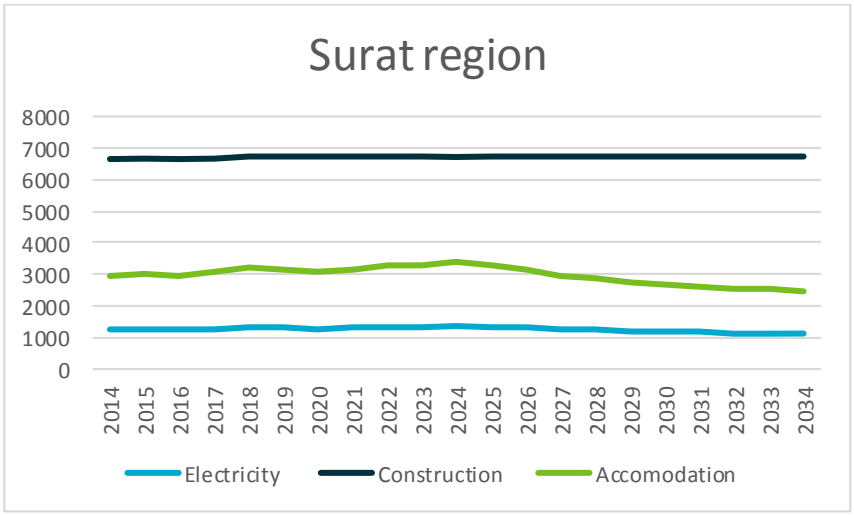


Figure 8. Scenario 3 under option c) and BAU [Scenario 3.3 in legend of figure 10]



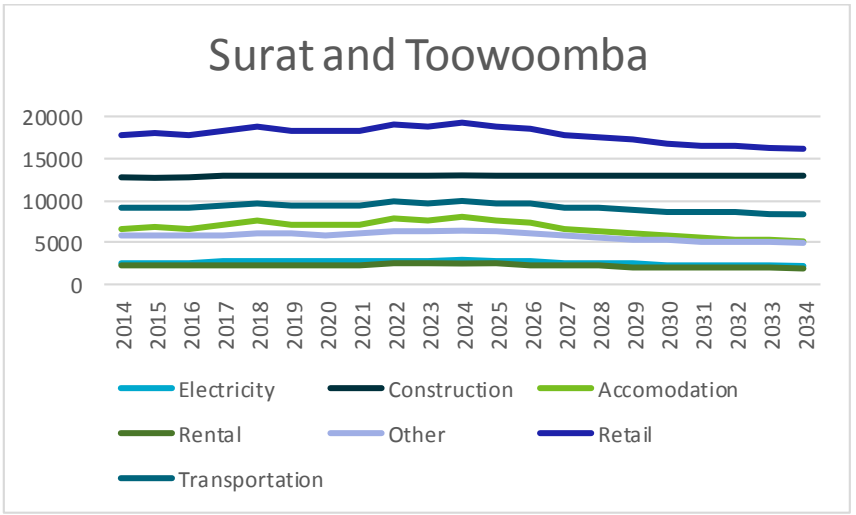


Figure 9. Scenario 3 under option c) and scenario SD2 [Scenario 3.31 in legend of figure 10]

Option a) shows how the construction industry is likely to change after changes in the CSG industry, with lower multipliers over time. As seen in Figure 5, with lower multipliers the construction employment trends flattens, so peaks and troughs are reduced over time. This is logical as lower multipliers will imply less dependency of the construction sector on the CSG industry and therefore fewer changes in its growth patterns coming from cycles in the CSG industry.

Option b), plotted in Figure 6 and Figure 7, produces much flatter lines than in other scenarios as sectors become less dependent on the CSG industry over time, especially in the case of Figure 7 (including a reduction in CSG employment projection). Thus, considering that we are only projecting employment changes in these sectors in response to CSG employment changes, as they become less attached to the CSG industry their employment changes tend to vary less.

Interestingly, option c) is the one most different from previous scenarios. The abrupt decrease in the construction multipliers over time means that as the industry becomes less dependent on the CSG industry, its line becomes practically flat and employment remains stable over time. On the other hand, as growth in the retail and accommodation sectors are assumed to increase their dependency on CSG (as multipliers increase in this option), once CSG employment starts decreasing, accommodation and retail services are negatively affected with a large employment drop after 2024 when considering the Surat and Toowoomba regions as shown in Figure 8 and Figure 9.

Finally, we plot the total employment spillovers into the analysed sectors across scenarios. Figure 10 shows the employment trajectories in the Surat region across the different scenarios analysed. All scenarios demonstrate an increase in total employment up until 2024 followed by a decrease from 2024 to 2034. The greatest change is found in scenario 3.3 which has the highest increase to 2024 and the sharpest decrease to 2034. As seen in Figure 10, for the Surat region seven out of the total nine scenarios produce total employment levels in 2034 below the initial levels of 2014. This finding is important because, other things being equal, the net employment effect of the industry will follow the cycle of the industry and therefore vanish by 2034.

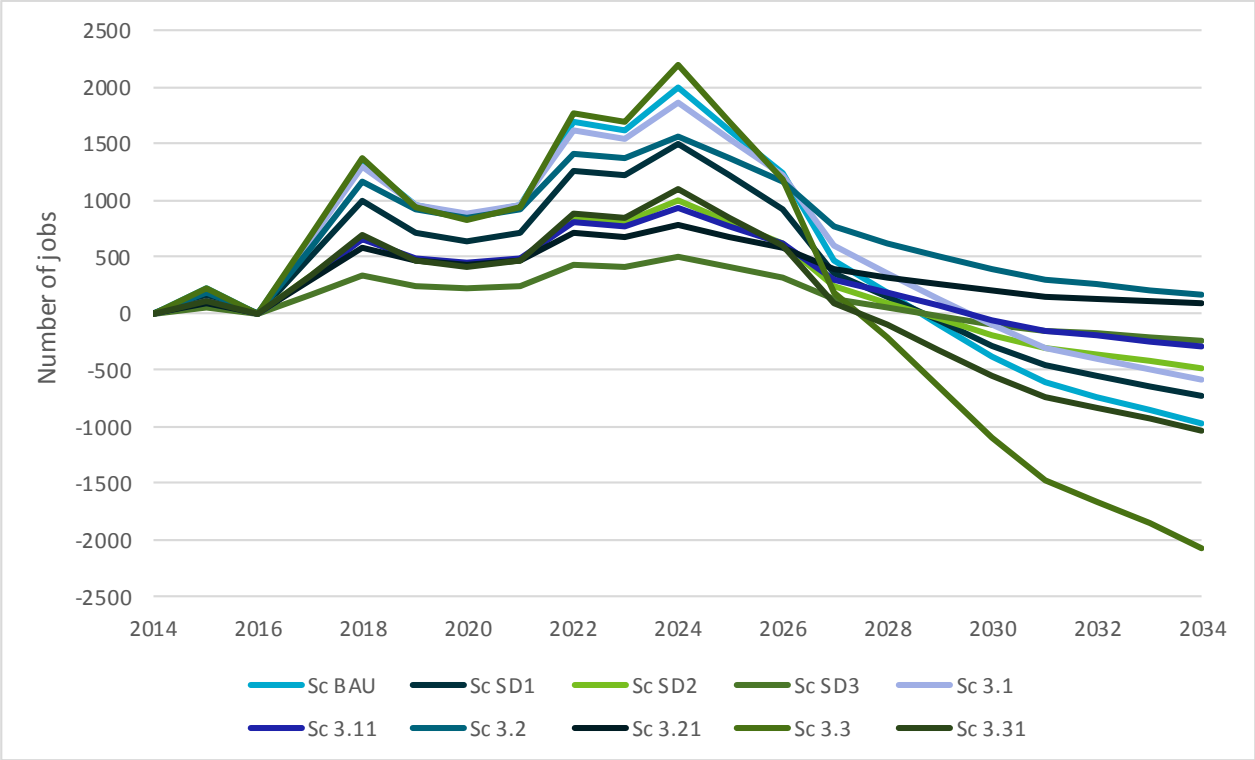


Figure 10. Total (net to 2014 levels) employment trajectories across scenarios in the Surat Basin case. [Sc = Scenario]

2.3 Comparing employment levels to 2006 and 2011

Although our forecast analysis starts in 2014, following the projection of CSG from Energy Skills (2015), in the following we present a table with employment numbers across industries for 2006, 2011 (these two from Census data), 2014 (from the ABS employment survey) and three select forecasted numbers – obtained from scenarios BAU, SD2 and 3.3.

We show these three scenarios because they are respectively the business as usual case (BAU), the one considering the mid-alternative (50%) on the CSG employment projections downgrade adjustment (scenario SD2), and the one resulting with the largest drop in employment in 2034 (Scenario 3.3). The 2006 and 2011 job levels are calculated from the respective Census data and the 2014 levels correspond to the average across quarters of 2014 from the employment survey data from the ABS (see footnote 6 in the appendix for direct source).

Table 1. Observed values for 2001 and 2006, 2014 and forecasted jobs in 2034 in three scenarios for the Surat region

Industry sector	2006 jobs	2011 jobs	2014 jobs	Jobs from Scenario BAU 2034	Jobs from Scenario SD2 2034	Jobs from Scenario 3.3 2034
Electricity, gas, water and waste management services	591	798	1,250	1,167	1,209	1,002
Construction	3,577	4,350	6,650	6,291	6,470	6,769
Accommodation and food services	2,679	3,215	2,950	2,623	2,787	1,971
Arts and recreation services	196	303	225	243	234	243
Other services	1,694	1,919	2,725	2,572	2,649	1,809
Administrative and support services	711	847	900	830	865	830

Note: 2006 and 2011 are values from Census data, 2014 from ABS employment survey (average across quarters for the SA4 of Darling Downs – Maranoa) select forecasted values from estimates shown in charts to 2034.

From the values in table 1 it can be seen that across all industries in the Surat Basin, with the exception of Accommodation and food services, the forecasted estimates in this work show higher employment numbers in 2034 compared to 2006. Compared to 2011 four out of the six forecasted industries have higher employment levels in 2034.[5]

[5] We only compare here the 6 industries that were forecasted in our analysis for the Surat basin as are the only ones reporting a statistically significant job multipliers to CSG employment change. See table A1 in the appendix for more references.

Interestingly, even though scenario 3.3 is the one that forecasted the largest drop in total employment compared to 2014 levels (see figure 10), the construction sector in this scenario actually shows higher employment levels in 2034 compared to all other years in table 1. This is produced because scenario 3.3 delink increasingly over time the dependence of the construction sector to the CSG industry, so in later years actually the construction industry ends up with positive job creation when the CSG industry decreases its employment demand.

3 Conclusions and considerations

Seven out of the nine scenarios produce total employment levels in 2034 that are below the levels at the start of projections in 2014. However it is important to clarify that across all industries in the Surat Basin, with the exception of accommodation and food services, the forecasted estimates in this work show higher employment numbers in 2034 compared to 2006.

The scenarios presented in this report were developed following consultation with the project reference group comprising industry, government and economic experts. They were further refined based on a thorough literature review and analysis of available economic modelling capable of accurately forecasting economic effects of CSG development in Queensland. The econometric modelling developed to inform the scenario analysis allowed the project team to track job multipliers across regions in Queensland and provide coefficients that reflect what happened in the regions between 2006 and 2011.

However the research is not exempt from caveats. At the time of writing the most detailed employment data at SA1 level was only available up until 2011 (prior to the peak of the construction phase), supplemented with labour force survey data up until 2014 (at SA4 level). As such, the values provide the best available insights of local impacts of the CSG industry and are used to project employment effects across the Surat and Toowoomba regions in coming decades. Data to be obtained from the 2016 Census (expected to be available in early 2017) can be used to improve this forecasting analysis as multipliers can be updated (for economy changes during the period 2011 to 2016) and refined forecasts projected.

It is important to recognise that that the base case was calculated after the CSG industry was already established. In other words, it is practically impossible to predict what would have happened in the regions without the CSG industry as the forecasting analysis is done in a region where the industry is already established and past historic data (before 2001, when there was no CSG industry) is not available. Therefore to provide insights into how the Surat and Toowoomba regions could have performed without the industry in coming decades would be impracticable. All projections presented in this report are done considering industry expansion, and do not consider employment growth scenario forecasts with a baseline excluding the CSG industry.

Beyond the effect of commodity prices and efficiency gains on labour demands we do not discuss wider external factors that could affect the CSG industry to 2034. However, given the nature of this analysis, current and future changes in the industry can be captured in our estimations and scenarios adjusted accordingly. These factors may range from variations in international oil prices to changes in well pad technology, which in the end will guide industry decisions in terms of production and investments.

Further research could investigate other indirect effects of the industry such as the increased amount of water generated as a by-product of CSG extraction, which has the potential to increase agricultural production and productivity.

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Technical Appendix

This project uses the Surat region, an area that has received high levels of intervention from the CSG industry, as a case study. However, following discussion with stakeholders, we have also included regions surrounding the Toowoomba shire, as the industry has directly impacted these regions, where many business and employees working with the CSG industry reside. In map A1 we show how these regions are defined.

Following the previous reports published for this project and consultation conducted with stakeholders, the forecasting analysis comprised two different empirical components:

1. Econometric modelling, and
2. Quantitative scenario analysis.

In the following we provide a brief description of how the forecasting analysis works.

Component 1: Econometric modelling

The initial step in producing an economic forecast was to estimate how the CSG industry has affected employment across regional Queensland in recent years. The analysis is based on the impact of CSG employment on employment in other sectors (the multiplier effect of CSG), because it has been shown in the literature that the main local economic effects of resource extraction activity are generated by changes in employment demand produced by the extractive industries (Fleming et al., 2015).

To perform this analysis several data options were considered and the research team finally decided to use census data provided at SA1 level as these provide more units of observation (more regions across the Surat and Toowoomba regions) and data are captured on a 'place of residency' form, i.e., employment numbers represent the people residing across the Surat and Toowoomba regions and therefore exclude FIFO labour coming temporarily from other regions. The data used includes employment levels for different industries in 2006 and 2011.

To perform a robust analysis, two different samples were considered:

- Surat CSG region, encompassing 354 SA1 regions (see map A1)
- Surat and Toowoomba regions, encompassing 718 SA1 regions (see map A1).

The job multiplier estimation was created following Moretti (2010) and Fleming and Measham (2014) using the following equation:

$$\ln(y_{i,t}) - \ln(y_{i,t-1}) = \alpha + \beta\,[\ln(\text{oil \& gas employment}_{i,t}) - \ln(\text{oil \& gas employment}_{i,t-1})] + e_i, \quad (1)$$

where ln is the natural logarithm, y is specific sectoral employment, i is the SA1 and e an idiosyncratic error term. We measure employment changes over the five-year period from 2006 to 2011 (the subscripts t-1 and t, respectively). Considering this econometric specification, we run separated regressions independently one from each other (in total 18 different regression runs,

which reflects the 18 rows with results in tables A1 and A2) and obtained the parameter β for each case, which give us the elasticity of the respective sector employment change to oil and gas employment change. The calculated elasticities provide estimates from which we can calculate respective local multipliers by multiplying their value by the ratio (sectoral employment / oil and gas employment) for the respective sample analysed.

Component 2: Quantitative Scenario Analysis

Once job multipliers were assessed for each economic sector, forecast estimates were conducted using the CSG employment projections reported by the CSG industry in the Energy Skills report (2015). Figure A1 below shows employment projections to 2034. Based on these industry projections, we calculated the potential job spillovers that the predicted CSG employment would produce. This analysis provides a base case from which we can develop different scenarios. The estimates provided by Energy Skills (2015) are based on direct industry consultation and, as seen in figure A1, its peak in employment numbers happens in 2024, which is their mid-point for their 20 years projection: 2014–2034.

The quantitative scenario analysis uses the 'base case' results obtained from the econometric specifications and CSG employment data projections. The quantitative scenario analysis includes stakeholder feedback in the form of testing different scenarios, which are described in the main text above (BAU, SD, and Scenario 3).

Econometric results and job multipliers

Results of the econometric modelling and job multipliers estimations are provided in Tables A1 and A2. The second column of Table A1 and A2 reports the coefficients obtained after using ordinary least square regressions on a set of models given by equation (1). Each row shows the coefficient result of the equation regressed using as dependent variable the respective change in employment in the industry sector. In other words, the row showing for instance 'ch_manufacturing' shows the regression results 'β' in equation 1 using as dependent variable the natural log of the difference in manufacturing employment between 2011 and 2006. The β coefficient shows the respective elasticity of the industry to changes in 'oil & gas employment' (also between 2011 and 2006), which in this study we assume is completely driven by changes in CSG industry employment. The third column in both tables shows the statistical significance of the obtained coefficient. Thus, the 'p-Value' shows the likelihood of having obtained the respective coefficient by chance. Following standard statistical procedures, in this report we consider only results where the p-Value is 0.05 or lower, which represents elasticities that have a 5% chance (or lower) of having appeared by chance.

The fourth columns in Tables A1 and A2 show the ratio given by the total number of the respective industry (sector) employment to the total number of employment in the oil and gas sector, in the overall region. The ratio is the average for years 2006 and 2011. Thus, the value of '12.143' in the manufacturing row of Table A1 means that on average in 2006 and 2011 there was 12 times more employment in the manufacturing sector than in the oil and gas sector in the whole Surat region area.

Finally the fifth column in tables A1 and A2 report the multiplier coefficients obtained for the respective sectors. As mentioned in the empirical exercise of this study we consider only sectors with a statistically significant value, as highlighted in the tables.

Using econometric results for scenario analysis

Given the results obtained in tables A1 and A2, the analysis moves to forecast potential employment generation in the Surat and Toowoomba regions considering employment figures provided by the CSG industry and different scenarios departing from their projections. All estimations performed here are based on the most conservative CSG employment projections reported in Energy Skills (2015) considering the development of 39,000 wells across south Queensland.

Initial assumptions to take into account for the scenario analysis include:

a) The proportion of total CSG employment in Queensland should be considered to relate to the Surat and Toowoomba regions. As seen in Fleming and Measham (2014), to 2012 60% of all CSG wells drilled in Queensland occurred in the Surat Basin region. Therefore, considering this past trend and current reservoir assessments, to project economic effects of the industry in regions located within the Surat and Toowoomba regions we assume that around 75% of the projected total industry upstream jobs will be in the Surat and Toowoomba regions. This 75% is an assumed value that can be changed in sensitivity tests that can be performed with the Excel spreadsheet dynamic tool to be provided with this project.
b) The fly-in fly-out nature of employment within the CSG industry. For this report and discussions provided here, we assume that 60% of all labour force projected in Energy Skills (2015) is to be provided by fly-in fly-out employees residing outside the Surat and Toowoomba regions; that is only 40% will be locally sourced employment (including new permanent migrants). For the Surat Basin we consider only a 20% provision coming from local employment. These 40% and 20% assumptions of local based employment are values that can be changed in sensitivity tests that can be performed with the Excel spreadsheet dynamic tool to be provided with this project. In any case, this adjustment plus the one described in point a) give fairly similar numbers of CSG projected employment to ABS quarterly employment data for 2014 values, as explained in footnote 6.
c) Industry projections start in 2014, therefore for our analysis we assume that the projection of the industry in 2014 is correct, and we estimate future job gains across industries in 'net' value, that is, considering only gains from values in 2014. All these gains are calculated from ABS employment data for the different industry sectors at SA4 levels and available

online.[6] It is important to note that we checked the consistency of the 2014 estimates with the ABS data, which provided a fairly close estimation, so we decided to use the Energy Skills numbers for 2014.[7]

The first scenario, which we define as the business as usual (BAU) case, uses the Energy Skills (2015) projected CSG employment data after adjusting them following points a) and b) above. This case only projects employment data across other sectors by adjusting upstream job location and fly-in fly-out labour. As these two adjustments are based on assumptions from the research team, it is important to note here that – as mentioned in footnote 5 in the main report – this forecasting study will be accompanied by an Excel file where different assumptions, such as these down ward adjustments, can be modified and tested. In other words, we will provide a dynamic tool where different scenarios can be projected based on changes in many of the underlying assumptions and parameters used in this work.

The second scenario adjusts the BAU case by reducing, in different proportions, the industry-provided CSG projected job growth. Given the recent drop in international oil prices, natural gas companies' caution about expanding as rapidly as they did in the past decade, and the potential that technological change might improve development and operational labour productivity, we analysed this scenario by considering reducing CSG industry employment projections in three different ways: by 25% (scenario 2.1), 50% (scenario 2.2) and 75% (scenario 2.3).

Finally, the third scenario considers changing the dynamics of the multipliers. For this alternative we consider the results obtained in scenarios 1 and 2, and adjust their trends by changing the respective multipliers. The options to be tested in this scenario are described in section 2 above in the main report.

[6] Data is available at: http://www.abs.gov.au/ausstats/abs@.nsf/mf/6202.0. As the data is reported quarterly, we used the average value across quarters in 2014.

[7] The quarterly employment data from the ABS do not break mining industry employment in categories, so we could not trace the real numbers in the 'Oil and gas' sector. However, by comparing employment numbers from the quarterly estimations and census data in 2011, we found that 'oil and gas' and 'exploration' employment sectors (in the Census) made around 40% of the total mining industry in both regions and that the total mining employment numbers from the Census and the quarterly employment numbers matched in around 75%. Given this, after adjusting the ABS mining quarterly employment data in 2014 by multiplying its values by the factors 0.4 and 0.75, the numbers were fairly similar to the adjusted 'Energy Skill' estimate employment numbers (after the adjustments on the energy skill projected data given by points a and b detailed above) that we use in this project. These employment numbers are 1,350 CSG local jobs in the Surat Basin and 2,700 in the Surat and Toowoomba regions in 2014.

Table A1. OLS results of multiplier models. Surat Basin regions (n=354)

Sector	Coefficient	p-Value	Employment ratio in region	Job Multiplier
ch_manufacturing	0.003	0.951	11.527	0.036
ch_electricity	0.168	0.008	1.602	**0.269**
ch_construction	0.124	0.003	9.415	**1.168**
ch_wholesale	–0.053	0.377	4.397	–0.231
ch_retail	0.029	0.49	14.231	0.407
ch_accommodation	0.151	0.002	7.028	**1.063**
ch_transportation	0.041	0.465	6.648	0.276
ch_media	0.051	0.332	0.685	0.035
ch_financial services	0.013	0.823	1.738	0.023
ch_rental	0.101	0.098	1.034	0.105
ch_public	0.014	0.789	7.398	0.106
ch_education	–0.025	0.584	9.526	–0.239
ch_health	0.049	0.28	11.425	0.558
ch_recreation	–0.107	0.024	0.554	**–0.059**
ch_other services	0.114	0.034	4.377	**0.497**
ch_scientific	0.001	0.983	3.467	0.004
ch_administrative	0.123	0.031	1.861	**0.228**
ch_agriculture	–0.069	0.116	30.601	–2.102

Notes: Robust (White-adjusted) standard errors used. Employment ratio is given by: Sectoral jobs/Oil&Gas jobs. Job multiplier estimates is obtained by multiplying the coefficient value in column 2 by the employment ratio value in column 4. Bold numbers and (*) denote statistically valid multipliers with p<0.05.

Table A2. OLS results of multiplier models. Surat Basin and Toowoomba regions (n=718)

Sector	Coefficient	p-Value	Employment ratio in region	Job Multiplier
ch_manufacturing	0.064	0.091	21.85838	1.402
ch_electricity	0.174	0	2.402334	**0.419**
ch_construction	0.123	0	16.43304	**2.015**
ch_wholesale	0.012	0.797	8.069657	0.095

ch_retail	0.069	0.036	25.44462	**1.767**
ch_accommodation	0.136	0	12.24863	**1.663**
ch_transportation	0.085	0.038	10.56713	**0.902**
ch_media	0.026	0.518	1.835205	0.048
ch_financial services	0.019	0.665	5.047996	0.096
ch_rental	0.127	0.006	2.639246	**0.336**
ch_public	0.071	0.065	14.19156	1.012
ch_education	0.036	0.292	19.466	0.696
ch_health	0.090	0.106	24.07022	2.176
ch_recreation	–0.030	0.432	1.47664	–0.044
ch_other services	0.098	0.013	8.43549	**0.827**
ch_scientific	0.047	0.265	7.517021	0.355
ch_administrative	0.073	0.104	4.164552	0.305
ch_agriculture	–0.018	0.631	28.95206	–0.528

Notes: Robust (White-adjusted) standard errors used. Employment ratio is given by: Sectoral jobs/Oil&Gas jobs. Job multiplier estimates is obtained by multiplying the coefficient value in column 2 by the employment ratio value in column 4. Bold numbers and (*) denote statistically valid multipliers with $p<0.05$.

Table A3. Industry sector names according to the ABS

Sector	Formal industry sector name
ch_manufacturing	Manufacturing
ch_electricity	Electricity, gas, water and waste management services
ch_construction	Construction
ch_wholesale	Wholesale trade
ch_retail	Retail trade
ch_accommodation	Accommodation and food services
ch_transportation	Transport, postal and warehousing
ch_media	Information media and telecommunications
ch_financial services	Financial and insurance services

ch_rental	Rental hiring and real estate
ch_public	Public administration and safety
ch_education	Education and training
ch_health	Health care and social assistance
ch_recreation	Arts and recreation services
ch_other services	Other services
ch_scientific	Professional scientific and technical services
ch_administrative	Administrative and support services
ch_agriculture	Agriculture, forestry and fishing

Table A4. Scenario names, assumptions and total net indirect jobs generated by 2024 and 2034
(Net difference is given by the difference in the number of jobs in the respective years [2024 and 2034] to the base year of 2014)

Scenario name (as shown in Figure 10)	Assumptions	Total net jobs generated from base year 2014	
		2024	**2034**
Scenario BAU (Business as usual)	Jobs estimated from calculated job multipliers (table A1 and A2) and CSG job projections adjusted by location of activity [point a)] and fly-in fly-out assumptions [point b)] as described in the technical appendix (pages 20 and 21) of the report.	1,994	–973
Main Scenario: Slow Down (SD)			
Scenario SD1	25% decrease on projected CSG jobs from BAU	1,496	–730
Scenario SD2	50% decrease on projected CSG jobs from BAU	997	–487
Scenario SD3	75% decrease on projected CSG jobs from BAU	499	–243
Main Scenario: Scenario 3			
Scenario 3.1	Scenario given by BAU forecast considering a 50% decrease in construction multipliers over time (every 5 years)	1,861	–587
Scenario 3.11	Scenario given by SD2 forecast considering a 50% decrease in construction multipliers over time (every 5 years)	930	–293

Scenario 3.2	Scenario given by BAU forecast considering a 25% decrease in all multipliers over time (every 5 years), except for 'Recreation' and 'Administration'	1,561	166
Scenario 3.21	Scenario given by SD2 forecast considering a 25% decrease in all multipliers over time (every 5 years), except for 'Recreation' and 'Administration'	780	83
Scenario 3.3	Scenario given by BAU forecast considering a 75% decrease in construction multiplier over time (every 5 years), but a 20% increase in multipliers of the rest, except for 'Recreation' and 'Administration'	2,194	–2,076
Scenario 3.31	Option c) Scenarios BAU or SD2 considering a 75% decrease in construction multiplier over time (every 5 years), but a 20% increase in multipliers of the rest, except for 'Recreation' and 'Administration'	1,097	–1,038

Note: Numbers in last columns can be observed in Figure 10 of the main report.

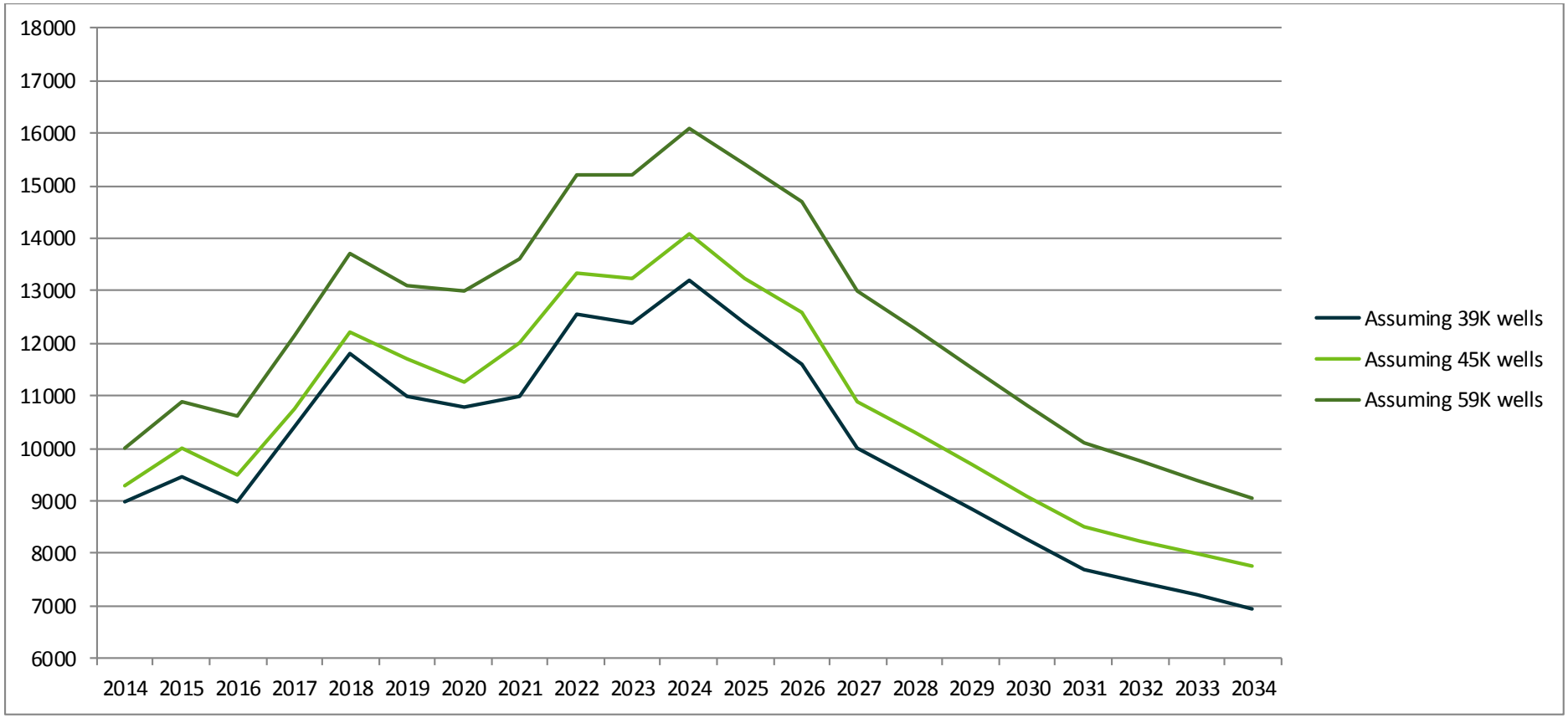
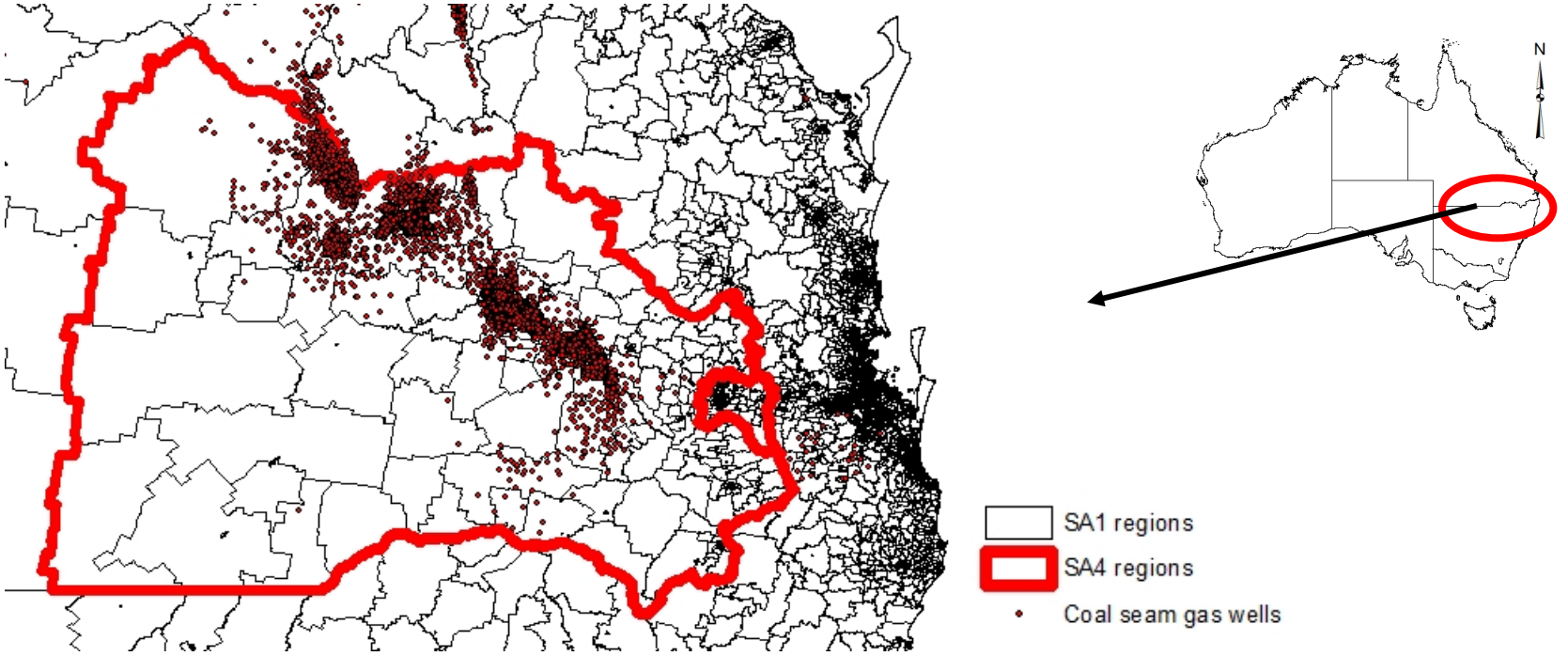


Figure A1. Total employment projections in the CSG industry (vertical axis shows employment numbers)
***Source*: Own replication from Energy Skills (2015).**



Map A1. Study area. Thin black lines show SA1 borders (n=567) and the thick (red) line shows the borders of the SA4s, with the larger one corresponding to the Darling Downs – Maranoa region (which we define as Surat Basin in this study) and the small one (towards east) corresponding to Toowoomba

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