

CHAPTER 10

Impacts on the Economy

CHAPTER 10: IMPACTS ON THE ECONOMY

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Executive Summary

Shale gas development (SGD) has the potential to yield highly significant economic opportunities, but also bears risks engendered by the extractive nature of SGD. In both respects it parallels other divisions of the mining sector.

Previous South African research into the macro-economic opportunities associated with SGD reveals little agreement on likely benefits, their extent, or the appropriate mechanisms for their measurement. Despite this ambiguity and uncertainty, certain aspects are clear. Highly positive impacts on the balance of payments can be expected from SGD irrespective of whether they come in the form of import substitution alone or combined import substitution and export growth. If the large scale production scenario (Big Gas) is assumed, gas revenue could be equivalent to between 8% and 16% of the current account deficit thereby making a potentially substantial contribution to deficit alleviation. This has the potential to precipitate exchange rate appreciation. It is not, however, possible at this stage to predict the likelihood of such an appreciation or whether it would have potentially damaging effects on other sectors¹.

The achievement of long term macro-economic benefits will necessarily depend on the uses to which the proceeds of shale gas, especially those accruing to Government, are put. More specifically, recent government expenditure allocation patterns in South Africa show an upward trend in recurrent consumption expenditure such as that on salaries and arguably too little capital expenditure more clearly directed at boosting longer term growth potential. Concerted efforts will need to be directed at ensuring that the lion's share of shale proceeds accruing to government are used to enhance the long term prospects of the country.

Ex-post assessments of the local and regional impacts of SGD on jobs and incomes indicate that impacts can be substantial though they seem often to have been over-stated by earlier predictive assessments, especially those that applied questionable static models. It is likely that the jobs suiting the average unemployed resident of the study area would be restricted to unskilled and semi-skilled positions. However, local participation could increase as the industry matures and local skills levels rise. It is estimated that the Big Gas scenario would eventually require roughly 2 275 operational staff for drilling and transport and 300 to operate the power plants. If study area residents are assumed able to initially fill 15% to 35% of positions, this would translate into between 390 and 900 direct jobs to locals. It should not be assumed that indirect and induced impacts in terms of jobs within the region would reach the same level as direct impacts. Over time, however, a vibrant local industry could

¹ These effects could be associated with so-called 'Dutch Disease' which refers to a situation in which businesses either cannot compete with imports or are squeezed out of export markets as a result of the appreciation of their home currency.

emerge representing a potentially substantial opportunity – this would be dependent on factors such as the willingness of industry players to foster local enterprise development, entrepreneurial responses and the formation of clusters that expand value-chains. Purchasing processes, hiring and training of staff and local socio-economic development initiatives/projects should act as a departure points to ensure that economic benefits to local communities are maximised. Measures could, for example, borrow from enhanced Social and Labour Plan (SLP) requirements which apply to the mining industry and the Independent Power Producers (IPP) Procurement Programme which are arguably superior to SLP requirements in some respects.

The risk that gas based development will ‘crowd out’ other sectors in the study area by causing rises in interest rates is regarded as zero, crowding out through increases in the prices of labour and other inputs, is generally considered low. Although it has also mostly been found to be low in the United States, the reasons were different. One exception is water, a resource in short supply in the Karoo. An important proviso is therefore that SGD does not seriously compete with local water users, or pollute local supplies. Note that movements in relative prices of business inputs are characteristic of a market economy and not necessarily indicative of market failures requiring intervention. The possibility of physical externalities, in which SGD imposes technical or physical costs on others, is a more serious problem. The assessment of such external costs, and recommendations for their mitigation, are the primary responsibility of the other specialist studies forming this scientific assessment. This study does, however, discuss their implications for the finances of public bodies and land owners.

Unless carefully managed, the externalities associated with SGD could impose significant budgetary strain on local authorities and public finances in general. Three key challenges are likely to emerge in this regard for municipalities in SGD areas: 1) not to overspend and be burdened with stranded infrastructure; 2) to smooth out their revenue streams through boom and bust cycles; and 3) to ensure financial sustainability after SGD activity ceases. In contrast to the United States, where significant local and state-wide revenue raising and retention are possible, South African local, regional and provincial authorities are constrained in both of these respects. It is thus likely that municipalities will face significant stresses as SGD expands particularly under the Big Gas scenario. These should include accessing additional human and financial resources to accommodate for environmental and other approvals and management, dealing with strain or damages to roads and other services such as water provision and sewerage services and addressing the long-term externality problems associated with abandoned or decommissioned wells.

In the event of the Big Gas scenario, impacted local authorities will have to estimate additional budgetary needs and be able access or generate funding to meet them. This will require the consideration of a number of measures. Additional staff, possibly from other municipalities and even secondments from other countries that have extensive shale gas experience, should be considered.

Dealing with road damage, for example, will require municipalities to consider special policies and measures such as a levy or bond for road haulage. National government will also need to be particularly responsive to legitimate municipal financial needs. It will be critically important that taxpayers are not burdened with the potentially highly significant rehabilitation costs after the abandonment or decommissioning of wells. In the South African mining industry, there has been some progress in this regard for currently operational mines. However, in common with experiences in other countries, substantially more needs to be done prompting the strengthening of the regulations governing financial provisions for mine rehabilitation and closure in 2015. These regulations should act as a key departure point, alongside experiences from countries where hydraulic fracturing (“fracking”) occurs, when crafting and implementing regulations for well abandonment or decommissioned.

Risks to property values in drilling areas are likely to vary significantly depending on factors such as drilling locations and trucking routes in relation to sensitive receptors. The evolution of the existing stigma associated with fracking will also play a key role. It is likely that property values in towns within SGD regions would increase on balance despite negative externalities. This would be in keeping with increased commercial activity and should endure to the extent that SGD activities continue. The application of mitigation measures outlined in the other studies forming part of the scientific assessment such as those focused on visual, noise and water impacts should also reduce risks to property values. There are, however, likely to be externalities that cannot be avoided requiring compensation payments to land owners. Compensation principles to be applied and, to the degree possible, fair minimum amounts or conventions/formulas for establishing compensation will need to be determined in consultation with land owners if they are to be protected from bearing costs and to ensure that they have a stake in the process. It is important to bear in mind that, aside from ensuring the fair treatment of land owners, compensation which goes beyond what is strictly required by law should also play an important role in facilitating the development of SGD. Interactions with land owners would be less likely to be acrimonious, reaching agreement would take less time and turning to the law to force land owners to grant access to their land is less likely to be necessary.

As in the case of other extractive industries, setting regulation for SGD through laws, policies and other guidelines is likely to be more straightforward when compared with implementing them successfully. Past and present environmental and associated socio-economic impacts from mining in South Africa are instructive in this regard. The industry remains a key driver of beneficial economic development and yet, if one considers the Mpumalanga coal fields among other examples, it is evident that the benefits of mining could be achieved at a substantially lower cost to the environment and society. This will be the challenge associated with the regulation of SGD and one that is unlikely to be addressed using a business-as-usual approach.

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10.1 Introduction and scope

International evidence (albeit much of this is from the United States (US)), a high-income economy and one where mineral rights do not belong to the state) indicates that shale gas development (SGD), like other mining related activities, offers both economic opportunities and risks. The production process could result in significant value addition and injections of expenditure, both of which could increase commercial activity, employment opportunities and income. Positive outcomes in this regard could also flow from the beneficiation of the gas-to-power (GTP) plants, gas-to-liquids (GTL) plants and other applications. These would enhance energy security and decrease imports. The risks stem from negative externalities. Prominent among these are competition for, and impacts on, scarce water resource in the semi-arid Karoo (Hobbs et al., 2016), and possibilities of land degradation (Hollness et al., 2016), visual impacts (Oberholzer et al., 2016), increased noise levels (Wade et al., 2016), air quality impacts (Winkler et al., 2016) and social ills (Atkinson et al., 2016) - particularly in the small relatively isolated communities that characterise the area. These risks would impact on land owners, residents and municipalities and are likely to be more concentrated at a local scale when compared to benefits. From a sectoral perspective, the two economic activities most reliant on natural resources and most clearly at risk are agriculture, the dominant sector in the area, and tourism which continues to grow in importance. This assessment responds to the need for a strategic consideration of the aforementioned economic impacts. Its focus and content is guided by the particular needs of the scientific assessment in combination with the other specialist input to it.

Clarifying the scope of the scientific assessment is particularly important given its strategic nature, time and resource limitations and the potential for overlap with other specialist inputs. The following needs to be borne in mind here:

- The scientific assessment has been carried out at a strategic level and relies on existing information². It does not, therefore, gather primary data nor does it attempt to undertake any economic modelling.
- The scenarios assessed by all specialists contributing to the scientific assessment essentially *assume* that financially viable production can be achieved. Consequently, the question of viability becomes somewhat moot within the scientific assessment. It is nevertheless important to recognise the key factors that will ultimately determine viability aside from size, quality and depth of any finds. They are explored in detail by Fakir (2015: 6) and include: 1)

² To the degree possible, this information has been validated or reality-checked and preference has been given to peer reviewed sources where choices between sources were present.

the rate of technology learning and efficiencies³, 2) knowledge and understanding of the geology, 3) market demand and a high enough price for gas and other incentives, 4) the timing and scaling of drilling intensity, and 5) the cost of mitigating the externalities for both the short and long-term. The availability of general economic infrastructure such as roads and gas-to-market infrastructure are also key.

- The primary focus or end-point is the identification of management and mitigation measures including measures for the enhancement of opportunities. Assessment of impacts is therefore limited to that which is required to understand impacts at a strategic level and identify such measures which may be developed further in an overall Strategic Environmental Assessment (SEA) of the opportunities and risks of SGD.
- The scientific assessment management team holds primary responsibility for the overall integration of all specialist findings and ensuring that all risk and opportunities are appropriately and holistically addressed. This study therefore limits itself to drawing on selected other specialist studies in order to understand key externalities and risks. The assessment does not, however, necessarily assess or quantify these risks further from an economic point of view and explicitly avoids overall integration through, for example, a cost-benefit or multi criteria analysis. Note that the lack of basic information such as the size of the gas resource also means that a cost-benefit analysis would be premature.
- Comparisons between alternative energy sources are not made in this study. The effects of SGD on national energy planning and energy security are, however, assessed in Wright et al. (2016).
- The assessment of environmental risks and externalities are the primary focus of the other specialist studies forming part of the scientific assessment. This dictates that less emphasis is placed on these risks in this study. It does not in any way imply that they are somehow less important from an economic perspective.

Taking into account the above clarifications of scope into account, the following overall impact categories were chosen for assessment recognising that the lines are often blurred between these impacts:

- Macro-economic impacts;
- Local and regional impacts from project ownership and spending;
- Impacts on municipal and public finances; and
- Impacts on property values.

³ This includes technology learning and efficiencies and the timing and scaling of drilling intensity in terms of capabilities.

It is important to recognise that agriculture and tourism are the key economic sectors in the study area that are likely to face increased risks from SGD. Given the potential seriousness of these risks, separate specialist studies were commissioned focusing specifically on impacts on agriculture and on tourism including their socio-economic implications. This obviated the need to address these impacts in this report bearing in mind that the findings of the specialist studies will be integrated into the overall scientific assessment thereby ensuring that risks are considered.

10.2 Key potential impacts and their mitigation

The following sections address the impacts identified for assessment starting with macro-economic impacts. Each new impact section starts with a description of impacts followed by an assessment of impacts and recommendations for mitigation and benefit enhancement measures. Risk and opportunity ratings are provided for impacts in Section 10.3.

10.2.1 Macro-economic impacts

10.2.1.1 Description of impacts

SGD offers both macro-economic opportunities and risks. Opportunities lie in the potential for a significant boost to the economy. This would be felt as increases in real Gross Domestic Product (GDP), in jobs, household incomes and tax revenues, and in a net foreign exchange inflow potentially relieving stresses like those recently borne by the balance of payments. The increase in GDP would be brought about by two factors. The first is the short term impact of increased expenditure – i.e. monies spent on opening up and operating the shale operations – capital and operational expenditure. The greater the proportion of these being spent on locally produced goods and services, the greater the impact on GDP. Second are the longer term structural changes in the economy that might ensue from a burgeoning gas beneficiation sector. These would largely be determined by the linkage effects of the gas sector, i.e. the extent to which shale gas provides upstream and downstream economic opportunities.

A subset of these benefits is that there would also be direct increases in government revenues. These would accrue directly from royalty payments, on the one hand, and indirectly from increased tax payments. These increased tax payments would come from shale operators, firms operating upstream and downstream of the shale industry, and indirect tax increases as a result of the multiplier effects.

The key macro-economic risks identified are as follows:

- The first is that government commits too much expenditure against the expected reserves and expected increases in government revenues. Avoiding this will require careful evaluation of expenditure and other forms of support to the SGD sector through, for example, cost-benefit and risk analyses and associated planning at various stages.
- The potential that the macro-economic benefits of SGD are overstated, even by the critics, creates risks. These estimates should form an important part of overall government decision-making processes.
- There is a further risk that the expenditure could be wasteful and that the long-term cumulative proceeds from SGD would not be put to their best productive uses. The consequence could be that even if short-term benefits outweigh costs, this may be reversed over the longer-term. The achievement of long term macro-economic benefits would depend on how the proceeds of shale gas were put to use, particularly those proceeds accruing to government.
- Improvements in the balance of payments can cause a currency appreciation. Such a currency appreciation may be benign, e.g. lowering the cost of imported capital goods. However, it could be problematic if it resulted in the so-called ‘Dutch Disease’ (see box for explanation) in which businesses either cannot compete with imports or are squeezed out of export markets as a result of Rand strength. An assessment of likely changes in the real exchange rate is needed to draw any concrete conclusions.

‘Dutch Disease’ Simplified: The term ‘Dutch Disease’ describes impacts similar to those suffered by the Dutch manufacturing sector following the discovery of North Sea gas. The extraction of gas caused an appreciation of the (then) Dutch currency, the Guilder. This resulted in a loss of competitiveness of traditional Dutch exports while making imports appear more attractive.

10.2.1.2 Assessment of impacts per scenario

Assessment in this section focuses on the potential for the macro-economic opportunities and risks outlined above.

10.2.1.2.1 **Opportunities**

Previous research in South Africa has focused on the estimation of macro-economic opportunities or benefits (see Econometrix, 2012; Wait and Rossouw, 2014; McKinsey Global Institute, 2015). Unfortunately, little agreement is evident with respect to likely benefits or even an appropriate approach for their measurement. Wait and Rossouw (2014) relied heavily on a dynamic computable general equilibrium (CGE) model and are critical of Econometrix (2012) who employed a more static

modelling approach⁴. They point out the key benefits of dynamic modelling, primarily referring to its ability to better take into account how economies adjust through the action of prices and markets which static models tend to treat as (unrealistically) fixed. A similar static approach seems to have been used by the McKinsey Global Institute (2015) although limited details on approach are provided⁵. Table 10.1 below provides a comparison of the results of these studies focused on employment and GDP. Significant differences are evident with respect to both indicators even where similar production volumes are assumed. These are clearly the consequence of the different assumptions and approaches followed. It is beyond the ambit of this assessment to conduct an in-depth analysis of such differences.

Table 10.1: Summary of national employment and GDP results from previous research on SGD in South Africa.

	Econometrix (2012)		Wait and Rossouw (2014)				McKinsey Global Institute (2015)	
Total size of resource in trillion cubic feet (tcf)	20	50	20	50	20	50	Focuses on production per year	
Timeframe	by 2035	by 2035	2-3 yrs	2-3 yrs	>10 yrs	>10 yrs	by 2035	by 2035
Potential life of resource (years)	25	25	25	25	25	25	Not given	
Ave production per year (tcf/yr)	0.8	2	0.8	2	0.8	2	0.3	0.7
Contribution to annual GDP (%)	3.3	9.6	3.5	6.9	4.4	10.4	Not given	
Contribution to annual GDP (Rbn)	35	90	26	52	32	77	up to 138	251
Potential permanent employment	300 000	700 000	1 441	2 471	Not provided – assumed exogenous to model		44 000	102 000 - 328 000

Macro-economic impact findings from the US are also instructive. On the whole, these studies found highly significant benefits in absolute terms and less so in relative terms when placed with the context of the large US economy. Hausman and Kellogg (2015) examined the impact of SGD on consumer and producer welfare and estimated that it resulted in an overall boost equal to 0.33% of US GDP⁶. Feyrer et al. (2015) focused on employment and found that 725 000 jobs were associated with new gas and oil extraction between 2005 and 2012. This translates to a 0.5% lowering of aggregate unemployment in the US over the period if one makes the arguably strong assumption of zero displacement from other employment (i.e. assuming that all the jobs created in the sectors were new jobs). Spencer et al. (2014) estimated that unconventional gas and oil added 0.88% to US GDP from

⁴ The Econometrix (2012) approach is also criticised by De Wit (2013) and Fakir (2012).

⁵ See Section 10.2.2.1.2.1 for further discussion of the limitations of static models such as Input-Output models when applied at a regional or local scale.

⁶ This assessment drew on a similar albeit less detailed assessment by Mason et al. (2014) which found qualitatively relatively similar impacts.

2007/8 to 2012 and will add about 0.84% to US GDP over the longer-term between 2012 and 2035. Houser and Mohan (2014) focused on the gas and oil sector as a whole predicting that it would add between 0.6% (conservative) and 2.1% (optimistic) per annum to US GDP between 2013 and 2020 thereafter decreasing to a contribution of between 0.4% and 1.0% of GDP between 2021 and 2035.

When considering the above results it must be borne in mind that the oil and gas sector in the US is well established and integrated into the rest of the economy allowing for greater benefits. Gas usage for residential and industrial purposes is also widespread. Despite the unique contextual and structural variations that prevent a strict replication, some scholars argue that the shale gas experience in the US is clearly still valuable as a source of policy making and learning for other countries (see Nülle, 2015 and Lozano Maya, 2013). Positive impacts on the balance of payments should be expected for three reasons:

- The opportunity for increased coal exports (to the degree that gas replaces coal in power generation) and lower oil imports (to the degree that gas replaces oil as a feedstock for fuel production in the large scale gas production scenario)⁷;
- Gas production levels in excess of the production and use scenarios assumptions of the scientific assessment could allow for exports; and
- The likelihood of foreign capital inflows both in the form of foreign direct investment (into shale) and foreign portfolio investment (into associated equity and bonds).

Balance of payment impacts will occur irrespective of whether they come in the form of only import substitution or import substitution and export growth. A basic calculation was done to determine the potential magnitude of the revenue that could be generated directly from the shale gas⁸. The estimate excludes potential imports of capital equipment during construction and small imports for maintenance. The value of these imports is currently not known. Given the wide range of estimates of potential gas revenues it is not clear that this is a material omission.

For the small scale production scenario (Small Gas), the value of revenue/turnover could reach between R 3.5 billion and R 7 billion per year increasing to between R 14 billion and R 28 billion per year if Scenario 3 (Big Gas) materialises. To put these values in perspective the annual current account deficit for 2015 was R 174 billion⁹. Total gas revenue could thus meet between 8% and 16%

⁷ Note that one should not necessarily assume that all of the 'excess' coal no longer needed for energy generation would readily find foreign buyers particularly if the 'Big Gas' scenario (and associated power generation from gas) is exceeded. Lower grades of higher sulphur thermal coal are probably least likely to be exported.

⁸ Calculation used annual production (total production volume per scenario smooth over 60 years) multiplied by a gas price range of between \$3 and \$6 per MMBtu and Rand/Dollar exchange rate of 14:1.

⁹ <https://www.resbank.co.za/Research/Statistics/Pages/OnlineDownloadFacility.aspx>

of the current account deficit for the Big Gas scenario. Note that these estimates are highly approximate and ignore all upstream and downstream changes, induced effects, structural changes, offsetting effects of machinery imports, etc. Nevertheless, one can conclude that SGD should make a substantial contribution to alleviating the current account deficit especially for the Big Gas scenario. Gas finds that exceed this scenario would only increase this significance. It is debatable but can be argued that the bulk of the revenue from gas would offset imports (oil, for example) or allow those fuels currently produced domestically to be exported (coal, for example).

10.2.1.2.2 Risks

10.2.1.2.2.1 Overstated Benefits

The conflicting results from other South African studies on the benefits of SGD outlined above raise concerns of creating unhelpful confusion and of possible overstatement. A study and/or transparent fact-based expert process focused on achieving the highest possible degree of neutrality would probably be needed before clarity emerges on this issue. Data on the extent of the resource does limit the accuracy of the macro-economic analysis. However, it is preferable to make some macro-economic estimates before the fact recognising the limitations of such estimates. These should then be repeated, to more carefully inform policy, as the extent of the resource becomes known.

10.2.1.2.2.2 Risks linked to the use of proceeds

Government can use the taxes (and other benefits such as royalties and any government free carried interest/stake in new oil and gas ventures which is being considered) for either consumption expenditure or capital expenditure. Consumption expenditure, a large portion of which is for the payment public servants, helps in the running of government but make a more limited contribution to long term growth in the economy. Capital expenditure on items such as roads, harbours and communication networks result in a more immediate impetus to economic growth. There is clearly also a need for growth in human capital through, for example, expenditure on education and health. This type of expenditure is made up of both consumption and capital expenditure. Education, for example, needs teachers – a form of consumption expenditure – as well as equipment such as computers and laboratories.

Recent government expenditure allocation patterns in South Africa show an upward trend in consumption expenditure and arguably too little capital expenditure directed at boosting longer term growth potential¹⁰. If this trend remains in place, or even accelerates, it will become less likely that

¹⁰ As a proportion of GDP, government consumption expenditure grew from just over 19% in 2007 to over 22% in 2013. In 2014, the latest available year, this declined slightly to just over 20%. In general South African

lasting benefits from SGD would be realised. Concerted efforts will need to be directed at ensuring that the lion's share of shale proceeds accruing to government are used to enhance the long-term prospects of the country. Without these, long-term costs are likely to exceed long-term benefits even if net benefits are experienced in the short-term.

10.2.1.2.2.3 Balance of payments risks

The magnitude of the beneficial impact on the balance of payment discussed above indicates that there is the potential for some exchange rate impacts. At this stage it cannot be known whether this would result in Dutch Disease. There may also be cumulative effects (i.e. SGD alone may not cause Dutch Disease, but could contribute to risks in combination with exchange rate effects from existing resource exports). Further research is needed on the likely changes in the real exchange rate and its associated impacts. This can be undertaken as needed if exploration confirms the existence of a significant recoverable gas resource. It must be stressed that presently the impacts are uncertain. A stronger Rand could also benefit the economy by making imported capital goods more affordable, and would promote the non-tradable segment of the economy (local services, etc.) ahead of the traditional tradable sectors such as mineral exports. By facilitating the import of capital equipment it might also encourage local value addition to primary products.

10.2.1.3 Options for mitigation or benefit enhancement

The dual objectives of mitigation should be the maximisation of macro-economic benefits and the minimisation of risks. Much will depend on macro-economic policy and management discussed below. Based on their review of the literature, Corrigan and Murtazashvili (2015: 1) note that, for example, the resource curse is not inevitable and that “political features of the economy, in particular the quality of governance, determine the extent resource wealth is a blessing rather than a curse.” The critical importance of governance is also clearly not limited to dealing with resource curse risks - it applies equally to all aspects of SGD if it is to proceed sustainably (see, for example, APERC, 2015).

In the short-term the use South African firms and labour should be encouraged where possible and include training programmes. Consideration could be given to some form of local content requirements bearing in mind the potential costs of such requirements. It is anticipated that the Department of Trade and Industry (DTI) along with the Department of Energy (DoE) and National Treasury would take the lead in this process. Indeed, the Industrial Policy Action Plan (IPAP) 2015/16 – 2017/18 proposes a Long Term Strategic Framework to leverage the opportunities presented by

government consumption expenditure has grown consistently since the 1970s. (source data: <http://www.tradingeconomics.com/south-africa/general-government-final-consumption-expenditure-percent-of-gdp-wb-data.html>)

petroleum and gas resources. Among other aspects, it notes that such a strategy would need to consider the way in which forward and backward linkages can be developed along the value chain assisted by investment and skills development. These measures are seen as a way “to demonstrate a serious commitment to avoiding the characteristic policy and regulatory errors that have given rise to the idea of the ‘resource curse’” (DTI, 2015: 123). The DTI has also recently announced that it will be establishing a unit to manage gas industrialisation that intends replicating the success of the Independent Power Producers (IPP) programme unit in the DoE (Mathews, 2016).

The only available mitigation measure to address the issue of the potential for overstated benefits is to commission an independent study, probably conducted by a small panel of acknowledged independent experts, to comprehensively assess the macro-economic benefits that could arise from SGD. Such an exercise could be repeated after some degree of activity to either prove or disprove the resource (i.e. through seismic exploration only) and once the size of the resources is known.

The minimisation of long-term risks is highly dependent on political decisions about the use of increased tax and other revenues originating from SGD. Ideally these need to be directed to maximising the growth potential of the economy. Here there are two overarching options to consider. The first would be some form or tacit arrangement in which government income from shale is directed to growth enhancing investments. It is not clear that this is a realistic option particularly as such an arrangement does not currently exist for other extractive industries such as mining. There does not appear to be any enforcement mechanism other than political will. The second would be based on the same principle just with the formal earmarking or ring fencing of tax and other shale revenues for specific types of expenditure. This could be in the form of a dedicated fund. National Treasury does not endorse ring fencing in principle making this an unlikely outcome. Note that sovereign wealth funds have been used for similar purposes. However, such funds tend to only be considered when countries experience current account surpluses; such surpluses are not predicted as outcomes of the shale production scenarios. In any event, such a fund would require additional political acceptance of the need to defer expenditure into the future in the face of pressing immediate socio-economic needs.

It would be worth exploring the establishment of an offshore sovereign wealth fund or similar should balance of payments risks emerge for the Big Gas scenario. Capital outflows to such a fund could offset the foreign exchange inflows thereby stabilising the exchange rate. This option would face the constraints discussed above. Another option would be to empower existing industry to counter the unintended short term consequences of a currency appreciation. This would be costly, not really

address the challenge (i.e. currency appreciation) directly and does not seem realistically achievable given the co-ordination required.

10.2.2 Local and regional impacts from project ownership and spending

10.2.2.1 Description of the impact

SGD would influence local and regional commercial activity depending on its scale and pace both of which would be dictated by market conditions. The key driver in this regard would be the magnitude and distribution of ownership (through, for example, shareholdings) and spending injections associated with these activities that would impact on jobs, incomes and associated business opportunities. Experiences abroad are illuminating in this respect; the following section therefore reviews these. This review, with selected data on the process anticipated for the Karoo, provides the basis for a scientific assessment of SGD scenarios.

10.2.2.1.1 Review of the literature on spending related impacts

Assessments of spending related impacts can be divided into those that attempt to predict impacts (*ex-ante* assessments) using techniques such as Input-Output (I-O) modelling, and those that focus on measuring impacts after the fact (*ex-post* assessments). There are also review studies that critique *ex-ante* assessments. These typically identify inappropriate models and/or overstatements of expected benefits particularly in terms of indirect and induced job creation (assessed using the actual impacts obtained by *ex-post* surveys).

10.2.2.1.2 Predictive or ex-ante assessments

The only South African study which provides a partial quantification of the impact of SGD at a regional scale in the Karoo is Toerien (2015). This study argues that several economic variables are closely related at the town level in the Karoo, namely Gross Value Added (GVA), population size, personal income, total enterprise numbers, and enterprise richness. It uses the premise that these variables have predictive power and if one can anticipate changes in one, the resulting changes to others can be forecast. Using these relationships, and only looking at the impact of worker spending, Toerien (2015) estimates the partial impact of SGD on any given Karoo town. The study assumes that each municipality will have 30 drilling rigs operating, each with 50 workers, for a period of one year. It hypothesises that if each worker spends R300 per day, the resultant injection to the local economy would amount to R 162 million per annum. It infers that this injection would result in a total population increase of approximately 4 300 persons, which should in turn stimulate the creation of between 37 and 41 new enterprises (Toerien, 2015). The number of workers or jobs created among these in-migrants is not estimated.

Industry-sponsored research particularly in the US has relied heavily on the use of multipliers generated from static Input-Output (I-O) models in order to estimate indirect and induced economic impacts. Key results from assessments of this sort include the following:

- In 2008 the Centre for Business and Economic Research (CBER) at the University of Arkansas estimated direct employment was between 4 498 and 4 813 people in the period 2008-2012 for the Fayetteville shale. Regional I-O modelling suggested between 6 769 and 7 722 indirect and induced jobs over the period (an employment multiplier in the region of 1.5 to 1.6).
- Mersich (2013) assessed impacts on Quebec, Canada using two production scenarios (i.e. ~0.18 tcf/yr and ~0.55 tcf/yr). He suggested that \$ 7.9 billion to \$ 23.8 of direct spending on SGD would yield a total economic impact of \$ 37.3 billion to \$ 112 billion between 2012 and 2036, implying an expenditure multiplier of 4.7 with 293 000 to 880 000 person years of employment in the same period.
- Considine et al. (2010) assessed the impacts of the Marcellus shale play using the IMPLAN regional I-O model¹¹. They predicted that during 2010 (1 743 wells producing 0.37 tcf) and 2011 (2 211 wells producing 0.73 tcf) shale gas would contribute roughly \$18.2 billion to Pennsylvania's state GVA.
- Scott (2009) estimated that the seven major shale firms of the Haynesville play spent \$ 4.5 billion in 2008 in the economy of Louisiana, 71% of which was on lease and royalty payments. He argued that this spending generated \$ 3.9 billion in household earnings and \$ 2.4 billion in new business sales within the state. Although the major firms had only 431 direct employees and contract workers, Scott (2009) predicted that they induced 32 742 new jobs in the state (implying an employment multiplier of 76 which is exceeding high particularly in relation to the findings of others).
- Regeneris Consulting (2011) used I-O to assess impacts in Lancashire and the United Kingdom. They concluded that every Pound spent on development, would yield an additional GBP of 0.70 in indirect and induced impacts. Their base case was for 400 wells to be drilled over seven years, leading to peak employment levels of 5 600 full-time equivalent jobs for the UK (of which 1,700 would be in Lancashire) (Regeneris, 2011).
- Wobbekind, et al. (2014) assessed the economic impacts of oil and gas activity in Colorado between 2008 and 2012. They found that the economic contributions of the upstream and midstream oil and gas industry totalled \$126.5 billion and that 61 633 direct jobs supported an additional 31 895 indirect and induced jobs, implying a job multiplier of 1.5.

¹¹ Shale gas is found in shale "plays," which are shale formations containing significant accumulations of natural gas and which share similar geologic and geographic properties (source: <http://geology.com/energy/shale-gas/>).

- The Perryman Group (2014) used an internally developed I-O model to assess the impacts of oil and gas production in the Barnett Shale on the Texan economy since 2001. According to the authors, the Barnett Shale produced over 15 tcf of natural gas between 2001 and 2014. The average annual gross geographic product they attributed to the Barnett Shale was \$ 11.8 billion which they said contributed 107 650 permanent jobs since 2001 (Perryman, 2014). The direct component of this impact, along with multiplier estimates, was not reported.

10.2.2.1.2.1 Critiques of Input-Output based assessments

Critics of I-O based studies have questioned both their appropriateness and their assumptions (e.g., Kinnaman, 2011; Barth, 2013; Christopherson and Rightor, 2011; Kay, 2011; Weinstein, 2014).

I-O models are static in nature and use fixed coefficients and prices to represent links between industries making up the economy. The most serious constraint associated with their static nature is that they explicitly exclude the ability of the economy to adjust through the price mechanism. This implies a highly significant (many would say unacceptable) failure to account for the role of prices as the key dynamic adjustment mechanism in economies.

I-O models are also based on historic economic data (and therefore historic industrial structures). This reliance of historical correlations makes them particularly unsuited to the assessment of an entirely new industry, especially if it is a large one. In this vein, Barth (2013) argues that they are not suited to the assessment of the introduction of SGD as the linkages and flows between it and other industries are likely to change, sometimes substantially (Barth, 2013).

I-O models have also been criticised for double counting, which gives them a built-in tendency to overstate impacts: *“If an economist ran an IMPLAN model on every industry, the direct spending of each industry would be multiplied to estimate the effects on the economy. But as every industry claims responsibility for jobs and revenues in other industries that supply the industry, IMPLAN would estimate more economic activity than actually occurs... Therefore, all impact statements based on input–output models such as IMPLAN are likely overstated”* Kinnaman (2011: 1247).

Much less problematic in the local economy, is Kinnaman’s (2011) critique that I-O models are not equipped to predict economic outcomes in situations where the economy is near full employment. They essentially assume that there are no supply constraints within the economy (Barth, 2013), and that a stimulation of a particular industry will bring idle labour and capital into production. There are places where this may be more applicable. In others it is more likely that capital and labour need to be diverted from their current uses or brought in from outside. A further significant weakness of I-O

models is that they are unable to adjust for and deal adequately with economies that have underemployed resources. This is a serious issue in South Africa, whose economy currently has much slack capacity. The implication is that little new employment might eventuate through the multiplier process.

Any assessment of economic outcomes will depend on assumptions of gas production, location and timing of expenditure. These can all be problematic. Assuming that patterns of production in one area will follow those in another is almost certain to be incorrect, given variations in the geological, geographical and economic environments (Barth, 2013). Undue optimism is also a concern; Berman (2010 in Kay, 2011) argues that evidence from the Barnett and Haynesville shales shows how the quantity and spatial scale of economically recoverable reserves were overestimated by both advocates and opponents of SGD. Overstatement of local economic impacts is also a risk in underdeveloped areas where few items are locally produced leading to overstated estimates of local spending capture (Kay, 2011; Kinnaman, 2011; Rousu et al., 2015). In the US a significant portion of local benefits has come from spending of lease and royalty incomes by land owners. Critics have pointed out that in many cases land owners in the US do not live in the states or even in the countries where their land is located (Kay, 2011; Hardy and Kelsey, 2015). In these cases, it is not clear that any of the payments that they receive are spent locally and over what period. Indeed, there is also much debate concerning the proportion of such payments that is actually spent on locally produced goods and services, and the proportions that are simply saved or used to pay off historic debts. Note that *land owner royalties would not be paid in South Africa* as mineral rights are state-owned. This does not, however, preclude the payment of compensation to land owners and others, an important issue which is discussed further in Section 10.2.4.

10.2.2.1.3 After the fact or ex – post assessments

Ex-post assessments typically assess positive impacts on employment, income and local taxes, but also such negatives as factor and product price rises leading to crowding out.

10.2.2.1.3.1 Impacts on employment and income

Brown's (2014) *ex-post* panel study for the Federal Reserve Bank of Kansas City investigated the economic effects of a 6.3 tcf increase in production of shale gas in 647 counties across nine states in the central USA between 2001 and 2011. Using two stage least squares regression, it contended that the increase in production was responsible for 49 000 new jobs in the counties concerned. Counties where production increased experienced an average increase in employment of 13%. For every billion cubic feet (BCF) of natural gas production, 12.7 jobs were created in total (12 700 jobs per tcf) with

7.3 of these being direct (indicating a job multiplier of around 1.7). Real average annual wages were found to have increased by \$ 43 per BCF of production and population by 18 people per BCF.

Hardy and Kelsey (2015) conducted an *ex-post* analysis in selected Pennsylvania counties between 2007 and 2010, paying particular attention to residents' income. They suggest that SGD has had a substantial impact on residents' income, largely due to the effect of royalty and lease payments, but also to increased profits of locally owned businesses. Counties with 90 or more wells saw a 6% increase in total taxable income compared to an 8.1% average decline (presumably as a result of income being drawn away) in counties without wells and a 5% decrease for the state. These benefits were however relatively concentrated within the 8.8% of the population that are land owners and therefore receive royalties. In this regard the payment of all royalties and lease payments to the central fiscus could be crucial in determining the balance between local and national impacts in South Africa.

Paredes, et al. (2015) conducted an *ex-post* county level assessment of SGD impacts on income and employment in the Marcellus shale play, Pennsylvania. Using statistical matching and panel data techniques, the authors found strong evidence for SGD having a positive impact on employment between 2004 and 2011. Less evidence was found for SGD leading to improvements in direct incomes, and no statistically significant impact on indirect or induced incomes, possibly because in-migrating workers are likely to report their incomes in their home counties. The authors also warn that the employment effects are for the period examined, and do not imply that SGD will provide long term employment benefits.

In a peer reviewed study, Tunstall (2015) looked at the impacts of unconventional oil and gas activity in 14 counties located above the Eagle Ford shale play in South Texas. To isolate the effect of oil and gas production on per-capita income, 56 observations spread over four years were analysed using ordinary least squares. Production was measured in terms of the number of wells drilled in a county during a given year, and was found to have a direct, positive impact on per-capita income.

The Multi-State Research Collaborative is a group of research and policy organisations from around the US that monitor the socio-economic impacts of SGD. In 2014, the group produced case studies of SGD in Tioga County, Pennsylvania (Ward et al., 2014) and in Carrol County, Ohio (Woodrum, 2014). In 2012, Tioga County had 811 shale gas wells, while Carrol County had only 138. In both case studies, the authors conducted a series of interviews with local officials and experts, and also analysed secondary data. For Tioga County, Ward, et al. (2014) concluded that the data demonstrated an overall positive impact of SGD on employment and income, particularly as a result of increased receipts from higher rents, bonuses and royalties. Woodrum (2014) appeared less confident that the

overall benefits to Carrol County had been significant, especially citing negative impacts such as strain on services, impacts on roads and increased crime voiced during engagements with stakeholders.

Weber (2012) used difference-in-difference analysis in a peer reviewed study to assess the impacts of SGD on employment and income between 1998/9 and 2007/8 in counties throughout Colorado, Texas and Wyoming. The average boom county saw a \$ 757 million increase in the value of gas production over the period, compared to \$ 10 million in non-boom counties. This generated modest increases in employment, wages, and median household incomes. Every million dollar increase in gas production appeared to provide 2.35 jobs. These *ex-post* results were five times less than those predicted by the CBER (2008) using I-O multipliers.

Weinstein (2014) conducted a wide ranging analysis of impacts from shale oil and gas development in 3060 US counties over the period 2001 to 2011. She found that, on average, shale boom counties experienced a 1.26% increase in employment while adjacent non-shale counties experienced a 0.43% increase. Furthermore, boom counties saw a 2.56% increase in earnings, while adjacent counties saw a 0.84% increase. The employment multiplier from oil and gas development was estimated at approximately 1.3 at a county level. The study also analysed employment dynamically. Incorporating a simple time trend into the model, it was found that employment in boom counties increases by an initial 3.3%, thereafter dropping off by 0.65% each year. While this may be evidence of crowding out of other sectors, it may simply be due to the life cycle of shale developments.

10.2.2.1.3.2 Risk of crowding out, boom and bust cycles

The natural resource curse is a catch-all phrase describing the negative impacts of expanding exploitation of natural resources. The mechanisms through which it operates has been described in various ways. Often labour costs are the key factor of interest particularly at a local level. By increasing the demand for labour, the growing (booming) extractive sector can put upward pressure on wages to the detriment of other sectors which are then 'crowded out'.

While crowding out is certainly important a myriad of other processes interact to determine the implications of increased natural resource extraction. These are discussed by Christopherson and Rightor (2011), Weber (2012, 2014), Brown (2014), Weinstein (2014), Allcott and Keniston (2015) and Feyrer et al. (2015), who are unanimous in their view that crowding out is the primary determinant of the natural resource curse at a local and regional level.

Both Weber (2014) and Brown (2014) showed net positive impact on states and counties in which SGD occurred. Weber (2014) concluded that any crowding out was minimal, and that indeed each mining job had created at least one non-mining job. Weinstein (2014), however, argued that merely demonstrating short-term or even medium-term positive net impacts is insufficient to make the natural resource curse implausible; to do so one would need to show that an economy was left in an overall better position following a natural resource extraction cycle than in the counterfactual case without it. Her results from the US, that shale gas based gains in employment and wages become incrementally smaller over time, lead her to question its long term economic implications.

Allcott and Keniston (2015) analysed the employment and wage effects of SGD at a county level in the US and concluded that these effects tended to vary directly with manufacturing rather than crowding it out. They argue that, "... while Dutch Disease is theoretically possible and wages do rise, our results clearly reject the idea of Dutch Disease within the United States, except for within a more narrowly-defined subset of manufacturing plants." (Allcott and Keniston, 2015: 32). However, when they extend their analysis to the oil boom of the 1970s a greater degree of conservatism emerges. The economic distortions induced by an expanding mineral sector can be amplified by conditions in the labour market. Allcott and Keniston (2015) concluded that contractions in tradable sectors are likely to be worsened by inflexible labour markets. Similarly, though focussing specifically on labour migration, Brown (2014) suggests that the natural resource curse is more likely to occur where geographical labour mobility is restricted, while Christopherson and Rightor (2011) note the risks it poses to specific sectors, such as agriculture and tourism, require reliable low cost employees. Fleming and Measham (2015) also found some evidence, although it is statistically not strong, of crowding out of the agricultural sector for coal bed methane development in Australia. So while the literature does not generally appear to support the idea that crowding out is necessarily at work in SGD, there are good reasons for caution.

Previous work on the subject of managing the risk of crowding out advocates a focus on local labour markets and associated skills development (Christopherson and Rightor, 2011). Mitigation can also be closely aligned with measures to smooth boom and bust cycles and discourage gas production patterns driven by the prospect of short-term gains. Christopherson and Rightor (2011) emphasise that the likelihood of sustained gains increases if SGD occurs at a measured pace and at a manageable scale. This allows for better municipal and business planning along with skills development and environmental monitoring of key risks.

10.2.2.2 Assessment of impacts per scenario

10.2.2.2.1 Opportunities

In the absence of detailed information on the extent of shale gas, this analysis will be scenario based. Scenario 0 is the 'Reference Case' which simply maintains the local and regional economic status quo. Scenario 1 (Exploration Only) describes shale gas exploration alone. This commences with one year of seismic exploration followed by five to ten years of exploratory drilling. Small scale production (scenario 2, 'Small Gas') is based on a total recoverable resource of 5 tcf. This would entail the use of three drilling rigs in the region and the establishment of a 1 000 MW power plant. Large scale production (scenario 3, 'Big Gas') assumes a total recoverable resource 20 tcf resource with 20 drilling rigs in the region and the establishment of two 2 000 MW power plants. A GTL plant would also be established but probably at the coast; its impacts on the local and regional economies would therefore be limited.

While estimating the jobs created under each scenario is difficult, predicting the proportion of these accruing to the local unemployed is even more so, requiring a clear understanding of regional worker availability per skill level. The Karoo is an area in which skilled labour is relatively scarce. It is likely that the jobs suiting the average unemployed Karoo resident would be restricted to unskilled and semi-skilled positions such as truck drivers and maintenance workers. However, local participation could increase as the industry matures and local skills levels rise¹². For the purposes of tentative estimation, we have assumed that initially between 15% and 35% of direct jobs would go to residents of the region¹³.

The likely initial direct operational employment opportunities associated with the SGD scenarios are summarised in the Table 10.2 below¹⁴. Seismic exploration would require between 500 and 750 employees for one year, 20% of whom are likely to be from the region given the highly technical nature of the work. Note that this does not necessarily imply that the remaining jobs would be newly created at a national level. Some would go to foreigners and to those already employed within the firms pursuing SGD. Exploration drilling would then last for five to ten years during which time up to 520 employees may be required, 80 to 120 of whom should come from the region. Small scale production would build to 340 staff for drilling and trucking with an additional ~80 jobs in power plant operations by 2050. Initially between 60 and 145 of all these employees should come from the

¹² A similar pattern applies to, for example, the renewable energy industry.

¹³ MSETC (2011) found that 70% - 80% of employees came from outside Pennsylvania in the early stages of the development of the Marcellus shale play with substantially less reliance on outside workers possible over time.

¹⁴ Note that additional temporary jobs would also be created primarily through the construction of (mostly gravel) access roads, wellpads, pipelines and worker camps.

region. Large scale production would build to 2 275 staff for drilling and trucking with an additional 300 people being required to operate the power plants by 2050. Initially between 390 and 900 of all these operational employees could come from the region.

Table 10.2: Preliminary estimate of direct operational employment per SGD scenario.

	Seismic exploration	Exploration and appraisal drilling	Small-scale production ('Small Gas')	Large-scale production ('Big Gas')
Size or recoverable reserve (tcf)	N/A	1	5	20
Use of gas resource	N/A	Potential movable modular power plants (1-2 MW each)	One 1 000 MW combined cycle gas turbine (CCGT) power station in the study area	Two 2 000 MW CCGT power stations in the study area and a 65 000 bpd GTL plant at the coast
Duration of activity (years)	1	5 to 10	35 minimum	35 minimum
Number of rigs/areas	5	5	3	20
Jobs per rig/area	100 to 150	100	100	100
Exploration and drilling jobs*	500 to 750	500	300	2 000
Transport/trucking jobs**	N/A	20	40	275
Power station jobs (by 2050)***	0	0	80	300
Total eventual jobs (regardless of where employees are from)	500 to 750	520	420	2 575
Initial percentage of employees from within the study area	20%	15% to 35%	15% to 35%	15% to 35%
Initial number of employees from within the study area	100 to 150	80 to 180	60 to 145	390 to 900

* Total exploration and drilling jobs were sourced from Burns et al. (2016).

** Transport/trucking jobs based on truck trip numbers in Burns et al. (2016) (these are substantially greater for the Big Gas scenario given the larger number of wells), assuming two drivers per truck and two return trips per eight-hour shift.

*** Power station jobs based on current jobs at larger Eskom power stations which are gas-fired or could be gas-fired such as Ankerlig and Gourikwa.

Table 10.3 below provides a comparison of SGD impacts to those associated with the agriculture and tourism sectors in the study area (where data was available from the relevant specialist assessments on these sectors) and with the 14 renewable energy projects in the study areas that have been awarded preferred bidder status¹⁵. This provides some broad context for potential impacts and shows that, for example, the Small Gas scenario for SGD should result in roughly half the direct jobs expected from the currently approved renewable energy projects while the Big Gas scenario should exceed these jobs by a factor of at least three.

¹⁵ List of project provided by the CSIR.

Table 10.3: Preliminary estimate of direct operational employment per SGD scenario.

Sector or project	Direct operational jobs for people within the study area	Broad indicators of economic value within the study area
Agriculture*	Not estimated in the Agricultural Specialist Assessment	Total Gross Farm Income (GFI) of R 5.006 billion/yr. Contribution of activities directly related to hunting equalling R 189 million/yr
Tourism*	10 100 to 16 400 jobs	R 2.3 billion/yr to R 2.7 billion/yr contribution to annual study area GVA
SGD	Initially 60 to 145 for the Small Gas scenario or 390 to 900 for the Big Gas scenario	R 3.5 billion/yr to R 7 billion/yr turnover for the Small Gas scenario or R 14 billion/yr to R 28 billion/yr turnover for the Big Gas scenario
Renewable energy projects**	Initially 115 to 270 assuming that the portion of jobs that go to local residents is same as for SGD	R 3.75 billion/yr to R 4.75 billion/yr turnover

* Sourced from respective specialist assessment where available (Oettle et al., 2016 and Toerien et al., 2016).

** Jobs estimates based on capacity (totalling 1 500 MW) of 14 preferred bidders/projects approved for the study area under the REIPPPP multiplied by jobs/MW averages for wind and solar power projects contained in the 'Green Jobs' report (Maia et al., 2011). Turnover estimates based on capacity per project multiplied by capacity factors for wind and solar published by NERSA and by contract prices per bidding round published by DoE.

Indirect and induced impacts would also flow from expenditure by shale gas developers and their employees in the region. Existing firms would benefit from gas sector workers' buying power, and new businesses such as convenience stores would probably be established if demand rose. The modelling options commonly used for their estimation, such as I-O models, are not satisfactory for reasons already outlined. Their modelling and estimation is also beyond the scope of this scientific assessment and not a pre-requisite for the generation of management and mitigation options. Based on *ex-post* job multiplier evidence from the US, it should not become a foregone conclusion that indirect and induced impacts in terms of jobs within the region would reach the same level as direct impacts. Note that the comparative scale and complexity of production is also a key issue here. In the US there is a large and well established oil and gas services sector which tends to support higher multipliers. It stands to reason that similar results should only be expected in South Africa if a viable local industry emerges over time. This would represent a potentially substantial opportunity dependent on factors such as the willingness of industry players to foster local enterprise development, entrepreneurial responses and the formation of clusters that expand value-chains.

The regional economy would also benefit from the diversification associated with the introduction of a new industry. This should increase its overall resilience in the event of external shocks to the existing sectors that drive the economy such as agriculture and tourism. Opportunities in this regard would be more pronounced for the Big Gas scenario relative to the Small Gas scenario.

10.2.2.2.2 Risk of crowding out, boom and bust cycles

Under the Small Gas scenario, the low to moderate level of activity and associated demand for workers and other inputs would limit the risk of localised rises in input prices. Large scale production would result in moderate to high levels of activity and demand which would increase the risk of localised input price rises. It is not, however, possible at this stage to predict confidently whether these would in fact occur and to what degree much less to predict whether they would be severe enough to crowd out other sectors. The evidence from the US indicates relatively limited risks or at least no clear evidence of serious problems in this regard.

At the level of principle, the risks in the Karoo are likely to be similarly low, albeit for different reasons. The first is that local enterprises are unlikely to be ‘crowded out’. That is to say, the prices of inputs including labour, interest rates, fuel prices etc., are unlikely to increase. There is extensive local unemployment of land and labour, and local enterprises use little of the physical capital required by the gas industry. The exception to this is water, a resource in short supply in the Karoo, and one that constrains the operations of farmers in the area. An important proviso is therefore that SGD does not seriously compete with local water users, or pollute local supplies. With regard to water availability in the US, Wang and Krupnick (2013) point out that there has generally been adequate water for SGD, but that in some areas water shortages are a growing concern.

In labour markets, the national agricultural minimum wage is generally above the local Karoo market clearing wage. Exploration or small scale production is therefore unlikely to impact on local workers’ wages. The Big Gas scenario may introduce limited upward pressure on local wages. In capital markets crowding out is precluded by institutional factors. South Africa’s interest rates are set as a policy instrument in Pretoria and are effectively unrelated to local conditions of money demand and supply in the Karoo. It is also worth bearing in mind that gas extraction and associated activity should be spread over a relatively long period of time (e.g. the power stations would only be established by 2050) giving time for other sectors to adjust.

With the exception of water, the points raised above relate to changes in relative prices that might advantage one sector over another. These ‘pecuniary externalities’ are characteristics of a market economy and even if they existed would not necessarily be signs of market failure. Physical

externalities, in which an industry imposes technical or physical costs on others, are a more serious problem. Their assessment and recommendations for their mitigation are the responsibility of much of the other specialist studies forming part of this scientific assessment (see assessment of risks on water resources (Hobbs et al., 2016), ecology (Holness et al., 2016), visual quality (Oberholzer et al., 2016), noise (Wade et al., 2016), air pollution (Winkler et al., 2016), agriculture (Oettle et al., 2016), tourism (Toerien et al., 2016), and infrastructure (Van Huyssteen et al., 2016)). Whether these externalities would be sufficient post mitigation to adversely impact the commerce of the central Karoo would clearly depend on their likely severity.

With regard to the potential for boom and bust cycles, the Small Gas scenario would entail minimal risks regionally and locally particularly as this scenario assumes that power generation would be the only use of the gas produced and is likely to be associated with a long term contractual arrangement ensuring a relatively steady demand. The Big Gas scenario may bring slightly higher risks since roughly half of the gas produced would go to a GTL plant (with the rest being used for power generation). Risks are only likely, however, in the absence of longer term contract for local gas to supply the GTL plant, which is considered unlikely, and if local gas prices consistently exceed those for gas that could be shipped to the GTL plant.

10.2.2.3 Options for mitigation or benefit enhancement

An important objective should be the maximisation of the local and regional benefits associated with gas extraction. Procurement processes, hiring and training of staff and local socio-economic development initiatives/projects should act as a departure points in this regard. Key focus areas should include:

1. Targets for use of local labour should be based on the needs of the applicant, the availability of existing skills, and numbers of suitable persons willing to undergo training. Worker training in local communities should be encouraged.
2. Local sub-contractors and suppliers should be used where possible and those from outside the study area that tender for work should also be required to meet targets for how many locals are given employment. Enterprise development at a local level should also be required particularly for less technical service requirements such as catering, laundry, transport, etc. Local supplier databases would be valuable in identifying potential suppliers and service providers to SGD.
3. Mechanisms to facilitate local and regional project ownership or shareholding should be explored whilst also taking the interests of existing shareholders in development companies into account.

4. Applicable empowerment targets should apply to ownership/shareholding, employment and procurement as per national legislation.
5. Developers should be required to enhance local community benefits with a focus on well-conceived socio-economic development projects that are clearly aligned with local needs as outlined in the Integrated Development Plans (IDPs) of local municipalities.

The process of devising specific requirements to govern local and regional benefit enhancement by developers should use existing Department of Mineral Resources (DMR) Social and Labour Plan (SLP) requirements which apply to the mining industry as a starting point. The mandatory requirements which apply to energy project developers under the DoE's IPP Procurement Programme should also be used for guidance as they are arguably superior to SLP requirements in some respects. These requirements set minimum requirements and target levels for such issues as local ownership, employment, procurement, enterprise development, socio-economic development contributions. The process of deciding on appropriate benefit enhancement measures should be as transparent and collaborative as possible involving local communities and municipalities.

There would be limited scope for mitigating the impacts of localised price rises should they arise albeit this is not considered particularly likely. Neither gas developers nor the authorities have the tools to exert much control over the prices of inputs not that such control would necessarily be desirable in a market economy. Among other potentials for distortion, fairness is likely to become an issue. For example, it would be difficult to ensure that wages in the agricultural sector remain low without infringing on the rights of agricultural workers whilst favouring farm owners.

If large scale production were to begin, mitigating the impacts of any potential collapse in gas prices would be particularly challenging. These would be associated with significant withdrawals of spending and employee layoffs. For employees, as in the case of the mining industry, some relief should come from focused programmes to re-skill workers for the time when development activity either decreases substantially or stops altogether. These are, however, likely to only really be effective if contractions in the industry can be anticipated far enough in advance; a difficult task for SGD based on experience in the US. Minimising impacts on suppliers and sub-contractors should focus on notifying them as soon as it is clear that purchases from them are like to decrease or cease altogether. This would not soften the blow of losing an income stream, but would at least allow for some level of planning which could be particularly important for smaller suppliers.

10.2.3 Environmental costs and public finances

10.2.3.1 Description of the impact

SGD has the potential to result in externalities which local and regional authorities and especially municipalities will be expected to deal with. Among others, these include strain on road, water, and other infrastructure. In common with other extractive industries, the eventual finite nature of the resource extraction process and the potential for boom and bust cycles to materialise in sparsely populated areas are key drivers in this regard. Unless carefully managed, externalities have the potential to pose significant budgetary challenges to local authorities and public finance in general. The nature of these challenges along with management solutions worth investigating further are the subject of this section. A more extensive review of the nature of externality risks to local municipalities are being covered in other specialist studies especially the study dealing with Impacts on Land, Infrastructure and Settlement Development (Van Huyssteen et al., 2016).

10.2.3.2 Assessment of impacts per scenario

High intensity localised activities such as SGD often do not necessarily live up to their promise of high levels of local benefits (see Section 10.2.2 for further discussion). There can, however, be substantive local benefits with proper planning based on a thorough understanding of the revenue and income distributional character of the shale gas industry (Christopherson & Righthor, 2011). In the case of South Africa, local areas with no previous oil and gas industry experience could face significant inflows of capital (in its different forms) followed by outflows until infrastructure demands and skills requirements are settled. Some towns are likely to experience booms under the Big Gas scenario which could push up the prices of retail services, housing and rentals (Weinstein, 2014). There is also a risk that locals may leave or be displaced by workers from outside local areas. It is not anticipated that the core towns where most of the SGD could be concentrated will have numerous workers with the high and medium level skills required by the new industry at least initially. These will have to be brought in thereby increasing demands on housing and other services. Since much of this workforce would not be permanent, they could introduce a hollowing out effect on towns during a bust period or once SGD ceases. Some shale workers may well stay but those with highly specialised skills are more likely to leave.

There are essentially three key challenges for municipalities: not to overspend and be burdened with stranded infrastructure, being able to smooth out their revenue streams through a boom and bust cycle and finally, ensuring financial sustainability after SGD. They will have to gain experience and understanding of the industry relatively rapidly to overcome these challenges. Eventual impacts will also depend a great deal on the fiscal framework under which a local authority operates. In South

Africa this framework is constrained for municipalities so localised benefits from shale gas can be limited if most revenues flow back into the national coffers and insufficient allocations are made to the impacted authority that has to bear the costs of the full SGD and production cycle.

Towns can grow rapidly and suddenly find themselves having to make additional allocations for infrastructure and the provision of social services that are hard to anticipate as they are linked to the uncertain pace of SGD. Municipalities in any case cannot raise special taxes and levies without national approval. South Africa's municipal finances have some level of decentralisation but are severely restricted by the provisions of the Municipal Finances Management Act (MFMA). A review of the Auditor General reports on the state of finances in many of the areas in which SGD is to be undertaken does not paint a pretty picture¹⁶. They describe a situation of limited revenue creation options, persistent lack of clean audits and the general incapacity to account for properly or demonstrate that funds received can be well managed. Municipalities falling under the Northern and Eastern Cape tended to do less well versus those in the Western Cape. Poorly functioning municipalities with little prospect of viable future revenues streams due to demographics and other reasons are likely to struggle to perform the planning, impact management and controls needed for traffic, waste disposal and other stakeholder concerns. The Auditor General reports also shows that even in well-resourced municipalities issues of accountability, discipline and performance management hamper the smooth running of municipal affairs.

The South African situation contrasts with that of the US where local and state authorities have significantly more scope to raise their own revenues from SGD. Additional revenue comes from severance taxes (a form of production/exploitation tax), impact fees and sales tax to cover expanded fiscal demands, they can additionally request companies to raise road haulage bonds and other measures to deal with any damage that may arise due to SGD. Even with revenue raising options in place, fiscal balancing requires astute forecasting as there is usually a lag between costs that need to be incurred and revenues that can be generated once the industry gets off the ground. Predicting peak and decline phases is challenging and something of an art. Potential difficulties in this regard are highlighted by vigorous and ongoing debates in the US regarding the best revenue raising options and their optimal structuring (e.g. linked to production amounts, well numbers or both).

It is likely that municipalities will face significant stress and friction as SGD expands particularly under the Big Gas scenario. The areas where externality effects are particularly likely to stretch their human and financial resources include the following:

¹⁶ See Auditor General report for 2013 and 2014 at:
<http://www.agsa.co.za/Documents/Auditreports/MFMA20132014.aspx>

- In the early phases of production, municipalities will require additional human and financial resources to accommodate for environmental and other approvals and management needed as exploration and drilling picks up. They may well have to recruit from outside the local workforce to attract the required expertise. Additional capacity needs are likely to emerge in environmental risk management, town planning and zoning and inspectorate. Other additional administrative and staff expansion is also anticipated for policing, public health care, teachers, and emergency services. Furthermore, the attractive salaries generally offered in the oil and gas industry could lead to the loss of municipal staff as they seek more lucrative careers in the shale gas industry. This could increase the wage bill for municipalities if they want to retain or attract the best staff or skills from a very narrow pool of expertise (Christopherson & Rightor, 2011)¹⁷.
- Municipalities are likely to have to face a major challenge from road haulage as trucks and other vehicles are needed to take equipment, gas (if there are no pipelines) and waste water for disposal. Distinctions must be made between drill site access roads which will be built and maintained by developers versus public roads. Experience elsewhere shows that the costs of road infrastructure damage accrue mostly to local and regional authorities and tend to grow as a recurrent expenditure on already tight municipal budgets. For example, Newell and Rhami (2015) found that road damage costs reached around \$ 1 million/mile in some US locations. They also refer to studies that show that road management and repair can be the largest expenditure item on the budget of local municipalities in shale areas. Bear in mind that road infrastructure is a non-exclusive good and unrepaired roads or congestion can impact on other economic activity.
- SGD will increase the demand for water and sewerage services. While some of this expansion is for human needs the rest may well be for dealing with waste water from the fracked wells. Since water from shale gas is a specially declared use under South African law, it has to be disposed of properly either permanently, for purposes of treatment or through recycling. Significant uncertainty surrounds the infrastructure required to manage temporary and long-term waste water disposal or storage in the Karoo. A key question is whether the approach that will need to be taken is a centralised infrastructure model or a decentralised system. These details have to be worked out.
- A further area of concern is dealing with the long-term externality problems associated with abandoned or decommissioned wells. These sites need constant monitoring and will require rehabilitation as well casings and ceilings wear and tear over time. In some instances in the US, long after oil and gas production has been completed, the liability of dealing with gas or

¹⁷ Some case studies based on the US experience show staff salary costs going up by 30-40%.

polluted water leakages from abandoned wells has become the responsibility of the local authority (Fakir, 2015). Generally, provisions for rehabilitation and closure tend to be inadequate either because the assessment of how much is needed is not done properly or the funds have not been adequately ring-fenced and securely managed (Ingraffea et al., 2014). It is important that this crucial aspect be investigated more closely including whether a special provisions model should be developed for SGD within the existing legal framework that has been established by the National Department of Environmental Affairs (DEA). A wealth of experience regarding the pitfalls associated with making financial provisions for mine closure is also available to learn from (for example, see Van Zyl et al. (2012) and court actions undertaken by the Centre for Environmental Rights in this regard).

10.2.3.3 Options for mitigation

The growth in SGD will require impacted local authorities to have increased budgets to meet various demands described above. The exact size of budgetary expansion required will have to be determined. In early phases, staff from other municipalities and even secondments from other countries that have extensive shale gas experience should be considered.

Dealing with road damage will require municipalities to consider special policies and measures such as a levy for road haulage. We recommend that the example of road haulage effects of coal transport to Eskom power plants will be a useful starting point if a model of externality costs is to be developed for shale gas impacts. Local authorities could, for example, consider a haulage bond for each operator or a special road haulage levy. The details of such a scheme will need to be investigated further as much depends on the haulage routes chosen and whether it takes place within a specific target municipality or within the jurisdiction of another local authority or province. Such an investigation will have to take into account scale of impact, revenue stream model and damage mitigation options. If road haulage damage impacts a number of jurisdiction, close co-operation between different municipalities and provincial authorities will have to be established to ensure fair and equitable cost and revenue sharing.

It is recommended that the cost of disposal and treatment of waste water be a private cost rather than a public cost as some of this water will have to be treated potentially for re-use in fracking. Municipalities can then focus on residential and commercial water and sewerage needs. In addition, they will have to increase their capacity to deal with the transport, treatment and disposal of hazardous waste water. These will require both onsite and off-site monitoring and assessment by specialists and inspectorate within the municipalities. Early learning and adoption of administrative and management

approaches to dealing with waste water from fracking will have to be facilitated by national and provincial government (Rahm et al., 2013).

Well abandonment or decommissioning is likely to create long-term externality challenges as well as casings; plugs and valves go through a natural wear and tear process. While there is existing mining-focused legislation that enables financial provisions to be set aside for exactly this eventuality, the South African experience in mining shows that funds are too often insufficient and/or not properly secured. Similar experience can be found in other countries such as the US for mining and fracking. We recommend that this be investigated further and an adequate financing and fund review model for abandoned or decommissioned wells be put in place – possibly done jointly by DEA, DMR, DoE and National Treasury and using the amended regulations for financial provisions in mining as a departure point. It will be particularly important that sound mechanisms are put in place to deal with all potential long-term legacy (i.e. latent and residual) risks including those which may remain beyond the ten year period post-closure for which financial provisions must be made in mining. This could, for example, include considering the potential role for industry-wide financial mechanisms that allow for the pooling of risks among producers in order to protect water resources drawing on lessons from the mining industry. A future SGD industry would have the rare opportunity to learn from mining and put such mechanisms in place from the start thereby enhancing the chances of achieving sustainability goals.

It is likely that the One Environmental System (OES) that has been instituted under new National Environmental Management Act (NEMA), Mineral and Petroleum Resources Development Act (MPRDA) and National Water Act (NWA) amendments, will also be applicable to shale gas although the status of the OES is yet to be finalised. The OES attempts to streamline and fast track the environmental authorisation processes so that companies can simultaneously apply for environmental authorisations, mining rights and water rights. Under the OES, the environmental management function will remain with the DMR but will be governed under NEMA (amended in November 2015) and not the MPRDA. The DMR will therefore assess applications based on NEMA and associated regulation and DEA will be the appeal authority with the power to prospectively prohibit and restrict the granting of environmental authorisations.

With specific reference to the new financial provisioning requirements, they are more onerous on companies who are required to be fully compliant with the new legislation by February 2017. They require companies to submit three closure plans (previously two were needed) as follows: (1) An 'on-going rehabilitation plan' which relates to regular activities during the life of mine; (2) a final rehabilitation plan with rehabilitation details and specifying use of land after closure; and (3) a post

closure plan focusing on potentially indefinite post-closure ‘latent and residual’ environmental impacts recognising that mine liability can continue indefinitely particularly where water treatment is involved.

The new regulations require companies to provide comprehensive itemisation of all the costs associated with annual and final rehabilitation, decommissioning and closure as well as the costs associated with remediating long-term latent or residual impacts (i.e. impacts that may only become visible in the future with a particular emphasis on potential water related threats). A permit or right holder or applicant must calculate and make provision for the availability of sufficient rehabilitation and closure funds, which the DMR Minister must approve. Importantly the regulations specify that, at any point, the funds available for **latent and residual effects** must be able to cover the actual costs of implementation for at least ten years after closure. Financial provisions can be made through a financial guarantee, a deposit to a specific account administered by the DMR Minister or a combination of both. A trust fund can only be used for the purposes of financial provisions for residual or latent impacts subject to conditions set out in the Act. This marks a change from previous regulation which allowed for a trust to be used for other impacts. The regulations prohibit the deference of “provisioning liability to assets at the mine closure or the mine infrastructure salvage value” and require the verification of registration of a financial institution in the case of a guarantee. In the case of residual or latent impacts, provisions must be ceded to the DMR Minister once a closure certificate has been issued. Companies are further required to review, assess and adjust all financial provisions and the assessment must be audited by an independent auditor. Furthermore, Environmental Management Plans (EMPs) are required to be publically accessible. Companies can be placed under care and maintenance subject to specific requirements and Ministerial approval but cannot operate under care and maintenance for more than five years. Finally, strict liability is imposed for non-compliance. Companies can be fined up to R10 million or their directors can be imprisoned for up to ten years or both.

10.2.4 Impacts on property values

10.2.4.1 Description of the impact

Property values are driven by fundamentals, some of which may be influenced by SGD, typically including both bio-physical and social effects (e.g. visual impacts, increased noise, and water pollution risk). Values can also be influenced by expectations based on incomplete or incorrect information and by stigma especially in the short and medium-term. The latter is defined by the US Appraisal Institute as “an adverse public perception about a property that is intangible or not directly quantifiable”. It tends to emerge particularly when new, unknown, land uses or activities are proposed

that are perceived to be risky or incompatible with the status quo in some way. In most cases it is not possible or very difficult to determine what proportion of negative market responses should be attributed to stigma and what proportion to the real possibility of adverse externalities. The results of research conducted in other countries on the impacts of SGD on property values is a useful point of departure in understanding likely impacts. This research is reviewed in the following section before proceeding with assessment and identification or mitigation measures.

10.2.4.1.1 Review of the literature on the impacts of fracking on property values

In North America, SGD has often occurred in both sparsely and comparatively densely settled areas with the latter typically experiencing more regular property transactions. Assessments of these sales which tend to be more residential in nature have demonstrated varied outcomes for property values. Wright and Vann (2010) conducted a study using a few different techniques to determine the impact of SGD on residential property values in Flower Mound, Texas. Using the sales comparison method, they found that houses immediately adjacent to well sites with a value greater than \$250,000 could experience a drop in value of between 3% and 14%. This drop was not recorded for houses which were separated from the well site by a buffer, such as trees or structures. Applying price-distance relationship, they estimated that the range of property value decline resulting from the presence of nearby well sites was between 2% and 7%, and that this effect dissipated beyond a distance of 300 to 460 m from well sites. When the authors subjected their findings to statistical analysis they were unable to demonstrate whether well site proximity had a significant impact on property values. This does not imply the absence of impacts, but it is noted that if these were “significant and sizeable” then the analysis should have detected them (Wright and Vann, 2010: 9). Finally, residential estate agents were interviewed all of whom mentioned difficulty in marketing houses whilst drilling rigs were in place but not thereafter. Estate agent interviewees also indicated that, on the whole, market participants tended to over-estimate the impacts of gas wells.

Gopalakrishnan and Klaiber (2013) used a hedonic regression model to quantify the impact of SGD on property values in Washington County, Pennsylvania between 2008 and mid-2010. Their focus was expressly on the period between permitting and commencement of drilling (typically six months), since this is the period when both actual impacts from drilling (noise, visual, etc.) and stigma related impacts (such as media coverage) were greatest. Using a sample size of 3 646 residential houses, they found impacts to be negative and significant, particularly where households were reliant on groundwater, close to major highways and where agriculture was the dominant surrounding land-use. The values of houses that relied on groundwater and were located within 0.75 miles of an active well site decreased by 21.7% with discounts dropping rapidly to 5.6% at a 1 mile distance. It was

suggested that this was probably because the results included value gains to property owners from potential royalties (Gopalakrishnan and Klaiber, 2013).

Kelsey et al. (2012) analysed changes in the values of properties throughout Pennsylvania between 2007 and 2009, using data from the Pennsylvania State Tax Equalisation Board. The period covers the earliest years of development of the Marcellus shale play. This is important to note for two reasons. The period does not cover the most significant period for Marcellus SGD, but given that it does cover an early period it is likely that changes in value reflect the initially high levels of stigma and impacts associated with permitting and drilling. The study's approach is less nuanced than that of hedonic studies and its units of analysis are the county and the municipality. It found that counties which were host to more than 90 wells saw an increase in average property values of 13.8% between 2007 and 2009. Increases in value thus exceeded any negative localised impacts which might have been felt. The authors advocate considering impacts on a case-by case basis, pointing out that a lack of evidence for significant changes to property values in aggregated datasets should not detract from the fact that for certain individual property owners, SGD has had very real impacts, "with direct implications for their economic well-being" (Kelsey et al., 2012: 2).

In a particularly thorough and wide-ranging hedonic study, Muehlenbachs et al. (2015) measured changes in property values throughout Pennsylvania between 1995 and mid-2012. GIS tools were used to establish the number of wells within view of a house at the time of each sale. This provided the authors with a sample of 229 946 residential properties in the vicinity of at least one of 6 260 wellbores (3 167 wellpads) at some point in time during the 16 year period. Results were similar to the Gopalakrishnan and Klaiber (2013) study in that value reductions were found for groundwater-dependent households within a 1 to 1.5 km distance of wellpads. The authors report this reduction to be large and significant, ranging from 9.9% to 16.5%. They note that "although data are not available to measure the impact of actual groundwater contamination, the perception of these risks is large, causing important, negative impacts on groundwater dependent properties near wells." (Muehlenbachs et al., 2015: 29). On the other hand, properties situated in close proximity to wells enjoyed value increases if the households had access to piped water (as opposed to groundwater). The authors suggest that this was due to the expectation that the value of future royalties from these properties would exceed risks. Note also that increases in property values only occurred for properties which were sold more than a year after adjacent wells had been drilled (i.e. after the most significant impacts, from permitting and drilling, had passed) and in cases where wells were not visible from the property. This suggest the possibility that positive impacts from royalty payments do not outweigh the negative impacts of being located near a well in a number of cases (Muehlenbachs et al., 2015). It also

further highlights that impacts and the balance between risks and benefits are most often highly case specific and linked to royalty payments levels.

10.2.4.2 Assessment of impacts per scenario

Impacts on property values should be driven by the real and perceived balance between negative and positive externalities in the presence of any mitigation or compensation measures. The studies reviewed above provide a good basis for understanding the plausible impacts of SGD on property values in the study area. Additional pointers are available in the other specialist studies forming part of the scientific assessment process. Impact findings from most of these studies have potential relevance to property values to the extent that property market participants take them into account in their buying and selling decisions. With this in mind, they have all been broadly considered when assessing risks to property values. Impacts on agricultural potential and, increasingly, the potential for land to remain attractive for those buyers focused on tourism and leisure uses would be key drivers. The following key points from the assessments of visual (Oberholzer et al., 2016) and noise impacts (Wade et al., 2016) also offer examples of findings which assisted in the assessment of overall risks to property values:

- The Visual Chapter (Oberholzer et al., 2016) concludes that SGD activities could affect property values. It notes that wellpads with drilling rigs on them would be dominant in views up to about 1 km during the day-time. It stands to reason that visual risks to property values would be greatest particularly when farmsteads, settlements or other sensitive receptors are located within this distance. Oberholzer et al. (2016) also find that beyond a distance of 2.5 km; rigs would entail a low visual risk to human settlements, private game reserves, game farms and tourist accommodations implying low risks to their property value. Note that at night, the visibility of lights and flares would tend to be visible over greater distances in a dark rural landscape. With respect to the development scenarios, Oberholzer et al. (2016) highlight the risks associated with the Big Gas scenario, which would entail a larger number and higher density of wellpads, infrastructure and related activity and may result in an industrialised landscape. The importance of project-level investigations at Environmental Impact Assessment (EIA) stage to determine specific setbacks and exclusion zones is also emphasised.
- The Noise Chapter (Wade et al., 2016) points out that noise levels in the Karoo are generally far below the typical levels for rural areas in South Africa. This should accentuate the risks to property values from the noise associated with SGD relative to other areas. These risks are likely to be variable and highly dependent on the presence of sensitive receptors especially

nearby wellpads and roads¹⁸. Wade et al. (2016) allude to the potential for variability and emphasises the importance of project-levels investigations at EIA stage to determine mitigation required in order to meet noise standards including potential setbacks from areas of human habitation.

The issue of stigma is likely to remain complex. Perceptions that SGD in the study area would cause unacceptable changes with limited benefits are arguably widespread. These perceptions have been realised in landowner/community mobilisations against fracking. Perceptions of high risk levels thus seem to be common and pronounced in many cases making it likely that stigma would contribute to property values risks especially for the Big Gas scenario.

Plausible negative externalities in urban areas are more likely to be driven by the increased presence of trucks, the potential for the emergence of social ills and strain on municipal services. Despite these issues, there would remain a strongly likelihood that property values in towns would increase. Such a rise could result from increased commercial activity, higher incomes and in-migration driving up property demand. It would endure to the extent that SGD activity continues and would reverse to the degree that activity reduces or ceases. This would correlate with experiences in other smaller towns in South Africa that have experienced significant increases in commercial activity from major new developments (for example, Kathu near the Sishen iron ore mine, and Lephalale near the Medupi Power Station). It would also be in keeping with what happened in the US. For example, Ward (2014) found that property values went up in the towns within Tioga County, Pennsylvania. This benefited property owners, but comes at the detriment of renters who tend to be from lower income groups.

An important determining factor with respect to property value risks would be the potential for mitigation of impacts on landowners including through compensation. Here the contrast with the situation in the US is instructive where property owners (i.e. holders of surface rights) commonly also own sub-surface mineral rights. This allows them to negotiate often highly significant royalty payments from SGD companies. For example, in 2014, six major US shale plays produced oil and gas valued at \$ 213 billion, of which, \$ 39 billion was paid out to property owners as royalties. Royalty rates were found to vary substantially across plays, from a low of 13.2% in the Marcellus play to a high of 21.2% in the Permian, and with a countrywide average of 18%. Note also that these amounts accruing to private landowners were more than four times the royalty income received by the Federal government in the same year (Brown, 2015). Since 2002, South African landowners have not been able to extract royalties as they have had no claim to sub-surface mineral rights which were

¹⁸ Assessments of the impacts of road traffic on property values have been reviewed by Bateman et al. (2001), for example, and generally include the estimation of Noise Sensitivity Depreciation Indices (NSDIs) which trace the link between increased noise levels and property value decreases.

transferred to the state. This weakened position means that land owners now have far less to gain if SGD occurs on their land, and may have much to lose if negative externalities eventuate, a situation that is likely to reflect in property values. Compensation to landowners does, however, occur in South Africa for other similar situations discussed below and in the case of SGD in other countries such as Australia where mineral rights are also state owned (for example, see Measham et al., 2016).

10.2.4.3 Options for mitigation

The key objective of mitigation should be the minimisation of risks to landowners and their property values. Measures should include:

- The application of mitigation measures outlined in the other specialist studies contributing to the scientific assessment such as those focused on impacts on water, visual quality, noise levels, sense of place, ecology, etc. Ideally these measures should reduce risks substantially. There are, however, likely to be externalities that cannot be avoided requiring compensation payments to landowners. This should include compensation for the use of their land and any damages to it that are unavoidable and of a more predictable nature (e.g. loss of productive land, degradation of roads, and disruption of activities).
- Measures aimed at ensuring that financial provisions are made to deal with unexpected negative impacts such as spills which could impact on property owners.

Compensation payments to landowners for the use of their land during SGD would need to be guided by the principle of comfortably compensating landowners for all impacts and losses. They would need to be based on best practice and include elements for loss of land value, future income, assets or infrastructure and have a solatium element¹⁹. Measham et al. (2016) emphasise the need to establish the appropriateness and legitimacy of compensation through dialog with stakeholders. This dialogue should include agreeing on the compensation principles to be applied and, to the degree possible, fair minimum amounts or conventions/formulas for establishing compensation. They also point out the importance of not relying too heavily on compensation, in a general sense, as a way for local communities to derive benefits given its potential to create and reinforce dependencies.

Compensation levels and associated property value impacts from private sector renewable energy project provide instructive guidance in this regard particularly when compared to seemingly similar types of projects. Renewable energy projects such as wind farms have the potential to impact negatively on the value of land where they are established mainly due to visual impacts. However, anticipation of potential private renewable project developer interest generally results in value

¹⁹ A solatium is essentially a form of broadly defined compensation element for inconvenience and ‘suffering’. It is often referred to as “tranegeld” in Afrikaans (direct translation – money for tears).

increases for land within potential sites. These increases can be linked to anticipation of the payments commonly offered by developers comfortably offsetting any perceived risks. For major powerline development the opposite is often the case. They too imply risks to values for visual impact reasons but they are generally not associated with equally generous payments to landowners and therefore more commonly result in property value decreases²⁰. Establishing acceptable compensation payments to landowners for SGD that are guided by processes such as the IPP Procurement Programme is thus recommended. It is important to bear in mind that, aside from ensuring the fair treatment of landowners, compensation which goes beyond what is strictly required by law should also play an important role in facilitating the development of SGD. Interactions with land owners would be less likely to be acrimonious, reaching agreement would take less time and turning to the law to force landowners to grant access to their land is less likely to be necessary²¹. A key caveat is that none of these processes or norms currently offer a clear remedy for adjacent or nearby landowners. Under South African law, those acquiring servitudes or undertaking major developments are not required to compensate neighbouring property owners for potential value losses. This limits the potential for full compensation if neighbouring property values decrease.

With strict implementation, the mitigation measures discussed in Section 10.2.3.3 focused on ensuring adequate financial provisions for well rehabilitation and closure would also offer mitigation for landowners and insulate them from potential risks associated with the financial position of developers such as bankruptcy.

Note that even with careful mitigation and compensation; it is likely that risks associated with stigma would remain. These would be difficult to counter but could be reduced somewhat through communications and media measures that limit the formation of ill-informed perceptions regarding activities and risk levels.

10.3 Risk and opportunity assessment

The key economic risks and opportunities for each SGD scenario have been described and assessed to the degree possible in the preceding sections (given the strategic nature of the assessment). Table 10.4 below provides qualitative ratings for these risks and opportunities guided by the approach and format provided by Scholes et al. (2016). On the whole, economic opportunities at a national and local scale should reach a low or moderate significance with benefit enhancement for the Small and Big Gas

²⁰ Note that this situation; where renewable energy producers are generally welcomed by land owners while powerline developers are not; also has been observed in the US for similar reasons (Fahey, 2010).

²¹ Under the MPRDA, companies with mineral exploration or extraction rights can force land owners (i.e. surface rights holders) to grant them access to their land.

scenarios, respectively. Macro-economic risks and those affecting public finances and property owners should generally remain moderate provided mitigation and compensation mechanisms are well crafted and rigorously implemented.

Table 10.4: Assessment of economic risks and opportunities.

.Impact	Scenario	Location	Without mitigation			With mitigation		
			Consequence	Likelihood	Risk / Opportunity	Consequence	Likelihood	Risk / Opportunity
Macro-economic opportunities	Reference Case	National	N/A	N/A	N/A	N/A	N/A	N/A
	Exploration only		Slight	Likely	Low	Slight	Likely	Low
	Small Gas		Moderate	Likely	Low	Moderate	Likely	Low
	Big Gas		Substantial	Likely	Moderate	Substantial	Likely	Moderate
Macro-economic risks	Reference Case	National	N/A	N/A	N/A	N/A	N/A	N/A
	Exploration only		Slight	Likely	Low	Slight	Likely	Low
	Small Gas		Moderate	Likely	Low	Moderate	Likely	Low
	Big Gas		Substantial	Likely	Moderate	Moderate	Likely	Low
Local and regional opportunities from project ownership and spending activity	Reference Case	Local and regional	N/A	N/A	N/A	N/A	N/A	N/A
	Exploration only		Slight	Likely	Low	Slight	Likely	Low
	Small Gas		Moderate	Likely	Low	Moderate	Likely	Low
	Big Gas		Substantial	Likely	Moderate	Substantial	Likely	Moderate
Risks to public finances associated with externalities	Reference Case	Local and regional	N/A	N/A	N/A	N/A	N/A	N/A
	Exploration only		Slight	Likely	Low	Slight	Likely	Low
	Small Gas		Moderate	Likely	Moderate	Slight	Likely	Low
	Big Gas		Severe	Likely	High	Moderate	Likely	Moderate
Risks to property values in areas where drilling occurs	Reference Case	Local and regional	N/A	N/A	N/A	N/A	N/A	N/A
	Exploration only		Slight	Likely	Low	Slight	Likely	Low
	Small Gas		Moderate	Likely	Moderate	Slight	Likely	Low
	Big Gas		Severe	Likely	High	Moderate	Likely	Moderate
Opportunities for property value increases in towns within SGD regions	Reference Case	Local and regional	N/A	N/A	N/A	N/A	N/A	N/A
	Exploration only		Slight	Likely	Low	Slight	Likely	Low
	Small Gas		Slight	Likely	Low	Slight	Likely	Low
	Big Gas		Moderate	Likely	Moderate	Moderate	Likely	Moderate

10.3.1 Limits of acceptable change

The concept of limits to acceptable change is generally more applicable to physical measures for which there are established minimum standards that need to be met (e.g. air or water quality). It is a somewhat ‘rule-based’ concept and for this reason is less compatible with the principles of economic assessment which tends to allow for and encourage the consideration of all trade-offs. Nevertheless, at the level of principle, establishing that a given action is economically desirable generally requires that one can show that it is still likely to result in a net benefit to society even when all externalities are taken into account or ‘internalised’. The most effective way to achieve this is through mitigation or compensation to the point when externalities are effectively dealt with. The limit of acceptable change is then up to the point at which externalities cannot be mitigated or compensated for (this would apply equally to SGD as it does to similar extractive industries such as mining). Going beyond this point generally results in significant and pervasive risks to other sectors thereby risking the emergence of an unsustainable, under-diversified and far less robust economy.

Setting limits to change through laws, policies and other guidelines is often more straightforward when compared with implementing them successfully. Past and present environmental and associated socio-economic impacts from mining in South Africa are instructive in this regard. The industry remains a key driver of economic development and yet, if one considers the Mpumalanga coal fields among other examples, it is evident that the benefits of mining could be achieved at a substantially lower cost to the environment and society. This will be the challenge associated with the regulation of SGD and one that is unlikely to be addressed using a business-as-usual approach. An evaluation of the effectiveness of environmental governance in the mining sector commissioned by the Department of Planning Monitoring and Evaluation (DPME) bears this out. It concluded that “...in theory the environmental governance framework is appropriate for promoting good environmental governance in the mining sector. However, in practice, the inadequate implementation and enforcement of the framework seriously compromises its efficacy and ability to ensure environmental sustainability” (Genesis Analytics and Digby Wells Environmental, 2015: vii).

10.4 Best practice guidelines and monitoring requirements

For certain impacts it will be necessary to establish baseline conditions and institute ongoing monitoring in order to either understand impacts better and/or to maximise the efficacy of mitigation. This section provides recommendations in this regard and briefly outlines key best practice guidelines that should be considered most of which have already been mentioned when discussing mitigation measures.

Macro-economic impacts

The DTI along with the DoE and National Treasury should take the lead in policy relating to macro-economic benefit enhancement and risk reduction. The Industrial Policy Action Plan (IPAP) 2015/16 – 2017/18 proposes a Long Term Strategic Framework to leverage the opportunities presented by petroleum and gas resources. The DTI has also recently announced that it will be establishing a unit to manage gas industrialisation that intends replicating the success of the IPP programme unit in the DoE.

The minimisation of long-term risks is highly dependent on political decisions about the use of increased tax and other revenues originating from SGD. Best practice dictates that these need to be directed to maximising the growth potential of the economy.

Local and regional impacts from project ownership and spending

The process of devising specific requirements to govern local and regional benefit enhancement by developers should use existing SLP requirements which apply to the mining industry and requirements under the IPP Procurement Programme as a starting point. The latter have a particularly strong focus on ensuring that a defined share of proceeds flows to socio-economic development in local communities.

Successful and equitable targeting of local beneficiaries would require baseline data on aspect such as:

- The availability of skills in the study area and of people willing to be trained obtainable through the commissioning of skills audit²².
- The availability of suppliers and sub-contractors in the study area.
- Which socio-economic development projects are viewed as a priority by local municipalities and appear in their Integrated Development Plans (IDPs).

This data for specific local areas can be gathered by developers largely at EIA stage in partnership with the affected local municipalities. There is also likely to be merit in gathering this information at a course level for the entire study area again in partnership with the affected local and district municipalities and preferably with support from the DTI.

²² This should be informed by an assessment of skills needed such as that contained in the Pennsylvania Marcellus Shale Workforce Needs Assessment (MSETC, 2011).

If the IPP Procurement Programme is used as a departure point, then similar monitoring requirements and processes in terms of the achievement of targets can be used for SGD.

Environmental costs and public finances

The key guideline here would be the amended requirements associated with financial provisions for mine closure under NEMA. These have been designed to tighten regulation and have built on experience in mining that could be used as a departure point for crafting similar regulations for SGD. Determining monitoring needs should be part of the process of generating such regulations. There may also be a need for industry-wide pooling of risks in order to ensure that resources are available for large unforeseen events.

Impacts on property values

If compensation of landowners is to be linked to property values then it would be beneficial to establish a baseline of property values in areas where SGD is proposed. This could be done at the EIA stage using a professional valuer(s). It need not be highly detailed but should ensure that a record of average values in targeted areas is established. Such an exercise could tie in with and be informed by the assessment of tourism baseline data (i.e. an inventory of all private reserves, game farms, guest farms, resorts and tourist accommodation) recommended in Toerien et al. (2016).

10.5 Gaps in knowledge

From an economic perspective the key piece of missing information to allow for further consideration of virtually all of the impacts of SGD is an assessment of the size of the recoverable gas resource. The exploration process, should it go ahead, would be the only way to address this information gap.

The conflicting results from other South African studies on the macro-economic benefits of SGD raise concerns of creating unhelpful confusion and of possible overstatement. A study and/or transparent expert process focused on achieving the highest possible degree of neutrality would probably be needed before clarity emerges on this issue. Such an exercise could be repeated after some degree of activity to either prove or disprove the resource (i.e. through seismic exploration only) and once the size of the resources is known.

Not enough is known about the likely nature and magnitude of financial strain that SGD may impose on local municipalities in particular. This would need to be studied carefully and in detail as a starting point in determining mitigation in this regard. Specific areas that would benefit from further study include:

- Consideration of South African case studies to appreciate the effects of boom and bust cycles associated with the resources sector on municipal economies and fiscal positions (for example, most recently, the platinum industry around Rustenburg and iron ore mining in the Kathu area)²³.
- Identifying other international best practice methodologies for the determination of road haulage damage, pricing it and levy the industry appropriately. A key issue will be determining which road maintenance costs should be an industry cost versus a state cost on public roads. Eskom has provisions set aside in its budget to deal with coal road haulage externality costs which can act as an informant.
- Crafting and implement an effective framework for long-term rehabilitation of abandoned or decommissioned wells will be one of the most significant challenges associated with SGD. Such a framework should be informed by detailed investigations of what has worked elsewhere adapted to the South Africa context. Canada, for example, is reported to have instituted good practice using a Licensee Liability Rating Programme. The Canadian approach is to proactively generate a due diligence measure that tries to match liability creation with the capacity of firms to offset potential liability taking into account their asset bases.

Once the size of the recoverable resource is known and better information is available on risks and other aspects such as the costs associated with internalising externalities, there should be an opportunity to inform further government decision-making through Cost-benefit Analysis (CBA). Subjecting any forms of significant government support for SGD to such analysis would be particularly useful. It could be conducted in terms of the Socio-Economic Impact Assessment System (SEIAS) developed under the DPME which encourages the use of CBA as part of a wider assessment process (DPME, 2015)²⁴.

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²³ Lessons could also be learnt from the decline of gold mining in the late 1990s around Klerksdorp and Orkney in the Northwest Province.

²⁴ The SEIAS was approved by Cabinet in 2015 to replace the older Regulatory Impact Assessment (RIA) guidelines.

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