OXFORD ECONOMICS

The economic impact of liquid rich shale and shale gas exploration in Tunisia

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CONTENTS

EXECUTIVE SUMMARY

This report provides a comprehensive economic impact assessment of a shale rich liquids and shale gas resource play in Tunisia. A number of resource plays/areas are currently recognised from geological studies across Tunisia. None of these resource plays are yet proven, and all first require exploration wells to prove up play concepts, followed by important exploration well testing before being able to progress to full appraisal and eventual development. There is no guarantee of commercial success in any of the Tunisian resources plays at this time. Given the uncertainty associated with the production of such resources it was decided to use different scenarios relating to the number of resource plays that moved successfully to the development phase with an industry-typical phasing of activity. These scenarios are described in more detail below:

- **Scenario 1** – Consistent with **one generic** resource play proceeding to the development stage. It is currently estimated that such an outcome would result in the extraction of 97 mtoe (660 MMboe) of hydrocarbons.
- **Scenario 2** - Consistent with **two generic** resource plays proceeding to the development stage. It is currently estimated that such an outcome would result in the extraction of 195 mtoe (1,330 MMboe) of hydrocarbons.
- **Scenario 3** - Consistent with **four generic** resource plays proceeding to the development stage. It is currently estimated that such an outcome would result in the extraction of 389 mtoe (2,650 MMboe) of hydrocarbons.

As part of this study, we have collaborated with a range of Tunisian experts who have assisted us in data collection and refining our methodological approach. We would like to take this opportunity to extend our thanks to these individuals whose support has helped to enrich our analysis. The key results from the study are summarised below.

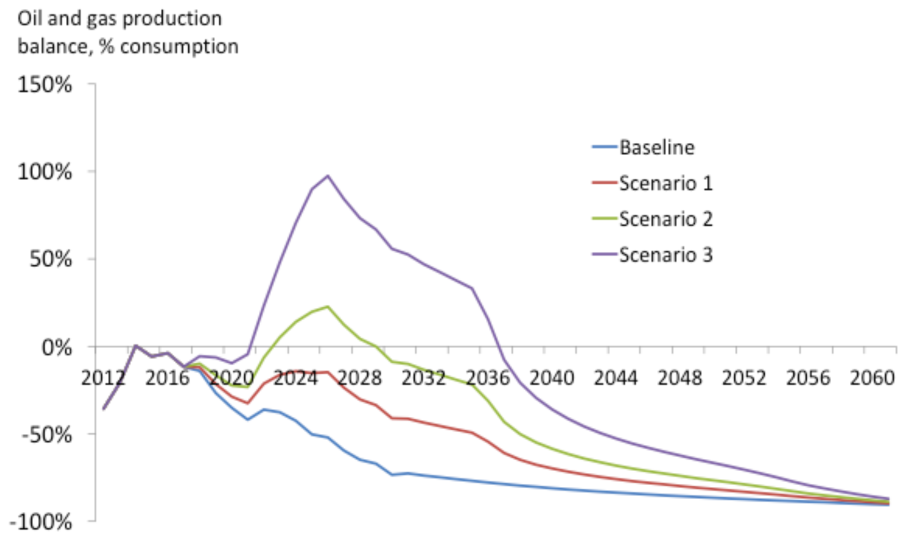
Enormous production potential...

- Current projections suggest that potential reserves of shale rich liquids and shale gas could be vast in comparison to current mature conventional reserves.
- Based on the three different scenarios related to the success of different resource plays, we estimate that production over the project horizon would range between 65%-260% of Tunisia's estimated remaining conventional oil and gas reserves.

...could have "transformative" implications for the Tunisian energy market...

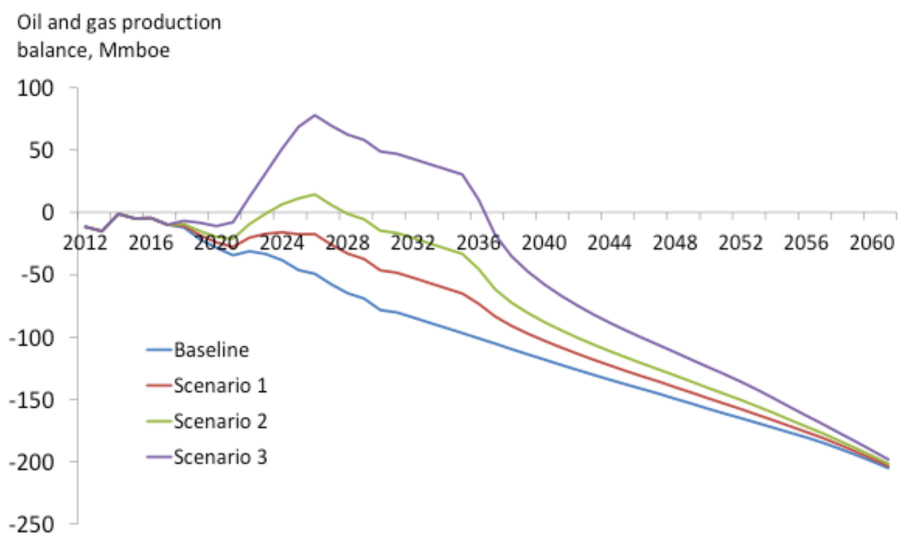
- Given the expected growth in real GDP, energy demand is likely to continue to grow steadily over the project horizon. Our baseline forecast is for Total Primary Energy Demand (TPED) to rise from an estimated 9.4 mtoe (67 MMboe) in 2012 to 34.6 mtoe (247 MMboe) in 2061, implying average annual growth of 2.7%. Together with projections about the changing pattern of usage by sector, this would result in the combined demand for oil and gas rising from an estimated to 8.5 mtoe (61 MMboe) in 2012 to 33.1 mtoe (236 MMboe) in 2061.
- In contrast, production of conventional oil and gas seems unlikely to pick up commensurately in the medium-term. Gas production is expected to increase in the near-term up to 2016 before falling back while oil production is likely to decline gradually reflecting depleted reserves.
- Based on these projections, the oil and gas production balance is likely to remain in a (marginal) deficit up to 2020. If production continues to rely purely on conventional resources, Tunisia is likely to become increasingly reliant on imports of oil and gas (see the blue line in Charts E.1 and E.2). The extent to which this would be altered by shale oil and gas resources depends significantly on the number of plays which successfully reach the development phase. In Scenario 3, where four out of six plays are successful, it is projected that the economy would be able to run a significant oil and gas production surplus during the peak production years of the project.

Chart E.1: Forecast energy balance in Tunisia by scenario (2012-61)[1]



Sources: STEG, DGE, Shell, Oxford Economics forecasts

Chart E.2: Forecast energy balance in Tunisia by scenario (2012-61)



Sources: STEG, DGE, Shell, Oxford Economics forecasts

...with knock-on benefits for the macroeconomy

- Increased production may confer other macroeconomic benefits. For example, increased energy independence would make the economy less vulnerable to sharp swings in commodity prices which have contributed to the recent spell of high inflation. Reduced reliance on energy imports would also boost the visible trade balance, other things equal.

Exploration will also make a significant direct contribution to economic activity...

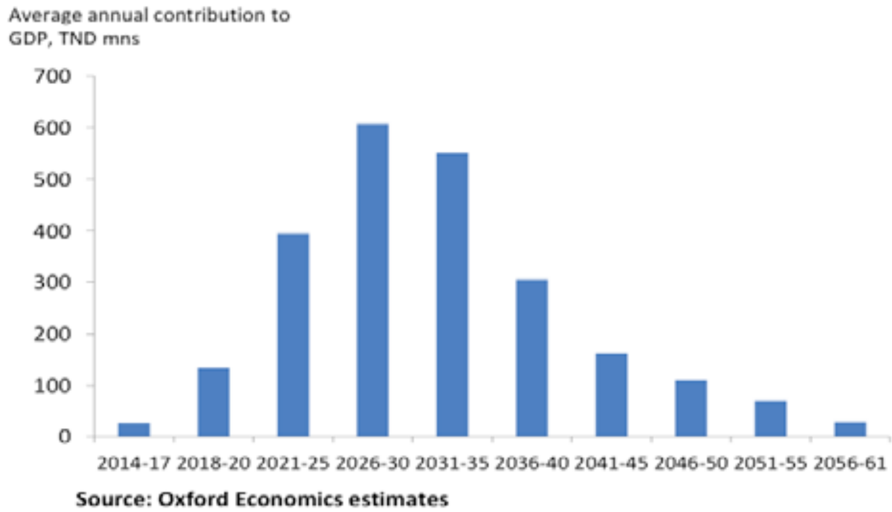
- Along with these expected positive developments for Tunisia's energy future, the resource play would also contribute significantly to economic activity during the project lifetime. These effects have been quantified across three core metrics: contribution to GDP; employment created; and revenue raised

1- The baseline case refers to a forecast for oil and gas production developed in partnership with Ammar Jelassi assuming that unconventional resources remain unexploited.

for the Treasury. All monetary values reported are in discounted constant 2012 prices unless otherwise stated [2]. It is worth noting that such play areas are typically developed and de-risked in a phased manner with the vast majority of the economic impacts likely to be felt several years into the project.

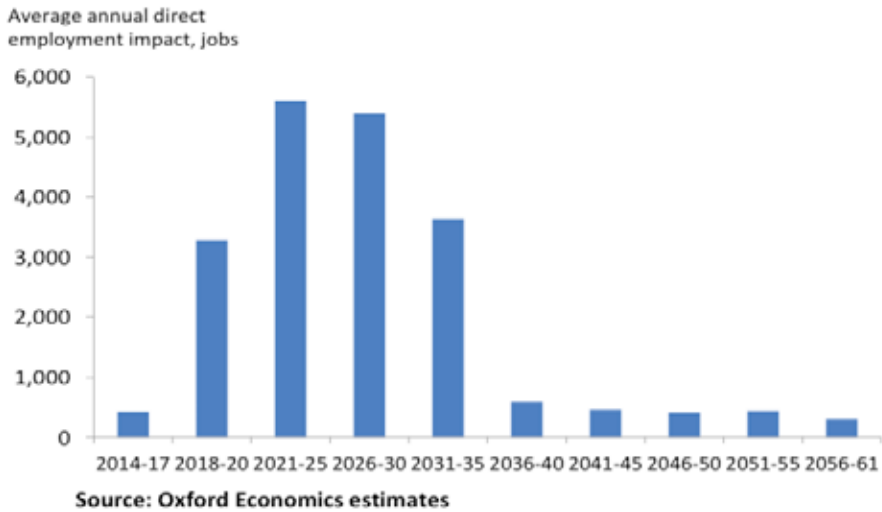
- This potential phasing effect is demonstrated in Chart E.3 which shows the estimated average annual contribution to GDP across different periods of the project of a single generic successful resource play. The project's direct contribution to GDP gradually builds through to the development phase reaching a peak between 2026-30 before gradually receding thereafter.

Chart E.3: Profile of direct contribution to GDP



- Meanwhile, the time profile of employment creation follows a similar pattern although jobs are more concentrated during the major construction years of the resource play, with a more significant fall-off during the second half of the development phase. These trends are summarised in Chart E.4.

Chart E.4: Profile of direct employment impact



- Key results are summarised below [3]:
  - o In Scenario 1, activity is projected to make a direct contribution to GDP of TND 11.7 billion throughout the 47-year project horizon, with the annual contribution peaking at TND 310 million. These figures rise to TND 23.4 billion (TND 620 million) and TND 46.8 billion (TND 1.2 billion) in scenarios 2 and 3 respectively.

2 - The discount rate used was 4%.

3 - Note that figures referenced in Table E.1 and the text may not sum due to rounding.

- Moreover, this activity will provide consistent support to the Tunisian labour market creating a consistently high level of well-paid jobs. In Scenario 1, we estimate that the project would create 96,000 job years with the number of jobs created in a single year peaking at 7,700. These figures rise to 192,000 job years (15,400) and 384,000 job years (30,800) in scenarios 2 and 3 respectively.

- ...with further benefits through indirect and induced effects...
- Moreover, further economic benefits will be derived from indirect (via supply chain purchases) and induced (via the spending of employee wage income) effects. Based on our modelling we estimate that:
  - In Scenario 1, indirect and induced effects together will contribute TND 1.3 billion to Tunisian GDP with the combined annual contribution of these "multiplier" effects peaking at TND 110 million. These figures rise to TND 2.7 billion (TND 210 million per year) and TND 5.3 billion (TND 420 million) in scenarios 2 and 3 respectively.
  - In Scenario 1, indirect and induced effects together will support 183,000 job years with the annual contribution peaking at 13,900 jobs. These figures rise to 366,000 job years (27,900) and 731,000 job years (55,700) in scenarios 2 and 3 respectively [4].

Table E.1: Overview of estimated economic impact by scenario

Summary of Resource Play's Economic Impact		Contribution to GDP (TND mns)				Employment created (Job years)			
		Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Scenario 1	Total Impact	11,700	560	770	13,000	96,000	44,000	138,000	278,000
	Peak Year Impact	310	50	60	390	7,700	3,700	10,300	21,300
Scenario 2	Total Impact	23,400	1,120	1,540	26,000	192,000	88,000	276,000	556,000
	Peak Year Impact	620	100	120	780	15,400	7,400	20,600	42,600
Scenario 3	Total Impact	46,800	2,240	3,080	52,000	384,000	176,000	552,000	1,112,000
	Peak Year Impact	1,240	200	240	1,560	30,800	14,800	41,200	85,200

Source: Oxford Economics estimates

The Tunisian treasury will be boosted substantially...

- Part of the direct, indirect and induced calculations reflect payments made to the government on profits and wages that will be used to fund necessary government spending. In total, inclusive of the three channels of impact, we estimate an average annual contribution to the Treasury of TND 206 million equivalent to 1.2% of total government revenues in 2011. These figures include projected contributions by the investor on the value of production, including the value of production claimed by Entreprise Tunisienne D'Activités Pétrolieres (ETAP), the state-owned exploration company.

...which could support regional development...

- Modelling how this revenue will be used is beyond the scope of this report but current wide disparities in regional welfare as implied by a range of socioeconomic indicators by Governorate suggest that an appropriately managed regional development policy could generate significant social gains.

4 - Due to the fact that the peak indirect and induced peak impacts do not occur in the same year, the peak combined effect reported in the text does not correspond with the sum of the two individual year peak impacts.

...while further spillover benefits may arise across a variety of channels

- An important benefit of shale liquids and gas extraction for Tunisia is the availability of a larger domestic energy supply for local industry. The prospect of lower and more stable energy prices should be particularly beneficial for energy-intensive sections of manufacturing such as building materials and metal-working.
- In Tunisia, a mixture of new infrastructure including access roads and upgrades to existing roads will be built as part of government and industry's shale gas and liquids extraction plans. The benefit of such activity in terms of its contribution to GDP is captured as part of the impact assessment but such investments typically generate spillover benefits to society from reduced travel time, lower incidence of accidents etc.
- The presence of one or more International Oil Companies (IOC's) should also trigger spillover benefits through knowledge transfers to domestic suppliers. In particular, local firms should benefit from exposure to the more efficient management and production processes employed by the IOC's.
- Tunisia currently has a capable skilled workforce servicing the conventional oil and gas industry. Exploring for and developing shale liquids and gas resource plays requires skilled staff, technologies and equipment to be developed. This process could bring further spillover benefits with workers and local firms better equipped to work on other unconventional resource plays within Tunisia and more widely across the MENA region.

GLOSSARY OF KEY TERMS

- **DGE** Direction Générale de l'Énergie: the Tunisian department of energy
- **ETAP** Entreprise Tunisienne D'Activités Pétrolières: the state oil and gas corporation
- **FDI** Foreign Direct Investment; cross-border investment by a resident entity in one economy with the objective of obtaining a lasting interest in an enterprise resident in another economy
- **GVA** Gross Value Added; the metric used to assess the project's contribution to Tunisian Gross Domestic Product.
- **IEA** International Energy Agency; an autonomous organisation which works to ensure reliable, affordable and clean energy for its 28 member countries and beyond.
- **INS** Institute National de la Statistique; the Tunisian national statistics agency
- **IOC** International Oil Company; a generic term used here to refer to a non-Tunisian oil explorer. It is assumed in this report that exploration is managed by an international investor although the analysis would be little changed
- **MMbbls** Million barrels; a volume measurement used to refer to one million oil barrels.
- **MMboe** Million barrels of oil equivalent; term used to describe a quantity of energy equivalent to that generated from burning one million barrels of crude oil.
- **MNC** Multi National Corporation; a corporate entity with operational bases in more than one country.
- **MTOE** Million Tonne of Oil Equivalent; term used to describe a quantity of energy equivalent to that generated from burning one million tonnes of crude oil.
- **Resource play** used in this report to refer to a generic or average-case exploration of shale rich liquids and gas in Tunisia. References to a single successful resource play do not refer to the expected effects of any specific location but rather reflect the average spending and production rates across a number of potential explorations.
- **SME** Small and Medium Sized Enterprise; a classification used by national statistics agencies to group companies. Typically refers to companies with less than 250 employees.
- **STEG** Société Tunisienne de l'Électricité et du Gaz; a public and non-administrative company whose responsibilities include increasing electrification and developing the natural gas network.
- **Tcf** Trillion cubic feet; a standard measurement used to refer to a quantity of natural gas.
- **TND** Tunisian Dinar; shorthand acronym for the Tunisian currency.
- **USGS** United States Geological Survey; scientific organisation that aims to provide reliable information to describe and understand the Earth, minimise loss

1. INTRODUCTION

1.1 Aims and objectives

The objective of this report is to investigate the economic contribution of the extraction of shale rich liquids and shale gas in Tunisia. Approximately six resource plays/areas are currently recognised from geological studies across Tunisia. None of these resource plays are yet proven, and all first require exploration wells to prove up play concepts, followed by important exploration well testing before being able to progress to full appraisal and eventual development. There is no guarantee of commercial success in any of the Tunisian resource plays at this time. A generic play model was developed using industry data. This generic model assumes a phased de-risking approach to exploration and development of a given area. For the purposes of the model, the development lifecycle is expected to last for forty years – thirty years as per Tunisian regulations plus a potential 10-year extension. It's important to note that if successful these types of plays can extend beyond the forty-year mark assumed in the study. Expenditure figures associated with extraction were benchmarked against other reports (see section 8.2 for further details). The analysis suggested that these were broadly in line with the experience of past unconventional resource plays in the US once due consideration was given to differences in the structure of respective economies. Given the uncertainty currently associated with the likelihood of these shale plays being successful in extracting a commercially viable resource we present three alternative scenarios regarding the scale of reserves:

- **Scenario 1** – Consistent with **one generic** resource play proceeding to the development stage. It is currently estimated that such an outcome would result in the extraction of 97 mtoe (660 MMboe) [5] equivalent to 65% of Tunisia's existing estimated reserves of oil and gas.
- **Scenario 2** - Consistent with **two generic** resource plays proceeding to the development stage. It is currently estimated that such an outcome would result in the extraction of 195 mtoe (1,330 MMboe) equivalent to 130% of Tunisia's existing estimated reserves of oil and gas.
- **Scenario 3** - Consistent with **four generic** resource plays proceeding to the development stage. It is currently estimated that such an outcome would result in the production of 389 mtoe (2,650 MMboe) equivalent to 260% of Tunisia's existing estimated reserves of oil and gas.

The core aspect of the analysis is to assess the economic contribution in terms of impact modelling (see section 1.2.1 for further details) but the scope of the report is wider than this. First, the study seeks to contextualise the scale of the project in terms of future expected trends in the Tunisian energy market (Chapter 2). Specifically, quantitative forecasts of future energy demand and supply (with and without shale resources) are presented to assess the extent to which this project could facilitate energy independence across the different scenarios. For simplicity, it is assumed that each resource play occurs synchronously across a specified 47-year project timeframe. However, it is likely that multiple successful plays would take place in a phased manner given resource constraints etc. Moreover, the potential macroeconomic effects of such an eventuality are explored focusing on the implications for inflation and the balance of payments. Second, the report seeks to inform readers about the nature of shale exploration (Chapter 3) initially at a generic level and then focusing more specifically on the Tunisian plays. Finally, Chapter 6 addresses some of the catalytic or "spillover" benefits that are likely to result from such a project.

1.2 Framework of analysis

1.2.1 Economic impact modelling

Economic impact modelling is a standard tool used to quantify the economic contribution of an investment. Technical detail about the methodology and assumptions used can be found in the appendix but here we define the framework of analysis in more general terms in order to help contextualise the results presented later in this report.

5- These figures were based on the following conversion factors; 1 toe = 6.849 bbls; 1 toe = 38.46 bcf.

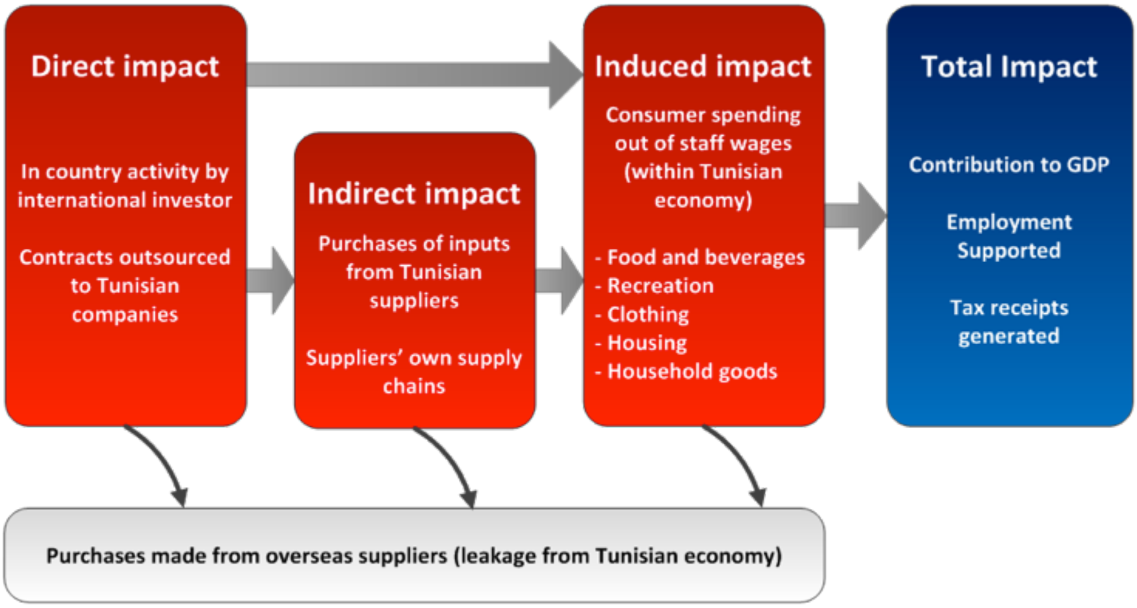
A successful generic resource play has been used to conduct the study applying the Tunisian fiscal framework. The Tunisian Hydrocarbon code allows developing hydrocarbon resources under both "Contracts of association" or "Production Sharing Agreements". Some assumptions have been made based on the current terms of these contracts to reflect an indicative revenue split between producer and Government.

Impact analysis traces the economic contribution of an investment through three separate channels:

- **Direct impact** – refers to activity conducted directly by an investor and work that is outsourced directly to Tunisian companies (the first-tier supply chain).
- **Indirect impact** – consists of activity that is supported as a result of the procurement of goods and services by the first-tier supply chain from Tunisian firms, purchases by those companies in turn and so on.
- **Induced impact** – reflects activity supported by the spending of wage income by direct and indirect employees.

Figure 2.1 illustrates the interaction between the different channels of impact.

Figure 2.1: The channels of economic impact



The scope of our modelling is restricted to analysing the activity of the investment in the upstream petroleum sector and how this supports the rest of the economy via multiplier effects. In particular, the quantitative results presented in Chapter 4 do not reflect any of the downstream activity [6] associated with the extraction of the oil and gas.

1.2.2 Key metrics

In accordance with standard economic impact assessments, the scale of the impact of the industry is measured using three metrics:

- *Gross value added* – Gross value added (GVA) is the contribution an institution, company or industry makes to Gross Domestic Product (GDP).[7] The sum of the gross value added of all Tunisian organisations

6 - The oil and gas sector is typically divided into two major components: downstream and upstream. Upstream activity refers to the exploratory work involved in the search for underground or underwater crude oil and natural gas fields and the subsequent drilling and operational activity that results. Meanwhile, the downstream sector refers to the refining of crude oil and the processing and purifying of raw natural gas and the subsequent transportation, storage and marketing of the products developed by these processes.

7 - GDP is the main 'summary indicator' of economic activity in the Tunisian economy.

is – with minor adjustments for taxes and subsidies – equal to Tunisian GDP. Similarly the sum of GVA for all organisations in a geographical region is equivalent to that area's GDP. GVA is most simply understood as turnover (i.e. value of sales) minus the cost of brought in goods and services used up in the production process.

- *Employment* – Employment is measured in terms of headcount rather than full-time equivalence. Fundamentally, this implies that jobs figures quoted in this report will reflect both part-time and full-time roles. Employment impacts estimated over a multi-year timeframe are expressed in job years (one job year can be thought of as a job created during a single year). Job figures specified will reflect roles taken on by both Tunisians and foreign workers.
- *Tax receipts* – Increases in profits and employment translate into additional tax revenues for the Tunisian treasury. This study considers the receipts generated by direct taxes on wage income, direct taxes on corporate profits (including those paid by an international company(s)) and VAT receipts generated via the spending of employees' wage income on local goods and services. For the purposes of this analysis, it is assumed that an International Oil Company (IOC) enters into a production sharing agreement with ETAP. The estimated value of the production resource claimed by ETAP as part of this agreement is included in the tax revenue figures presented in this report.

1.3 Project timeframe

The economic impact analysis contained within this report is based on the assumption that exploratory drilling commences in 2014 with production continuing until 2061. For each resource play it is expected that exploratory drilling will be used to determine the likely commercial viability of extraction. Exploration activities typically follow a phased approach to understand whether a project will be successful or fail. To help clarify the project has been divided into four different stages set out below:

- **Early exploration: Phase I (Years 1-2)**: The first two years will consist of exploratory drilling for the presence of a resource play in an area. At the end of this two year period a decision would be taken on whether to continue drilling or abandon the project.
- **Exploration well testing: Phase II (Years 3-4)**: Well drilling activity increases substantially in comparison to the exploration phase but remains significantly below that which is expected later in the project. A further decision will be taken at the end of year four as to whether to continue the project based on expected commercial viability.
- **Exploration and extended well testing: Phase III (Years 5-7)**: During the pilot phase, activity would step up again. The pilot phase is the first point at which exploration would yield production of liquids and gas. At the end of these three years, a final decision will be made over whether to enter the full development stage or abandon the project.
- **Development: Phase IV (Years 8-47)**: During development, well drilling activity would accelerate sharply persisting for around 20 years before falling away. However, these wells will continue to produce oil and gas for a considerable period thereafter. The exact length of the development phase is subject to large uncertainty. For the purposes of our modelling, we have assumed it lasts for 40 years.

1.4 Environmental impacts

The objective of this report is to present the findings of an analysis of the economic implications of the development of liquid rich shale and shale gas resources in Tunisia. As such, it does not take account of any potential environmental effects, evolving regulations, technological or social elements. Therefore, this report should be seen as making a contribution towards the overall assessment of the likely impact on Tunisian society. Each country decides whether they wish to explore for and develop these resources. For countries which successfully produce these resources in economic quantities, there can be significant economic benefits such as greater energy security, additional economic activity, employment opportunities and improved quality of life for local communities.

1.5 Acknowledgements

During the course of our research we have worked closely with a group of Tunisian experts who have assisted us in tasks such as data collection, the development of a long-term macroeconomic forecast for the Tunisian economy and the modelling of energy supply and demand. We would like to take this opportunity to acknowledge their contribution to this report and thank them for the willingness and commitment they displayed during collaboration. They include:

- **Ammar Jelassi**, Independent Energy Consultant
- **Ezzeddine Larbi**, Lead Economist, African Development Bank
- **Faicel Zidi**, Assistant Professor of Economics, High School of Economics and Commerical Services (Tunis)
- **Zouhair El Kadhi**, Chief Economist, Tunisian Institute of Competitiveness and Quantitative Studies

The remainder of the report is structured as follows:

- **Chapter 2** offers an overview of the Tunisian energy market in order to contextualise the scale of the potential exploration. Forecasts of future energy supply (with and without shale resources) and demand are presented in order to highlight the role that shale exploration can play in promoting energy independence in Tunisia.
- **Chapter 3** provides further background information on the project and the nature of "fracking" and other features of shale exploration. The geography of the plays will be visually illustrated.
- **Chapter 4** describes the results of the core economic impact analysis breaking down the contribution of the exploration to GDP and employment via direct, indirect and induced effects through the different stages of the project. Analysis will also be presented about the fiscal contribution of the project.
- **Chapter 5** decomposes these results to a broad regional level.
- **Chapter 6** assesses the likely spillover benefits that will result from the project including: knowledge transfers from more advanced technologies and management practices; social investments by the foreign investor in local communities; external benefits from associated road infrastructure investment; and the potential for other industries particularly manufacturing to benefit from the enhanced availability of oil and gas.
- **Chapter 7** concludes by summarising the key findings of the report.
- **Chapter 8** consists of a detailed technical appendix outlining the methodology used to quantify the results presented in this report.

2 . THE TUNISIAN ENERGY MARKET

This chapter presents information on the Tunisian energy market with the aim of contextualising the scale of the resource associated with the proposed shale play. The chapter begins by discussing the current environment and recent trends including the consumption of energy by different sectors and the production of conventional oil and gas. Forecasts of energy demand and supply (both with and without shale resource plays) are outlined for the entirety of the project horizon facilitating conclusions about the likelihood of the project supporting energy independence. Finally, some of the macroeconomic implications of this analysis are investigated, particularly the potential impact on inflation and the balance of payments.

Key points

- The Tunisian energy market has been characterized by a persistent production deficit over the past decade with consumption exceeding production. This has led to a persistent energy trade deficit which increased noticeably to 2.7% of GDP in 2012 although the majority of this increase can be attributed to transient factors relating to political unrest rather than structural effects.
- Near-term projections suggest that despite an expected pick-up in gas production, the energy balance is likely to be characterized by a continued deficit up to 2020, with energy demand set to continue to increase steadily reflecting forecast real GDP growth in excess of 5% per year on average.
- Thereafter, the level of oil and gas production is likely to depend crucially on the implementation and success of shale resource plays. In a baseline case, where production remains purely conventional the oil and gas production balance is currently at a plateau and forecast to steadily deteriorate post-2018. Recent conventional exploration successes have been limited across onshore and offshore Tunisia, and have been characterized by relatively small reserve discoveries that are not expected to significantly change this trend.
- However, should shale oil and gas exploration be successful, the outlook would be considerably improved. For example, in Scenario 3, where four of the six resource plays are assumed to proceed to development stage, Tunisia could run a production surplus between 2022-36.

2.1 Key terms

This section begins with a set of definitions of key terms to help inform the reader for the remainder of the chapter[8] :

- **Biomass**: in this section references to biomass apply to traditional biomass i.e. the use of fuelwood, charcoal, animal dung and agricultural residues in stoves to generate power typically with a very low efficiency.
- **Energy intensity**: refers to the level of energy consumption required to support a given level of GDP. Other things being equal, a fall in energy intensity can be equated with an improvement in the efficiency of energy use although it is important not to fully conflate the two concepts.
- **Total Final Consumption (TFC)**: is equivalent to the sum of energy consumption by different end-use sectors. TFC is broken down into energy demand in the following sectors: industry, transport, residential, commercial services, agriculture and other (including non-energy use). It excludes international marine and aviation bunkers, except at world level where it is included in the transport sector.

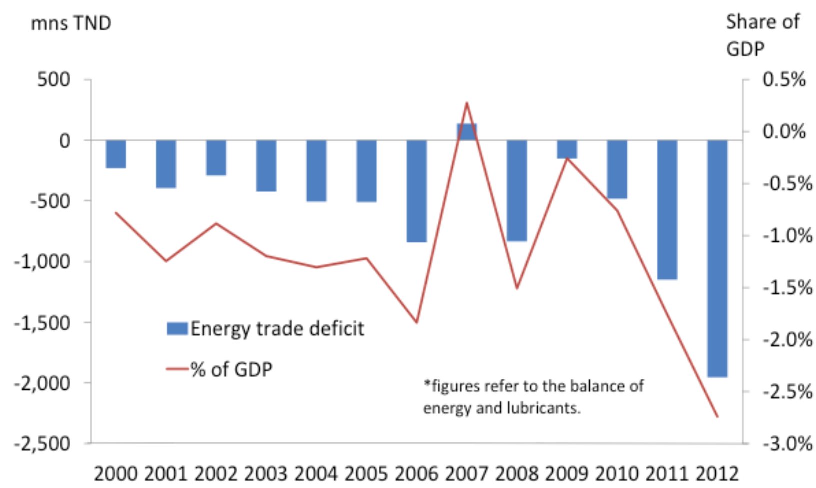
8- These definitions are based on information provided in the IEA online glossary. See http://www.iea.org/glossary for more details.

- **Total Primary Energy Demand (TPED)**: refers to the total direct use at source of crude energy i.e. that which has not been subjected to any conversion of transformation process. TPED is composed of three items: TFC (as above); power generation and other energy use. Figures on TPED provide an indication of total domestic demand for energy.
- **Total Primary Energy Supply (TPES)**: the IEA technically defines this as the sum of indigenous production plus imports of energy less exports of energy less consumption by international aviation and marine bunkers plus any change in stocks. Effectively, therefore, it captures domestic energy production adjusted for net trade, bunkers and stock changes. In practice, TPES should equal TPED.

2.2 Current environment and recent trends

Data from the INS was available for energy production and consumption (TFC) on a monthly basis between 2006-12. The data indicate a persistent deficit with consumption exceeding production in every year for which the data is available. Meanwhile, trade data indicate that export receipts from energy and lubricants increased rapidly between 2003-8 before falling back sharply in 2009, reflecting the collapse in both world trade and commodity prices. They have since rebounded strongly, surpassing the 2008 peak in 2012. Imports have followed a broadly similar pattern with the Tunisian energy trade balance having been in deficit in every year between 2000-2012 except 2007. However, the deficit has increased notably in the past two years reaching $1.95 billion or 2.7% of GDP in 2012.

Chart 2.1: Tunisian energy* trade balance (2000-12)



Source: INS

In terms of the origin of Tunisian energy imports, the vast majority (70%) of petroleum gas is sourced from Algeria with gas being delivered across various points of the Algeria-Italy pipeline (Chart 2.2). Of the remainder, just over half is sourced from France with Italy and Greece other notable trade partners. Meanwhile, the origin of imports of petroleum products is more diverse with together Russia and Italy supplying around 70% of total volumes. Other significant import partners include a range of European economies such as Spain, France, Bulgaria and Croatia.

Chart 2.2: Origin of Tunisian imports of petroleum gases

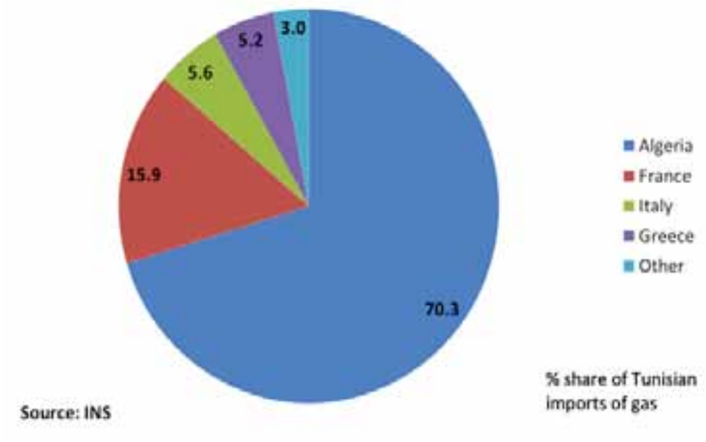
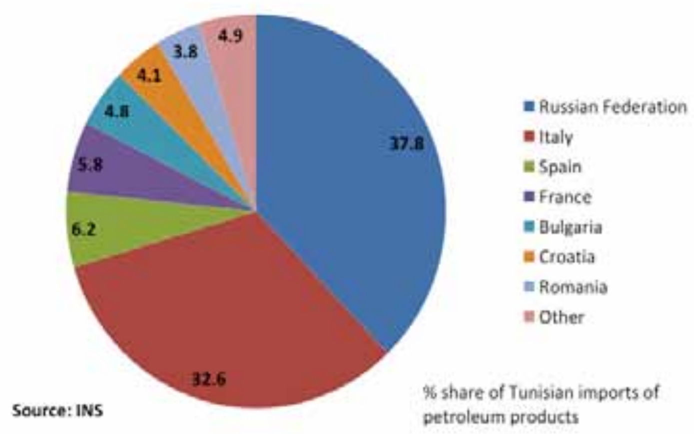
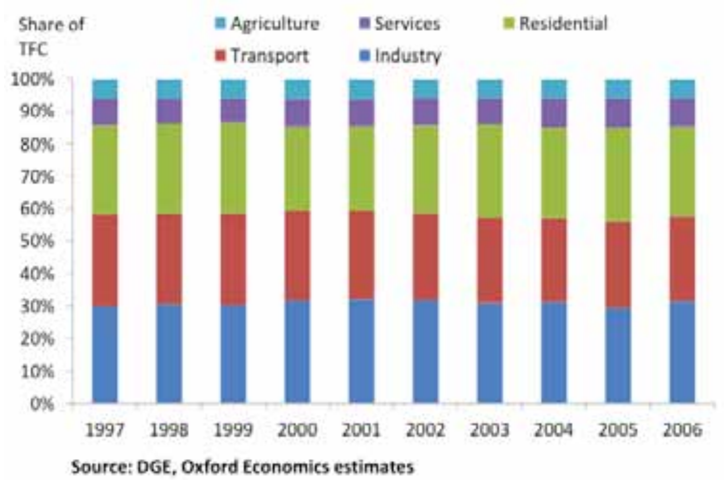


Chart 2.3: Origin of Tunisian imports of petroleum products



Meanwhile, data on the origin of crude oil imports was not available at the time of this report. However, discussions with Ammar Jelassi indicated that the majority of crude is imported from Libya, largely Sidra crude which is mixed with Zarzaitine crude from El Borma for processing at the domestic refinery in Bizerte. Official Tunisian energy balances for TFC are produced by the Direction Générale de l'Énergie (DGE) up to 2006. Although the latest data point is somewhat out-of-date, since the share of different sectors in TFC is a slowly evolving trend, the data can be considered to be informative of the pattern today. The largest consumers of energy are the industrial, transport and residential sectors which together generally account for around 85% of TFC (Chart 2.4). The service sector typically accounts for around 2/3 of the remaining 15% with the residual consumed by the agricultural sector.

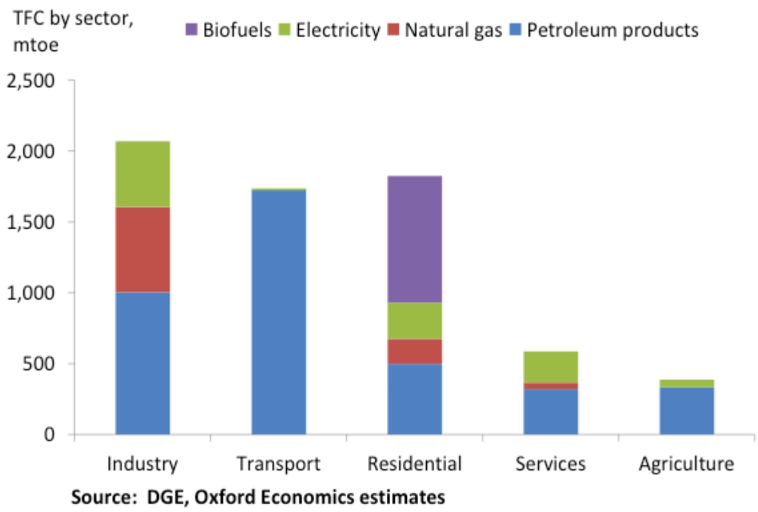
Chart 2.4: Sectoral breakdown of total final energy consumption in Tunisia 1997-2006 [9]



9- The figures on this chart are slightly adjusted from the raw data produced by DGE. Specifically, the TFC of the residential sector has been adjusted upwards to reflect non recorded consumption of biomass. Full details on this can be found in section 8.2.1.

The energy balance also split out TFC between the different sources of energy including petroleum products, natural gas, electricity (itself almost exclusively powered by natural gas) and biofuels[10] . Chart 2.5 describes the breakdown of TFC by source for the five economic sectors in 2006. As expected the extent to which sectors rely on different sources of energy varies considerably. For example, transport relies almost exclusively on petroleum products reflecting the constraints of current technology. Elsewhere, industry consumes a fairly balanced mixture of petroleum products, natural gas and electricity reflecting the varied nature of production within manufacturing. The residential sector relies heavily on biofuels, reflecting significant consumption of biomass for heating and cooking in rural areas with the majority of remaining energy use supplied by petroleum products and electricity. Meanwhile, both the agricultural and commercial services sectors are mainly reliant on electricity and petroleum products in particular.

Chart 2.5: Breakdown of industry sector energy consumption by source



As noted in section 2.1, TFC only represents part of the energy consumption story. In addition to this end-use, significant energy is also consumed in power generation (processes such as oil refining and electricity generation required to produce the final products consumed by end-users). In addition to the energy that these transformation processes in themselves consume, significant losses can also occur. Although data on power generation is scarce, our estimates suggest that its share of TPES has increased over the past decade from around 15% in 2001 to just under 21% in 2011 [11]. This could reflect a number of factors such as increasing electrification.

2.3 Future expected trends – energy supply and demand forecasts[12]

This section presents forecasts for energy supply (with and without conventional resources) and demand for the entire forecast horizon. Clearly, forecasting over such an extended period results in a considerable degree of uncertainty and the results should be viewed within this context. As such, the focus of the reader, particularly during the latter stage of the forecast horizon, should be directed towards the general trends implied by the analysis rather than the figures themselves.

10 - The official data from DGE does not include biofuels so the figures presented in the chart are adjusted based on our estimates.

11 - The IEA's energy balances for 2009 imply an even higher share for power generation (around 28%) but our analysis which partially relies on available data from DGE suggests that the IEA's figures for TFC are too low.

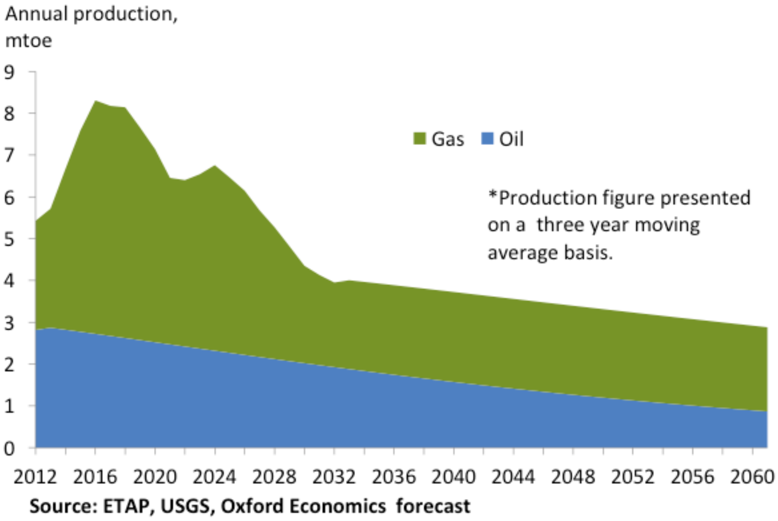
12 - Full methodological detail on how these forecasts were constructed can be found in the Appendix, section 8.2.

2.3.1 Energy supply

Projections presented in this section are based on conventional resources only, therefore excluding the shale rich liquids and shale gas resources focused upon in this report [13]. The aim is to generate a baseline projection which can act as the basis for scenario analysis around the extent to which shale resource plays are successful.

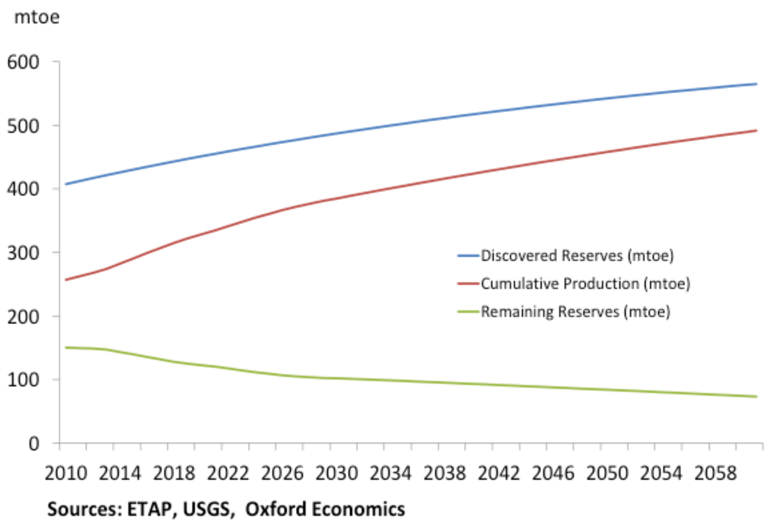
Our baseline forecast is that both the discovery and production rate of conventional oil is set to decrease gradually over the forecast horizon. On the other hand, in line with forecasts from ETAP, gas production is expected to increase over the next few years following a more erratic production curve up to 2030. Post-2040 a gradual decline in annual production is forecast given an expected declining rate of new discoveries (Chart 2.6)[14] .

Chart 2.6: Forecast annual production of oil and gas in Tunisia (2012-61)*



Overall, the implication of the forecasts is that both production and reserves of conventional oil and gas are likely to decline materially over the project horizon (Charts 2.6 and 2.7). Remaining reserves are projected to decrease from slightly less than 150 mtoe in 2012 to 73.3 mtoe in 2061 with declining annual production helping to maintain the reserve to production ratio at around 25 years.

Chart 2.7: Forecast oil and gas production and reserves in Tunisia (2010-61)



13 - *Other unconventional resources have been identified such as the shale gas resources in Southern Tunisia (Silurian Tannezuft shales and Middle Devonian Hot Shales) estimated by EIA to 18 tcf.*

14 - *The derivation of the forecast is discussed in more detail in section 8.3.*

2.3.2 Energy demand

The key input to our forecasts for energy demand were projections of changes in the future level of GDP and the sectoral decomposition of such growth. From this, forecasts for TFC were derived. Meanwhile, projections for power generation were taken directly from a recent STEG report up to 2030, with the forecast then extrapolated based on the expected path of TFC. Full methodological detail can be found in section 8.2.1.

Overall, TFC is expected to rise from an estimated 7.3 mtoe in 2012 to 29.4 mtoe in 2061 (Chart 2.8), an average annual growth rate of 2.8%. For reference this compares to an assumed real GDP growth rate of 3.9% per year during the same period, implying that energy intensity would decrease by around 1.1% per year on average. Consumption growth for most of the final end users of energy are expected to fall in a fairly narrow range of between 2.8-3.0% per year with the exception of agriculture where slower GVA growth results in a slower modelled rate of energy consumption growth (2.3% per year). Meanwhile, based on assumed growth in energy consumption from power generation TPES is forecast to grow from 9.4 mtoe in 2012 to 34.6 mtoe in 2061.

In order to make these forecasts more meaningful in the context of this report, projections were developed for the extent to which this increase in demand for energy would translate into increased demand for oil and gas. Therefore, for each end-user demand was decomposed between petroleum products, natural gas, electricity, biofuels and renewables [15]. For power generation, official forecasts for electricity and associated primary energy demand from Société Tunisienne de l'Électricité et du Gaz (STEG) were used up to 2030. These figures were then extrapolated to 2061 using growth in TFC, assuming an increasing share for renewable sources in power generation. Meanwhile, TFC was decomposed into four sources (petroleum products, natural gas, electricity and biomass) based on historical data from the Tunisian energy balances and other sources such as the IEA. These were then grown forward based on our forecast for TFC together with assumptions about the likely changing composition of TFC, agreed in discussion with Ammar Jelassi. Further detail on these adjustments can be found in the Appendix.

Chart 2.8: TPES forecast by end-user

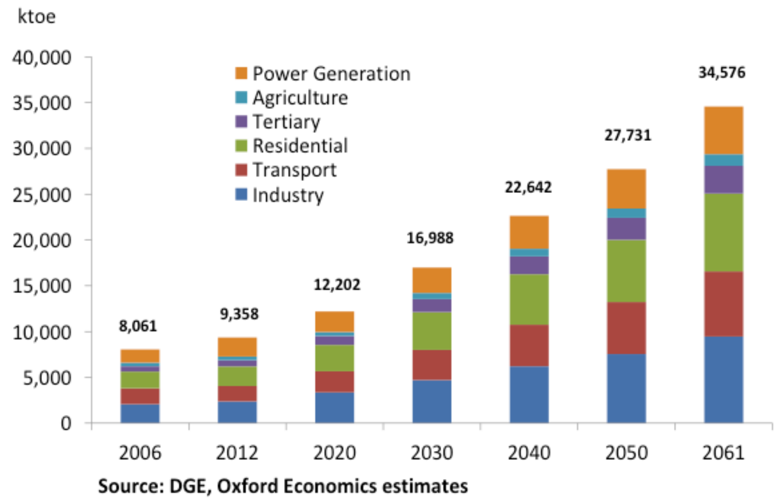
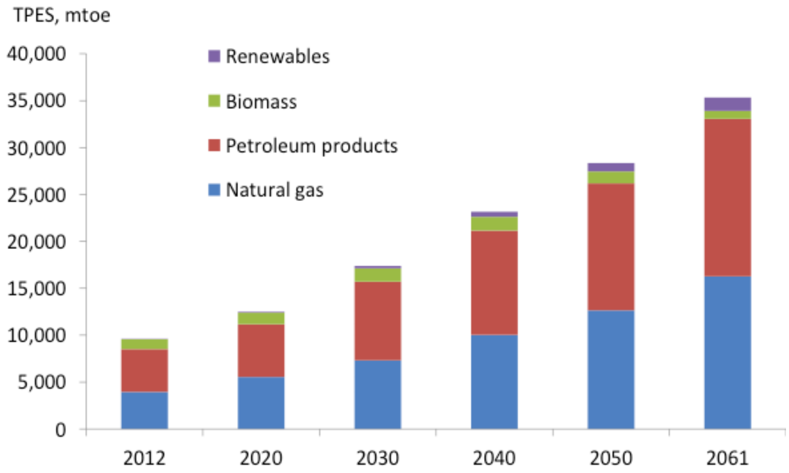


Chart 2.8 illustrates this forecast with TPES expected to increase from 9.4 mtoe in 2012 to 34.6 mtoe in 2061, implying annual average growth of 2.6%. Growth will be faster in the earlier period 2012-30 reflecting stronger growth in real GDP before falling back gradually between 2030-40 and more sharply thereafter. In terms of the balance between alternative energy sources, renewable sources (likely solar and geothermal) are assumed to become a gradually more important driver of electricity generation while biomass consumption is expected to fall (in relative terms) reflecting increased urbanisation.

15 - The obvious exclusion from this list compared to conventional breakdowns is coal. At present, coal is not used as an energy source in Tunisia to any meaningful extent, and although it does represent a realistic potential energy source for supporting future power generation it was determined that further exploiting existing conventional gas reserves and developing renewable power sources was a more likely outcome.

Chart 2.9: Forecast TPES in Tunisia by energy source (2012-61)

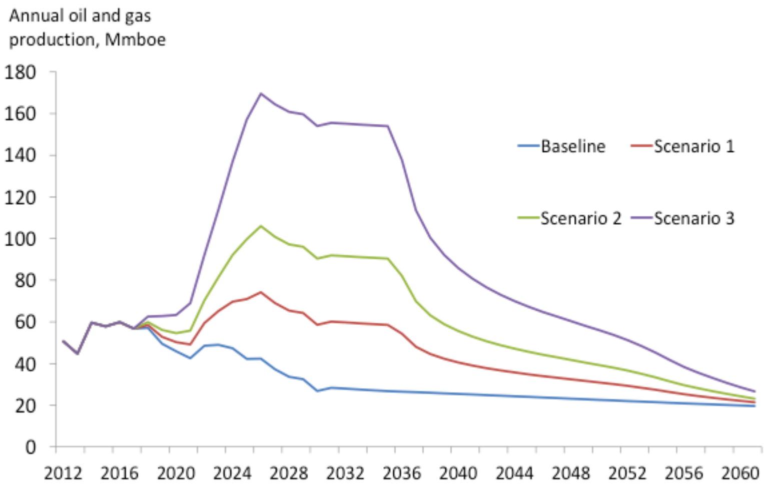


Source: STEG, DGE, Oxford Economics estimates

2.4 The potential role of shale energy sources – scenario analysis

As can be gathered by a casual inspection of our forecasts of future energy demand and conventional production, ignoring shale resources is likely to result in a significant deterioration in Tunisia's energy balance. In this section, we evaluate the potential role of shale resources across the three different scenarios outlined in the introduction. Chart 2.10 illustrates the expected impact on cumulative annual production of oil and gas of the shale resource play across the three scenarios. The blue line accords to a baseline case in which no shale production is assumed to occur. The first difference in production in the scenarios occurs in 2018. In scenario 1, the increase in annual oil and gas production quickly picks up from 2020 onwards (the start of the development phase) peaking in 2026 but remaining significant until 2035. The difference begins to recede gradually from that point onwards reflecting the completion of drilling activity. Scenarios 2 and 3 follow a similar pattern with even larger differences in the level of production.

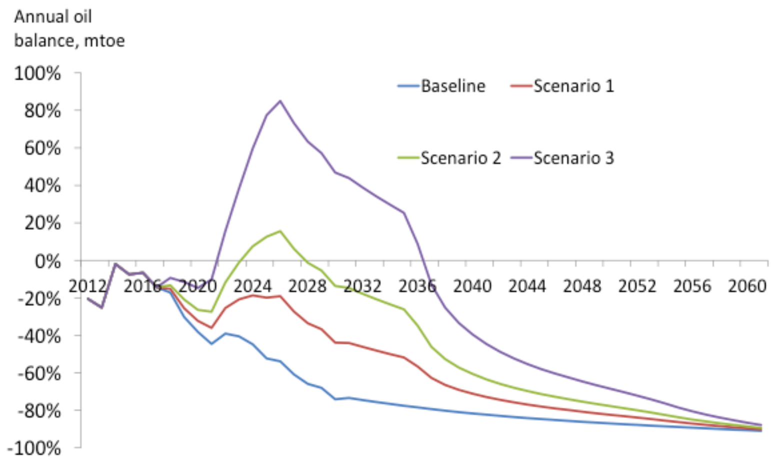
Chart 2.10: Forecast oil and gas production in Tunisia by scenario (2012-61)



Sources: Shell, Oxford Economics forecasts

Putting the two sets of analysis together, Chart 2.11 illustrates the implied path of the Tunisian oil and gas production balance under the different generic resource play production scenarios projected by Shell. These are compared to a baseline case in which production is assumed to consist of purely conventional resources. Even though shale exploration is assumed to begin in 2014, the first production output is not expected until 2018, so the four lines do not diverge until this point. In our baseline case, the production balance remains in marginal deficit throughout the current decade before entering steady decline post-2020. As is ably demonstrated by the chart, the outlook would be improved by successful shale resource plays. Indeed, in scenario 3, we expect that Tunisia would be able to run a persistent oil and gas production surplus during the peak production phase of the project.

Chart 2.11: Projected oil and gas (2012-61) by scenario



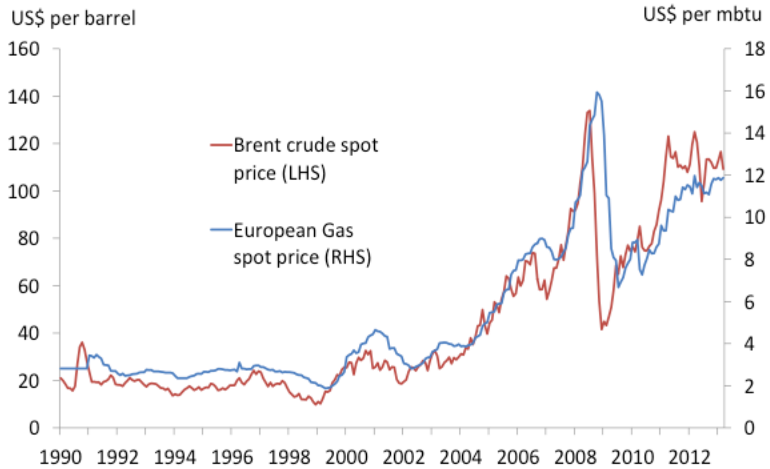
Sources: Shell, Oxford Economics forecasts

2.5 Macroeconomic implications

2.5.1 Inflation

A feature of the recent global macroeconomic environment over the past decade has been increasingly rapid commodity price inflation (Chart 2.12). The volatility of these price movements has also risen as evidenced by an increase in the standard deviation of monthly prices. For example, focusing on oil prices, the standard deviation was around 2.3 times higher during the period 2000-2012 compared to 1990-99 [16]. Meanwhile, the equivalent ratio for European natural gas prices was 4.0. Increasing commodity price inflation and volatility has generated challenges for central banks throughout the world with monetary policy typically only used to control domestically generated inflation (DGI) [17]. These challenges have been particularly acute in several of the more developed economies, where the depressed state of the real economy would, other things being equal, have demanded a loose monetary policy stance.

Chart 2.12: Oil and gas prices since 1990



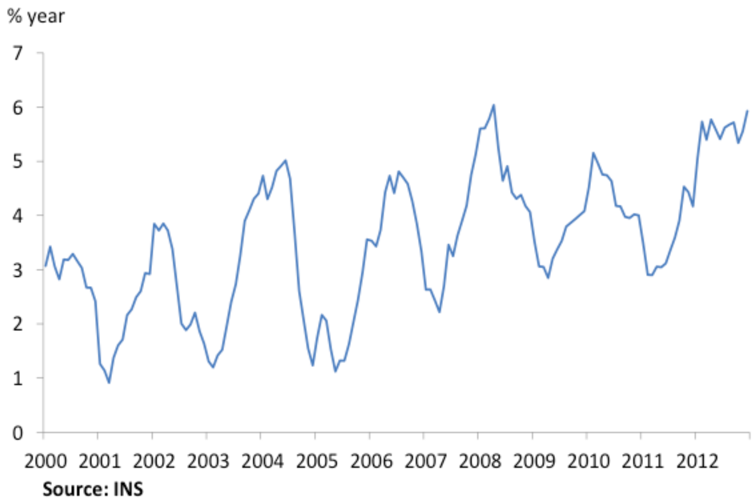
Source: World Bank

16 - *The standard deviations were normalised for the difference in the mean value of oil prices during the two respective periods.*

17 - *To some extent recent unorthodox policy measures such as Quantitative Easing by monetary authorities in countries such as the USA and the UK may have contributed to the recent movement of commodity prices. However, in the context of Tunisia this statement effectively holds without this caveat.*

Meanwhile, Tunisian CPI inflation has fluctuated between 1-6% since 2000. As can be seen from Chart 2.13, there is some evidence of an increase in the rate of trend inflation since 2003 which is likely to partly reflect higher energy price inflation during this period. Less reliance on energy imports should increase Tunisia's ability to adjust to price shocks although much would depend on the extent to which the government chose to regulate prices set by the utilities sector.

Chart 2.11: Tunisian CPI inflation (2000-12)



2.5.2 Current account

Another macroeconomic area where a significant change in the oil and gas production balance would have implications is the current account of the balance of payments. The overall impact on the current account is likely to be positive. Clearly, in isolation, higher production of oil and gas will benefit the balance of trade both through any export revenues that are generated from the sale of the products abroad and through the reduced reliance on imports of energy products. Based on our in-house commodity price forecasts [18] and the scenario analysis for oil and gas production and consumption forecasts outlined above, we estimate that in Scenario 1 this effect would boost the visible trade balance by around $6.5 billion per year on average during the peak production phase of the project (2025-35). This figure rises to $12.9 billion and $25.1 billion in scenarios 2 and 3 respectively. For reference, the total value of merchandise imports in 2012 was $23.1 billion.

However, any increase in oil and gas production is likely to have a number of other effects which need to be accounted for when assessing the overall impact on the current account. Perhaps most prominently, very significant energy discoveries and the associated inflow of foreign currency typically drive an appreciation in the host economy's real exchange rate which impacts negatively on the external competitiveness of the manufacturing sector. Such linkages have been termed as "Dutch Disease" and are well documented in the economic literature. In our view, given the expected scale of production, such effects are unlikely to be material except in Scenario 3, in which the impact on the energy sector can justifiably be described as "transformative". Other potential external effects include the increase in competitiveness experienced by Tunisia's exporting industries as a result of lower domestic energy prices and the potential technological and other spillover benefits that may increase the competitiveness of domestic firms (see chapter 6 for more details on these).

18 - For the purposes of this analysis, forecasts of the Brent crude spot and European natural gas prices were used.

3. PROJECT BACKGROUND

The objective of this chapter is to offer background information about shale exploration and more specifically in the context of Tunisia. The chapter begins by defining a set of technical terms in order to assist the understanding of less informed readers. This is followed by a geological introduction to shale liquids and gas. The second section discusses the "shale revolution" more widely in a global context. The chapter concludes by examining the geography and timing of the proposed plays in Tunisia.

Key Points

- Shale oil and shale gas refer to natural oil and gas (hydrocarbons) trapped within shale formations. Because the oil and gas are trapped in very low permeability shales, they can be present over a much larger area than conventional oil and gas fields. However, the hydrocarbons do not flow easily through the rock and have often been considered too difficult to access and economically produce from. With recent advances in horizontal drilling and fracturing technology, these resource plays can now be produced, opening up potential for new energy supplies in many countries.
- The recent boom in shale production of both liquids and gas has been heavily concentrated in North America, where a confluence of enablers (government incentives, technical advances, contractor capability, supportive regulatory EP framework, pre-existing knowledge of hydrocarbon potential) has combined to spur activity. To date, only in North America has commercial shale oil and gas production been proven. However, recent studies do suggest that production potential could exist in some hydrocarbon provinces across the rest of the world. This potential is yet to be proven and requires new exploration drilling.
- The exploration that is the focus of this report is modeled on a group of potential resource plays across two separate regions. The first set of plays are centered in the Centre Ouest and Centre Est regions around the Governorates of Sfax, Sousse, Kairouan, Monastir, Sidi Bouzid and Mahdia with the remaining plays located further south overlapping the Governorates of Tatouine, Medenine, Gabes, Tozeur and Kebili.
- For the purpose of this study, exploratory drilling for an unconventional resource play is modeled to begin in 2014. During the initial phases of the project, activity will be relatively subdued compared with the full development stage. Exploratory drilling and well testing will be conducted to assess the commercial viability of exploration in order that an area is "derisked" from the point of view of the investor. This initial stage is modeled to last around seven years by which point the investor's geological knowledge of the area should be sufficiently advanced to assess the viability of entering the development phase.
- The point at which a generic resource play enters the development phase will be characterized by a sharp acceleration in drilling activity and associated construction work. This is modeled to remain elevated for approximately fifteen years. Following the completion of drilling, the resource play will continue to contribute to economic activity through supporting in-country operational expenditure and the money that accrues to the government and ETAP due to the continued production of the resource.

3.1 Technical terms

To assist the reader we begin this section by defining a set of key technical terms:

- **Hydrocarbons** – chemically a hydrocarbon refers to a natural organic compound composed entirely of hydrogen and carbon. The vast majority of hydrocarbons naturally occur in crude oil and gas.
- **Horizontal drilling** - involves drilling a vertical well to a specified depth and then changing the direction of the drill bit to drill horizontally along the target source rock formation. The main objective of horizontal drilling is to provide access to a larger area of the objective source rock. Horizontal drilling evolved from directional drilling since 1929, but became increasingly used in the offshore oil & gas industry since the 1980's.
- **Hydraulic Fracturing or "fracking"** – is used to create artificial fractures around a focused area in shale formations. Essentially, this involves the injection of a fluid (mostly water (98-99.5%) and a mixture of sand/proppant and other additives) into the rock in order to create new fractures (tiny cracks) with the sand helping to stop the fracture from closing once the pressure has been removed. Together with horizontal drilling, advances in the technique have been critical to the recent advancement in shale oil and gas exploration.
- **Porosity** – can be thought of as tiny spaces in the rock that hold water, gas and/or oil.
- **Permeability** – can be thought of as the connectivity between the rock space defined above.
- **Darcy** – the unit used to measure permeability, named after Henry Darcy. A medium with a permeability of one Darcy permits the flow of 1 cm3/second of a fluid with a given viscosity and under a given pressure gradient.

3.2 What is different about shale exploration: A geological introduction

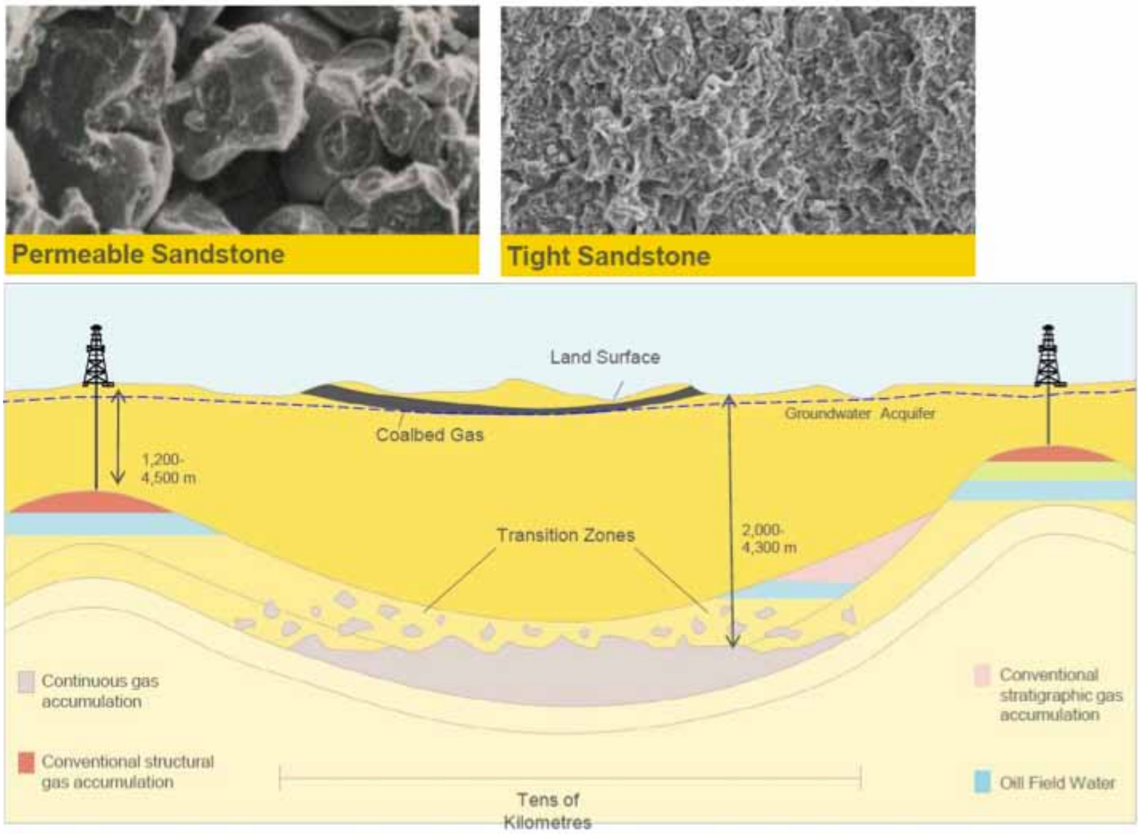
This section aims to compare and contrast geologically conventional oil and gas resources with liquid rich shale and shale gas resources that are the focus of this report.

To obtain a conventional oil and gas discovery the combination of four major factors are required (Figure 3.1):

- A source rock, usually organic-rich black shales or tight limestones, which will generate hydrocarbons when buried at great depths (often deeper than 3,500 m below the surface)
- A porous and permeable reservoir rock, ideally sand, which will store the hydrocarbons expelled from the source rock
- An impermeable cap rock that will cover the trap to prevent the escape of hydrocarbons
- A hydrocarbon trap that is a geological or stratigraphic feature comprising the reservoir rock and sealed by the cap rock and is capable of retaining hydrocarbons that have migrated from the source rock into the reservoir rock.

With conventional hydrocarbon exploration, production of oil and gas is achieved from the high porosity and permeability reservoir rocks in hydrocarbon traps. By contrast, in unconventional shale gas or oil exploitation, the objective is to access and produce hydrocarbons directly from the source rock itself. As the source rock is characterised by low porosity and very low permeability compared to the conventional reservoirs, hydrocarbons can remain trapped in the source rock itself and can potentially extend over large areas.

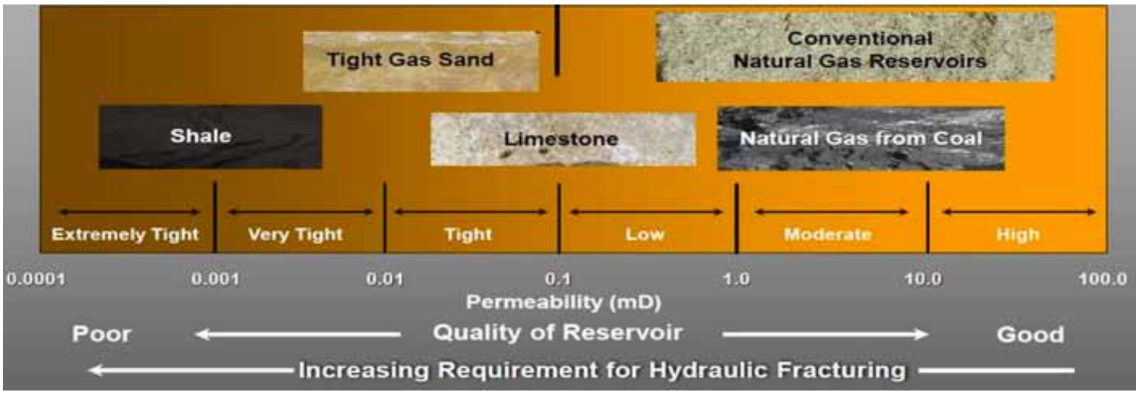
Figure 3.1: schematic geology of natural oil-gas resources



Source: Shell

Typically, a conventional reservoir would have a permeability of between 10-100 milliDarcies whereas shale reservoirs are more likely to have permeability in the micro to nanoDarcy range (CSUR (2011), as demonstrated in Figure 3.2. The high porosity-permeability in conventional reservoirs generally allows for easy flow of oil-gas into a production well.

Figure 3.2: A comparison of the permeability of conventional and shale resources



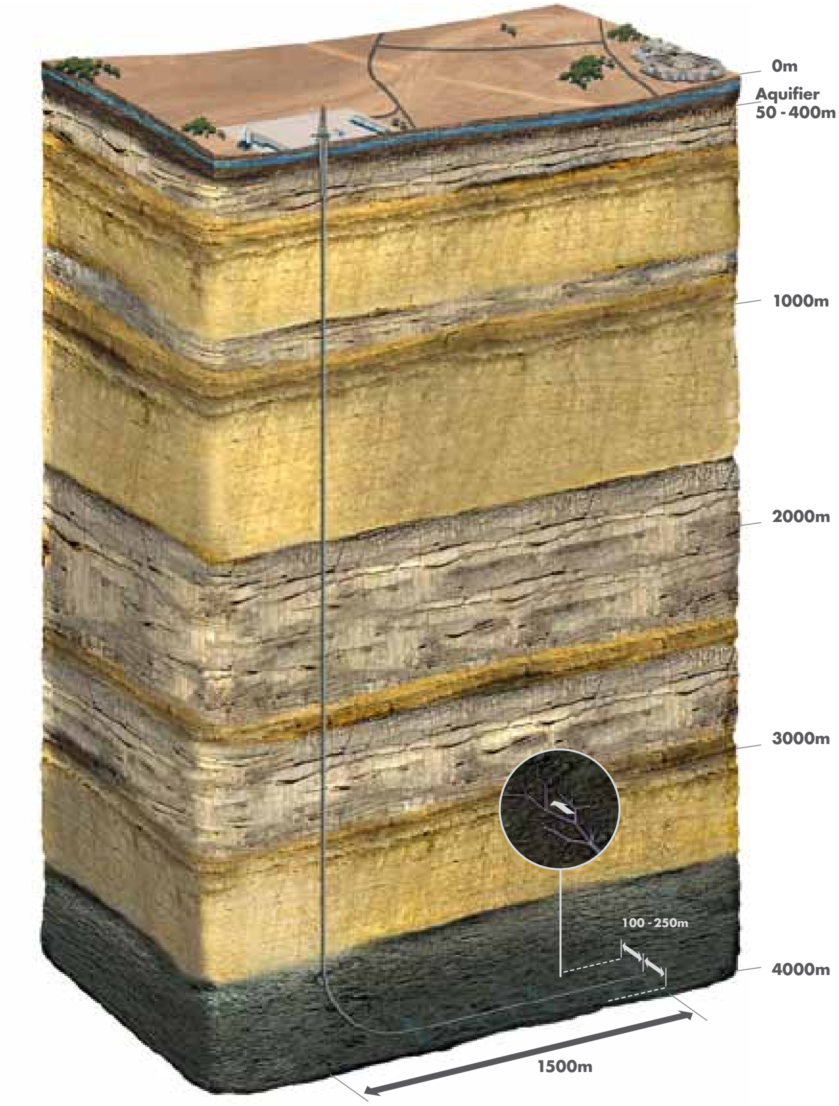
Source: Canadian Society for Shale Resources [19]

However, hydrocarbon production from the unconventional tight source rock shales is much more difficult. The low porosity-permeability restricts movement of oil-gas molecules. In order to produce a reasonable amount of hydrocarbons it is first necessary to improve the permeability of the shale rock over a large area.

19 - Image taken directly from CSUR (2012), side 3

This is achieved by the combination of (1) drilling long horizontal wells (1,000-3,000 m long) and (2) by then artificially creating a dense network of thin fractures (few mm wide, several 10's m long) in the shale rock, which, today, is best achieved via hydraulic fracturing. The expertise in hydraulic fracturing and horizontal drilling technique particularly has made accessible hydrocarbon resources that where once considered as non-producible.

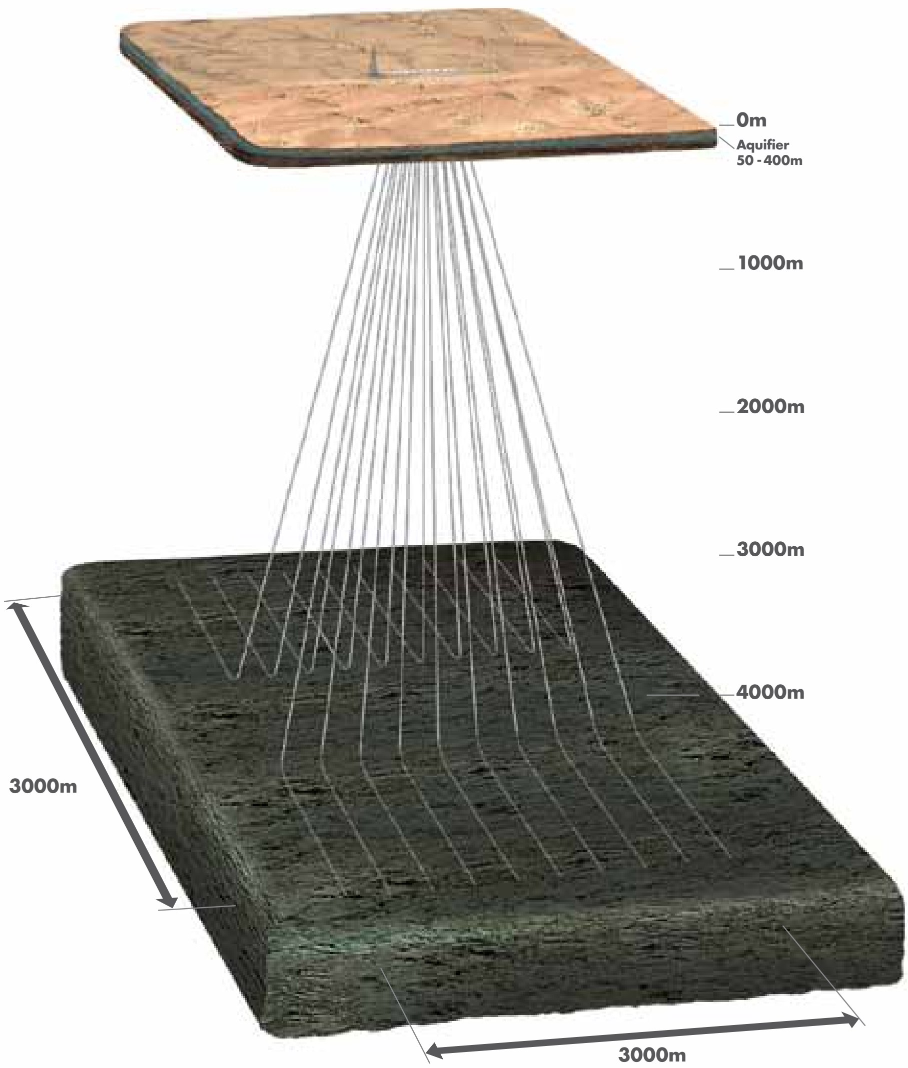
Figure 3.3: Schematic of horizontal well with hydraulic fracturing



Source: Shell

Additional advances in oil industry technologies and operations practices now also allows for multiple wells to be drilled from a single well pad location. This is common practice in offshore oil-gas production and is now becoming increasingly utilized in development of shale gas and shale oil plays. Multi-well pad drilling practice offers considerable advantages including (1) in reducing impact on the surface environment as fewer numbers of well pad locations are required, (2) provides flexibility in selecting well pad location, allowing for avoidance of environmentally sensitive areas and incorporating community desires, (3) fewer well pads helps minimize supporting infrastructure (e.g. roads) and (4) allows for increased efficiency in integrating development facilities that can also easily take advantage of incorporating new technologies (e.g. water recycling).

Figure 3.4: Schematic of a multi-well pad comprised of horizontal wells with hydraulic fracturing for development phase.



Source: Shell

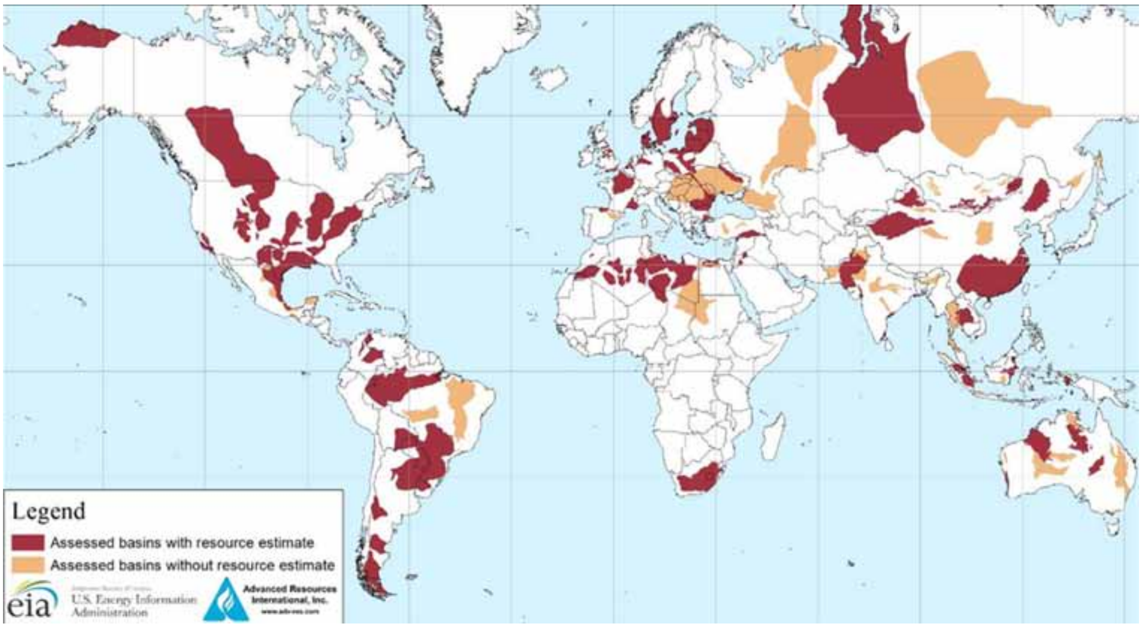
3.3 The "shale revolution"

The past decade has been marked by an energy revolution as developments in drilling techniques, particularly the horizontal drilling and the hydraulic fracturing, have enabled more efficient extraction of reserves, thus transforming the commercial viability of shale resource plays. The impact has been particularly noticeable in North America, where favourable fiscal regimes allowed the production of shale resources to be far advanced compared to the rest of the world.

However, whilst commercial production is advanced in North America, the current consensus is that extensive potential resource plays could also exist outside of this region. For example, EIA (2013) produced a synthetic assessment of shale gas resources across 41 countries indicating 7.299 tcf of technically recoverable shale gas reserves of which less than 17% was located in the US and Canada. By way of comparison, this is greater than the entire global supply of proven natural gas reserves. Figure 3.5 provides a geographical illustration of global shale gas resources. While it is appropriate to note that significant uncertainties exist around these estimates and that the successful development of these resource plays will depend upon the resolution of a diverse set of regulatory, environmental, social and economic challenges, it is clear that shale plays have the potential to act as a "transformative" driver of the global gas market.

Meanwhile, current estimates of the potential growth of shale liquid production suggest that it is unlikely to be such a "game-changer". Again, North America stands out as the region with by the most advanced current level of production with Wood Mackenzie (2012) in a recent report forecasting that tight oil output is set to rise from 1.5 million b/d in 2012 to 4.1 million b/d in 2020, led by the Bakken and Eagle Ford plays. In contrast, the same report predicts a gradual expansion of production outside of North America that might reach 1.5 million b/d by 2030.

Figure 3.5: Global shale gas resources



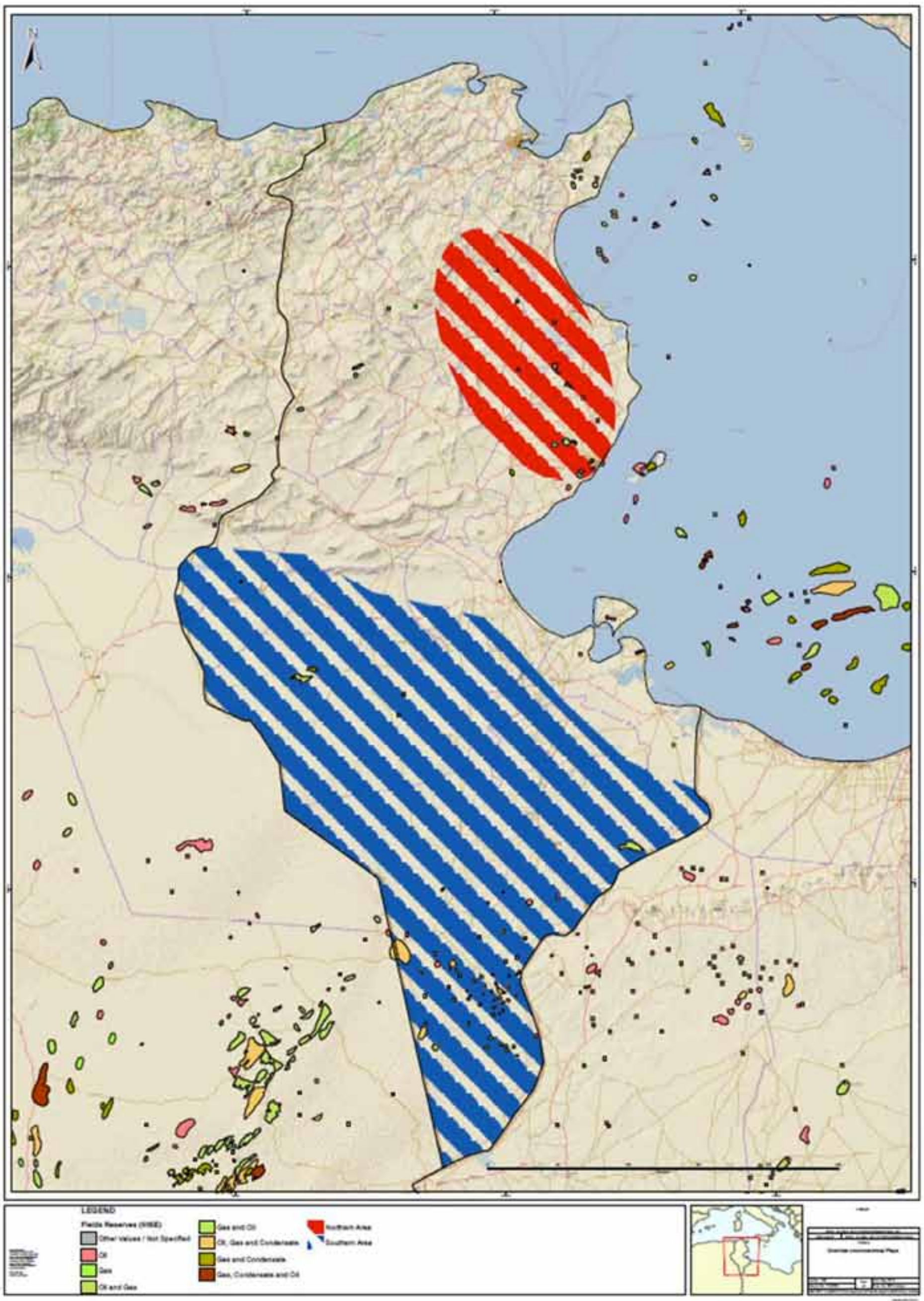
Source: EIA

3.4 The geography of this shale play

A number of potential shale gas and shale oil resource plays have been identified across Tunisia based on geological studies. It should be remembered however, that none of these plays have yet been proven to exist, and early exploration wells will be required to test the geological models.

The exploration that is the focus of this report models four potential successful resource plays that could be present across two large regions in Tunisia. The location of the separate regions is highlighted in Figure 3.6, with two wide areas marked in red and blue respectively. All plays are considered to cut across a number of Tunisian districts. For the purposes of economic modelling, this report considers that up to two resource plays are located in the area marked in red on the map covering the regions of Sfax, Mahdia, Monastir, Sousse, Kairouan and Sidi Bouzid. Meanwhile, up to two resource plays, coloured in blue in Figure 3.6, could be present much further south with activity concentrated in Tatouine, Kebili, Medenine, Gabes and Tozeur.

Figure 3.6: Map of potential shale resource plays

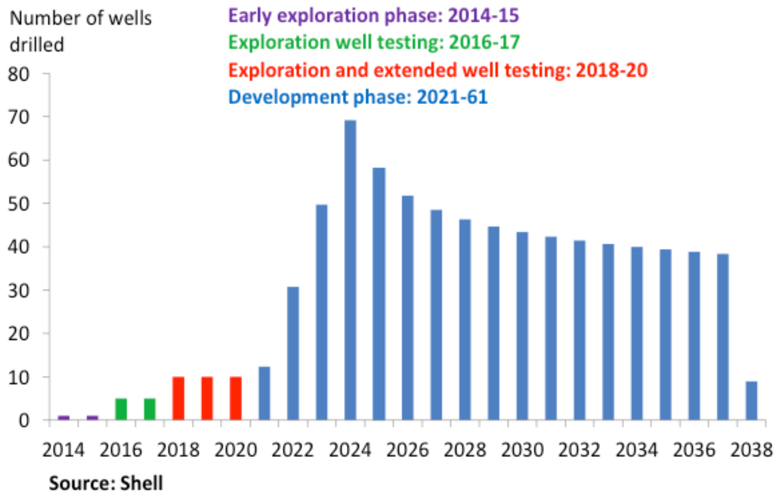


Source: Shell, IHSE

3.5 The project timeline

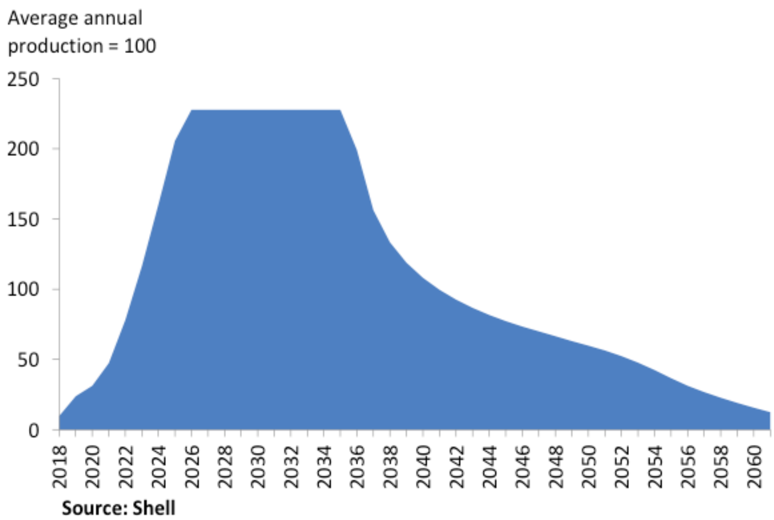
The analysis in this report assumes that exploratory well drilling commences in 2014 (a delayed commencement date would not materially alter the headline results). Exploratory drilling in each area will last for two years, at which point a decision will be taken about the commercial viability of continuing exploration. Should it be assessed that the probability of successful extraction is sufficient to warrant further investment, additional exploratory drilling will be commissioned lasting a further two years (2016-17), technically known as the "exploration well testing" phase. The activity in this period will increase significantly compared to the early exploration phase (phase I) with the number of wells drilled rising from one to five (Chart 3.2). At the end of this next two year period, it is assumed another decision will be made by the international investor(s) with regards to the commercial viability of exploration. Should this again prove to be positive then a further three years of drilling activity would be commissioned – the "exploration and extended well testing" phase – during which well drilling would double compared to the appraisal phase. This period would be associated with the small production of the first consumable resources from the project. A final decision would then be taken at the end of 2020 as to whether to continue to the full development phase which would imply a sharp increase in well construction. In the development phase well drilling is projected to continue until 2038.

Chart 3.1: Projected well drilling activity of a single resource play based on a generic exploration and development model scenario



However, the contribution of the project to the Tunisian economy will continue well beyond 2038 due to two factors. Firstly, completed wells will continue to produce liquid rich shale and shale gas in significant quantities generating fiscal revenues which will contribute directly to economy GDP. Secondly, the operation and maintenance of completed wells will require continued operational expenditure supporting domestic economic activity. Our analysis extends to 2061 although the exact timing of the completion of production and hence operational support is subject to a significant degree of uncertainty. Chart 3.3 illustrates the project's expected production profile with each year's production projection benchmarked against the expected mean annual production rate. It is clear that production will increase sharply following the movement to the development phase reaching a peak between 2026-35. Annual production should then decline fairly rapidly until 2038 at which point the annual rate of decrease should become much more gradual.

Chart 3.2: Expected production curve of a single resource play based on a generic exploration and development model scenario



4. THE ECONOMIC CONTRIBUTION OF EXPLORATION AND DEVELOPMENT

This chapter presents the results of the economic impact analysis, quantifying the expected contribution of exploration to GDP, employment and tax revenues. The focus of this chapter is on reporting the key results with detail on the methodology provided in the technical appendix in Chapter 8. As indicated in the introduction, the scope of our modelling was restricted to the direct upstream exploratory work and activity that was supported via indirect and induced effects. It is important to note that due to the de-risking strategy typical to resource plays, the majority of the economic impact occurs several years into the project in the Development phase.

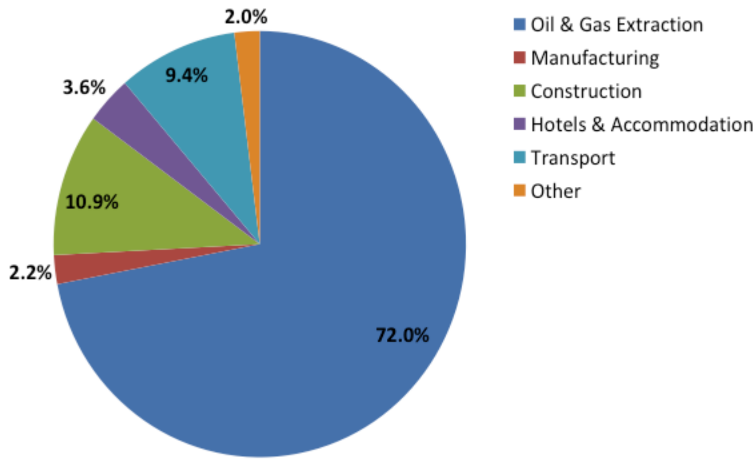
Key Points

- Total capital expenditure associated with the successful development of a single resource play is projected to be approximately TND 29 billion over a 47-year period of which around 77% is expected to be spent within country therefore contributing to Tunisian GDP. Investment will gradually increase before peaking between 2020-35 reflecting increased well drilling and construction activity.
- Given the nature of production and investment, the economic impact of the project will be unevenly distributed with the majority of the value added and particularly the employment generated during the peak activity part of the development phase.
- In total, we estimate that in Scenario 1 the project will make a direct value added contribution to GDP of TND 11.7 billion over a 47-year period with a peak year impact of TND 310 million, equivalent to 0.5% of Tunisian GDP or around 7% of the current value added of the entire oil and gas sector. These figures increase to TND 23.4 billion with a peak annual impact of TND 620 million (1.0% of GDP) in Scenario 2, and to TND 46.8 billion and TND 1.2 billion (2.0% of GDP) in Scenario 3.
- Our modeling indicates that should one play move successfully to development stage (scenario 1), it would support 96,000 job years over the project horizon with a direct peak employment impact of 7,700 jobs; equivalent to over 20% of current total employment in the Tunisian oil and gas industry.
- The project's contribution to GDP is supplemented by indirect (via supply chain activity) and induced (via employee wage spending) effects. In total, it is estimated that indirect impacts will contribute a further TND 560 million during the project horizon in Scenario 1, thereby supporting 44,000 job years. These figures rise to TND 1.1 billion (88,000 job years) and TND 2.2 billion (176,000 job years) in scenarios 2 and 3. Meanwhile, induced spending of employee wage income is estimated to support TND 770 million in GVA and 138,000 job years in Scenario 1. These figures rise to TND 1.5 billion (276,000 job years) and TND 3.1 billion (552,000 job years) in scenarios 2 and 3.
- In total, inclusive of all three channels of impact, we estimate that one play that proceeded successfully to the development stage would contribute TND 13.0 billion to Tunisian GDP with a peak annual contribution to GDP of TND 390 million. These figures rise to TND 26.0 billion in scenario 2 (a peak year impact of TND 780 million per year) and TND 52.0 billion in scenario 3 (a peak year impact of TND 1,560 million).
- Moreover, successful exploration would generate considerable fiscal benefits. In total, inclusive of activity supported directly, indirectly and via induced effects, we estimate that one successful development play would raise TND 9.9 billion or TND 206 million per year with the latter equivalent to 1.2% of current government revenue.

4.1 Capital investment

In total, capital expenditure associated with a single successful generic modelled resource play is projected to be approximately TND 29 billion (US$17 billion) measured at constant 2012 prices. Of this around 77% is expected to be spent within country thus contributing to Tunisian GDP with the remainder leaking abroad. This total expenditure figure was split between four categories: exploration drilling activity; well costs; facilities spending; and operational expenditure. In turn, this was allocated to different economic sectors based on data taken from other economic impact studies of shale projects with refinements made to reflect the characteristics of the Tunisian market [20]. This breakdown for in-country spending is presented in Chart 4.1. Unsurprisingly, oil and gas extraction accounts for the majority; reflecting funds required to support the development and operation and rigs and facilities and latterly spending related to the repair and maintenance of wells and facilities. Elsewhere, significant benefits will also be derived in the Tunisian construction sector relating to the building of pipelines, roads and residential structures such as camps to help house workers and transport services, which will be employed in logistical operations.

Chart 4.1: Allocation of projected direct in-country expenditure by economic sector



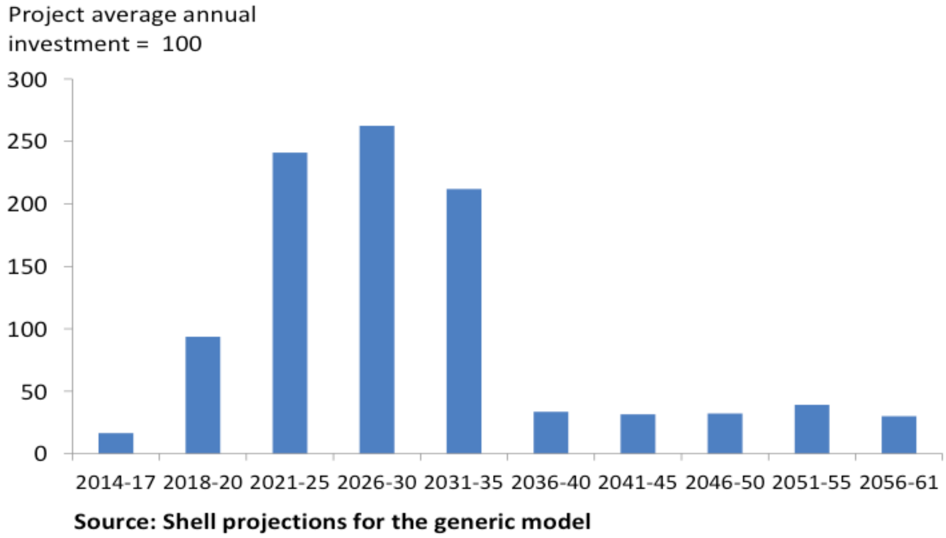
Source: Oxford Economics estimates

The generic model assumes in-country investment is projected to begin in 2014 and continue to 2061. Investment during the initial exploration period will be relatively limited reflecting lower drilling activity (Chart 4.2). Investment would increase significantly should the play move from exploration phase II to III (2018-20) and then again into the full development stage in 2021. As shown in section 3.2, the development of the play has been modelled to maintain a high level of drilling activity for the first fifteen years of the development stage, meaning that capital expenditure remains material through to 2035. Once well drilling has been completed in 2035, investment will tail off sharply being comprised solely of operational expenditure [21].

20 - Further detail on this benchmarking exercise can be found in section 8.2.

21 - Although investment does fall sharply post-2035 the continued production of oil and gas and therefore the ongoing fiscal injection from the play ensures that the contribution to Tunisian GDP remains considerable post-2035.

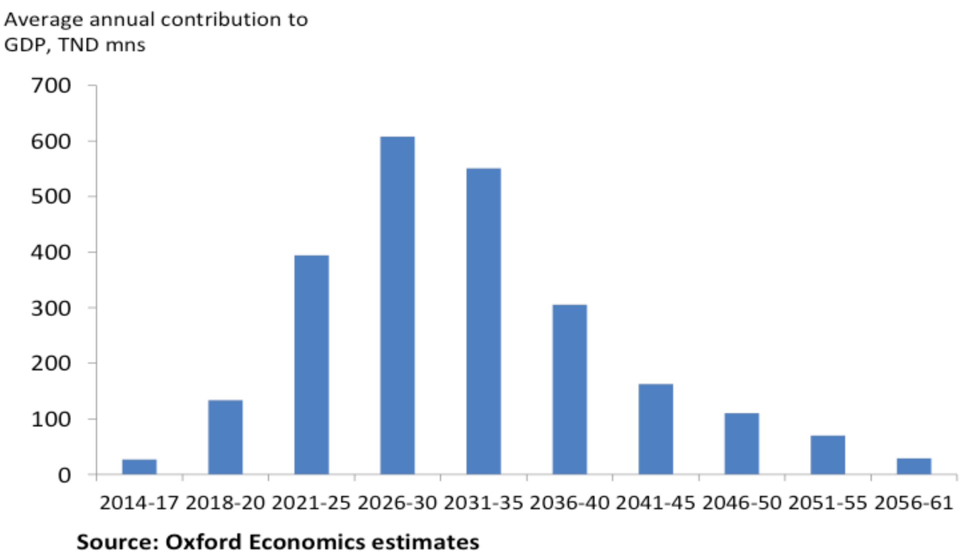
Chart 4.2: Profile of in country average annual investment spending based on a generic exploration and development scenario[22]



4.2 Direct impact

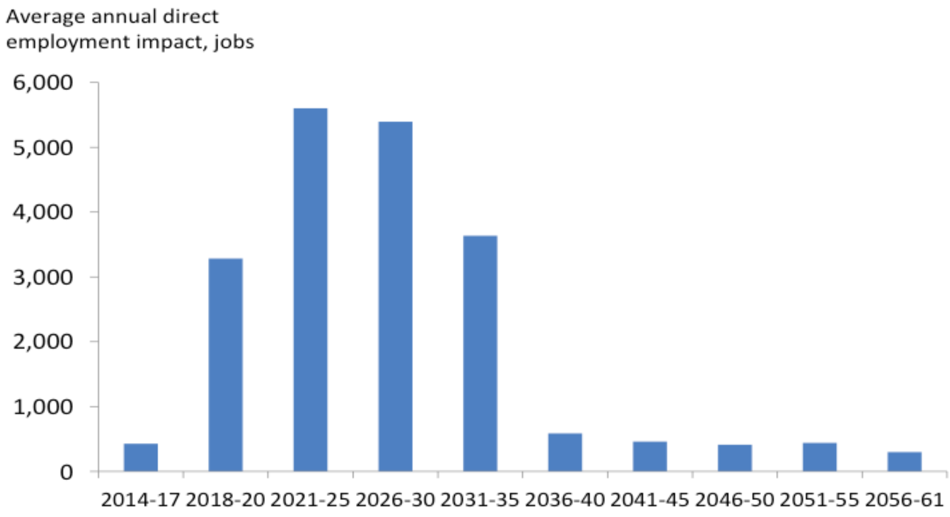
It is worth noting that due to the fact that play areas are typically developed and de-risked in a phased manner, the vast majority of the economic impacts likely to be felt several years into the project (Chart 4.3). The project's direct contribution to GDP is concentrated during the development phase when investment annual production volumes are maximised, particularly during the peak production period between 2025 and 2035. Meanwhile, the bulk of the employment impact of the project occurs due to in-country spending by the IOC particularly in the labour-intensive construction sector. Therefore, the peak job creation phases occur during the exploration and the extended well testing phase (phase III) and the first half of the development phase. On the other hand, direct job creation during the early exploration phase and the latter part of the development phase is relatively modest.

Chart 4.3: Profile of direct contribution to GDP



22 - Figures in this chart are based on spending projections in constant 2012 prices.

Chart 4.4: Profile of direct job creation



Source: Oxford Economics estimates

4.2.1 Contribution to GDP

The project's direct contribution to GDP is driven by three factors: the value added generated by contracts outsourced to Tunisian companies; revenues accumulated by the government and ETAP from the value of production; and wage payments to in-country employees by an investor. In total, we estimate that in scenario 1 the project will make a value added contribution to GDP of TND 11.7 billion implying an average annual impact of TND 243 million, equivalent to 0.3% of Tunisian GDP [23] or around 5.3% of current GVA of the entire extractive sector. As is demonstrated in Table 4.1, the project's average annual contribution to GDP gradually builds throughout the four phases, averaging TND 273 million during development. These figures can be assumed to be proportionately scaled up depending on the number of plays that successfully reach the development stage. Therefore in scenario 2, we estimate a total economic contribution to GDP of some TND 23.4 billion with an annual average impact of TND 487 million (0.6% of GDP), figures that rise to TND 46.8 billion and TND 974 million (1.2% of GDP) in scenario 3. The results through each phase of the project are summarised in Table 4.1.

Table 4.1: Direct contribution to GDP by scenario

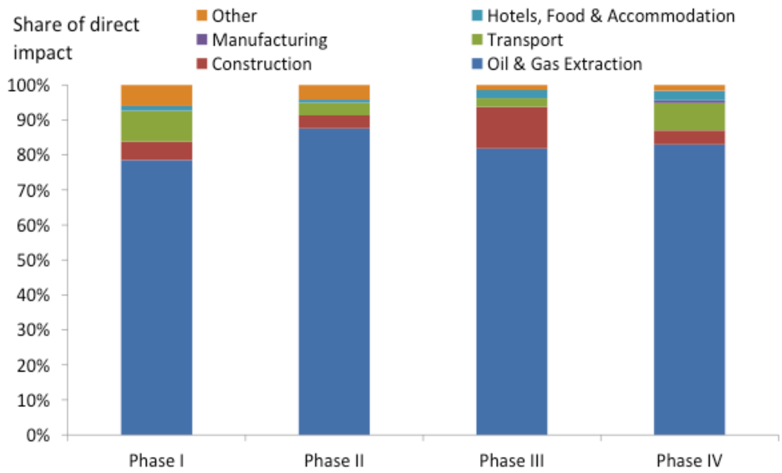
Direct Contribution to Tunisian GDP (mns discounted TND/US$ at 2012 prices)							
		Unit of measurement	Early exploration Phase I	Exploration well testing Phase II	Exploration and extended well testing Phase III	Development Phase IV	Total Phases 1-IV
			Years 1-2	Years 3-4	Years 5-7	Years 8-47	Years 1-47
Scenario 1	Total Impact	TND	35	73	401	11,179	11,688
	Average Annual Impact	TND	17	36	134	273	243
	Total Impact	US$	21	43	235	6,793	7,091
	Average Annual Impact	US$	10	21	78	166	148
Scenario 2	Total Impact	TND	70	146	802	22,358	23,376
	Average Annual Impact	TND	35	73	267	545	487
	Total Impact	US$	42	85	470	13,587	14,183
	Average Annual Impact	US$	21	43	157	331	295
Scenario 3	Total Impact	TND	140	292	1,603	44,716	46,751
	Average Annual Impact	TND	70	146	534	1,091	974
	Total Impact	US$	83	170	939	27,174	28,366
	Average Annual Impact	US$	42	85	313	663	591

Source: Oxford Economics estimates

23 - Based on the official projection for Tunisian GDP in 2012.

As is made clear by Chart 4.5, the direct contribution to GDP is heavily concentrated in the oil and gas extraction sector in which 83% of the project's GVA is generated. Elsewhere 7.6% of GVA is generated in transport services, the vast majority of which will occur in the development phase reflecting both the transport of surplus waste water and logistical support to operations. Meanwhile, 4.3% of the total impact is expected to occur in the construction sector with 2.7% in hotel, food and accommodation services. As emphasised previously, the size of the impact will be unevenly distributed between different phases of the project (see Chart 4.3).

Chart 4.5: Direct contribution to GDP by sector[24]



Source: Oxford Economics estimates

4.2.2 Employment

Estimates of the direct employment impact across the three scenarios are presented in Table 4.2. Job creation is expected to build steadily through the different phases of the play before peaking between 2020-35 when capital expenditure and construction activity are maximised. Our modelling indicates that should one play move successfully to development stage (scenario 1), it would support 96,006 job years over the project horizon or 2,000 jobs per year on average equivalent to over 20% of current total employment in the Tunisian oil and gas industry. These figures rise to 192,011 job years or 4,000 jobs per year in the case of scenario 2 and 384,023 job years or 8,000 jobs per year in the case of scenario 3. It's important to note that the bulk of these jobs are generated in the development phase once a play has been de-risked and drilling activity intensifies post 2020.

Table 4.2: Direct contribution to employment by scenario

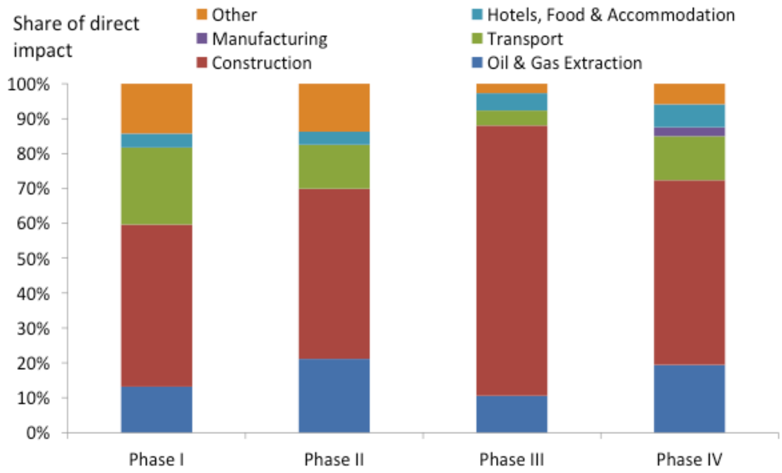
Direct Contribution to Employment							
		Unit of measurement	Early exploration Phase I Years 1-2	Exploration well testing Phase II Years 3-4	Exploration and extended well testing Phase III Years 5-7	Development Phase IV Years 8-47	Total Phases 1-IV Years 1-47
Scenario 1	Total Impact	Job years	574	1,132	9,855	84,445	96,006
	Average Annual Impact	Jobs per year	287	566	3,285	2,060	2,000
Scenario 2	Total Impact	Job years	1,149	2,263	19,710	168,890	192,011
	Average Annual Impact	Jobs per year	574	1,132	6,570	4,119	4,000
Scenario 3	Total Impact	Job years	2,297	4,526	39,420	337,779	384,023
	Average Annual Impact	Jobs per year	1,149	2,263	13,140	8,239	8,000

Source: Oxford Economics estimates

24 - The proportions in this chart are exclusive of the fiscal contribution of the project.

In contrast to the sectoral composition of GVA, the distribution of jobs between different industries is expected to be more even as shown in Chart 4.6. The rationale for this is that productivity in the oil and gas extraction sector (measured as GVA per worker) is much higher than in the rest of the economy [25] and hence a given level of GVA supports much fewer jobs than elsewhere. Overall, our modelling suggests that the most important industry employer will be construction, where just over half of total direct jobs will occur [26]. Elsewhere, it is estimated that just under 20% of all direct jobs will fall in the oil and gas sector with a further 12% in transport services. As emphasised previously, the actual size of the employment effects will vary considerably through the four stages of a resource play.

Chart 4.6: Sector breakdown of direct contribution to employment



Source: Oxford Economics estimates

4.3 Indirect and induced effects

4.3.1 Contribution to GDP

Moreover, exploration will generate further economic benefits through indirect and induced impacts as summarised in Table 4.3. In comparison to the direct impact, the so-called multiplier effects are much smaller reflecting a number of factors. First, as a relatively small and open economy, the amount of "leakage" along the supply chain is commensurately higher. Second, the direct impact activity is concentrated in by far the most productive sector of the economy – oil and gas extraction. Finally, and most significantly, a large proportion of the direct contribution consists of revenues generated for the government and ETAP neither of which generate an indirect or induced impact [27].

In total, we estimate that one play moving successfully through the development phase would support a further TND 559 million in indirect effects or TND 12 million per year on average. These figures can be scaled up appropriately in scenarios 2 and 3. Meanwhile, the induced impact is slightly larger totalling TND 767 million in scenario 1 (TND 16 million per year on average), rising to TND 1,534 million in scenario 2 (TND 32 million per year) and TND 3,068 million in scenario 3 (TND 64 million per year).

25 - Based on official projections estimates in the oil and gas sector in 2012 was TND 480,558 compared to an economy-wide productivity rate of TND 20,777. For reference, the next most productive sector, telecommunications, generated TND 97,363 of value added per worker.

26 - The very high level of employment in the construction sector is partly a reflection of the very low reported level of productivity in the construction sector – GVA per worker in 2011 was just TND 6,163. Although in most countries construction is relatively unproductive due to the high level of brought in costs, we were very surprised by the extent to which this was the case. In discussion with Zouhair El Kadhi it was determined that due to more efficient management practices and more sophisticated technological equipment, it was reasonable to assume that productivity in the construction sector was 20% higher than the economy wide average. The very low productivity may be the result of a high incidence of part-time work in the sector but unfortunately data on the split of headcount employment between part-time and full-time roles in not available and therefore no adjustment to account for this effect was made.

27 - Of course the fiscal revenue generated by the project would be recycled and used to support economic activity elsewhere in the economy. However, modelling this is far from straightforward largely because the counterfactual of the government would use the funds is essentially unanswerable.

Therefore, inclusive of direct, indirect and induced effects, we estimate that one play that proceeded successfully to the development stage would contribute TND 13.0 billion to Tunisian GDP or TND 271 million on average per year. These figures rise to TND 26.0 billion in scenario 2 (TND 542 million per year) and TND 52.1 billion in scenario 3 (TND 1,085 million per year).

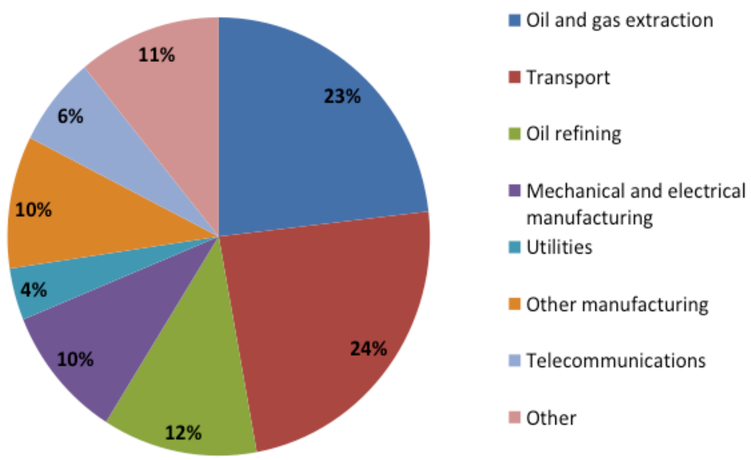
Table 4.3: Indirect and induced contribution to GDP by scenario

Indirect and Induced Contribution to Tunisian GDP (discounted TND mns)							
			Early exploration	Exploration well testing	Exploration and extended well testing	Development	Total
			Phase I	Phase II	Phase III	Phase IV	Phases 1-IV
			Years 1-2	Years 3-4	Years 5-7	Years 8-47	Years 1-47
Indirect Impact	Scenario 1	Total Impact	8	17	66	468	559
		Average Annual Impact	4	8	22	11	12
	Scenario 2	Total Impact	17	33	133	936	1,119
		Average Annual Impact	8	17	44	23	23
	Scenario 3	Total Impact	33	67	265	1,872	2,238
		Average Annual Impact	17	33	88	46	47
Induced Impact	Scenario 1	Total Impact	8	18	67	674	767
		Average Annual Impact	4	9	22	16	16
	Scenario 2	Total Impact	16	35	135	1,348	1,534
		Average Annual Impact	8	18	45	33	32
	Scenario 3	Total Impact	32	70	270	2,697	3,068
		Average Annual Impact	16	35	90	66	64

Source: Oxford Economics estimate

As expected there are significant differences in the sectoral composition of value added compared to the direct impact. In general, the distribution is much more even, with the largest source of value added, transport services, accounting for less than a quarter of the total indirect contribution to GDP (Chart 4.7). Significant activity is also likely to occur in the oil and gas sector (23%), oil refining (12%), mechanical and electrical manufacturing (10%) and telecommunications (6%).

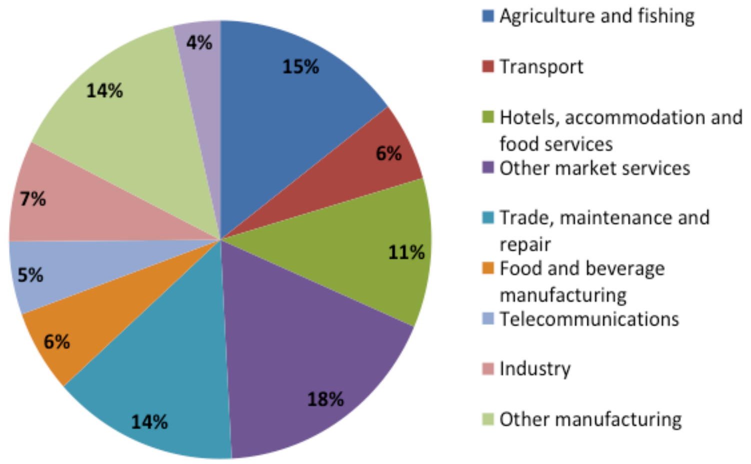
Chart 4.7: Sectoral distribution of GVA from indirect impact



Source: Oxford Economics estimate

Meanwhile, the sectoral distribution of value added from the induced effect is concentrated in industries that serve consumers such as trade, maintenance and repair (14%) and hotels, accommodation and food services (11%) or key suppliers to those industries such as agriculture and fishing (15%) and food and beverage manufacturing (6%) (Chart 4.8).

Chart 4.8: Sectoral distribution of GVA from induced impact



Source: Oxford Economics estimate

4.3.2 Employment

Such activity will support further employment creation across the Tunisian economy. The bulk of the activity will be generated in the development phase once a play has been de-risked and drilling activity intensifies. In Scenario 1, it is estimated that the project will support 44,091 job years or 919 jobs per year on average. These figures rise to 88,182 job years in Scenario 2 (1,837 jobs per year) and 176,365 job years in scenario 3 (3,674 jobs per year). Meanwhile, the spending of employee wage income (the induced effect) is expected to support 138,457 job years in Scenario 1 (2,885 jobs per year) rising to 276,913 job years in scenario 2 (5,769 jobs per year) and to 553,826 job years in Scenario 3 (11,538 jobs per year).

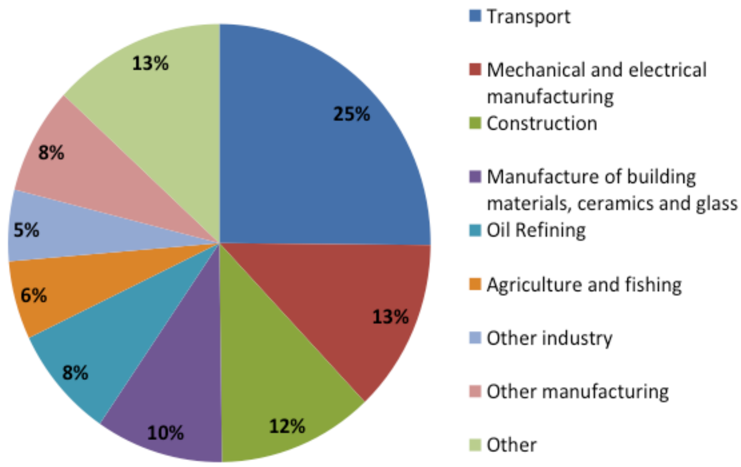
Table 4.4: Indirect and induced contribution to employment by scenario

Indirect and Induced Contribution to Employment (Jobs)								
			Early exploration	Exploration well testing	Exploration and extended well testing	Development	Total
			Phase 1	Phase 2	Phase 3	Phase 4	
			Years 1-2	Years 3-4	Years 5-7	Years 8-47	Years 1-47
Indirect Impact	Scenario 1	Total Impact	263	668	3,916	39,244	44,091
		Average Annual Impact	132	334	1,305	957	919
	Scenario 2	Total Impact	527	1,335	7,831	78,489	88,182
		Average Annual Impact	263	668	2,610	1,914	1,837
	Scenario 3	Total Impact	1,054	2,671	15,663	156,977	176,365
		Average Annual Impact	527	1,335	5,221	3,829	3,674
Induced Impact	Scenario 1	Total Impact	502	1,481	7,336	129,137	138,457
		Average Annual Impact	251	741	2,445	3,150	2,885
	Scenario 2	Total Impact	1,005	2,963	14,673	258,273	276,913
		Average Annual Impact	502	1,481	4,891	6,299	5,769
	Scenario 3	Total Impact	2,009	5,925	29,345	516,546	553,826
		Average Annual Impact	1,005	2,963	9,782	12,599	11,538

Source: Oxford Economics estimate

It is evident that although the indirect and induced effects in terms of the contribution to GDP are relatively insignificant in comparison to the direct impact, that is certainly not the case of employment. The rationale for this is that activity is concentrated in less productive sectors (particularly for the induced effect). Taking the indirect effect first, a quarter of jobs are expected to be located in transport services with 13% in mechanical and electrical engineering, 12% in construction and an additional 10% in the manufacture of building materials, ceramics and glass.

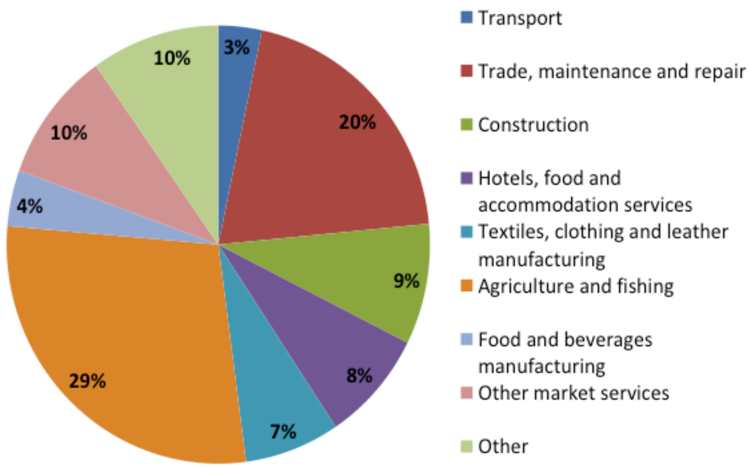
Chart 4.9: Sectoral distribution of indirect employment



Source: Oxford Economics estimate

Meanwhile, jobs supported by the induced impact will be concentrated in sectors that depend on the strength of consumer spending either directly such as trade, maintenance and repair (20%) and hotels, food and accommodation services (8%) or indirectly such as agriculture and fishing (29%) and textiles, clothing and leather manufacturing (7%).

Chart 4.10: Sectoral distribution of induced employment



Source: Oxford Economics estimate

4.4 Fiscal contribution

The project's total fiscal contribution has been modelled through a number of channels. Alongside the share of direct production value that will be claimed by the government and the state petroleum company ETAP, further fiscal benefits will be created by direct tax payments levied on employee income, corporate tax revenues raised on the profits of other firms (i.e. excluding the international oil company) and VAT revenues generated by the spending of employee wage income. As Tunisia's oil and gas law provides for two Exploration and Production (EP) fiscal models (a Contract of Association and Production Sharing Agreements), a detailed breakdown between these revenue sources is difficult to present in this study. Instead, this study presents timing and total value of the payments based on a generic model.

In total, inclusive of activity supported directly, indirectly and via induced effects, we estimate that one successful development play would raise TND 9.9 billion or TND 206 million (Table 4.5), with the latter equivalent to 1.2% of current government revenue [28]. These figures rise to TND 19.8 billion and TND 412 million per year in Scenario 2 and TND 39.5 billion and TND 823 million per year in Scenario 3. As an indication of the scale of these figures, we estimate that raising an additional TND 206 million (Scenario 1) would require a one percentage point rise in the headline rate of VAT.

Table 4.5: Total fiscal contribution by scenario

Total Contribution to Tunisian Treasury (discounted mns TND, 2012 prices)						
		Early exploration	Exploration well testing	Exploration and extended well testing	Development	Total
		Phase I	Phase II	Phase III	Phase IV	
		Years 1-2	Years 3-4	Years 5-7	Years 8-47	Years 1-47
Scenario 1	Total Impact	6	14	207	9,654	9,881
	Average Annual Impact	3	7	69	235	206
Scenario 2	Total Impact	11	29	414	19,308	19,762
	Average Annual Impact	6	14	138	471	412
Scenario 3	Total Impact	23	58	827	38,616	39,524
	Average Annual Impact	11	29	276	942	823

Source: Oxford Economics estimates

4.5 Net economic impact

It is worth noting that the results presented in this chapter reflect our best estimates of the contribution of exploration and development to economic activity. In particular, since they do not take account of displacement effects the figures should not be interpreted as an indication of the impact on economy GVA. Global Insight (2011) modelled the permanent effect of shale gas extraction on the US economy up to 2035. Their results imply that the near-term impact on both GDP and employment is significant with the economy currently operating well below full capacity. In the long-run the effect is more marginal with a small positive impact registered in 2035 due to beneficial supply-side effect of lower energy prices. The more material development is to drive a significant increase in the level of industrial production, effectively implying a structural shift in resources towards manufacturing, construction and extraction.

In the near-term, it is reasonable to assume that the Tunisian economy is operating below full capacity and hence the impact on the level of GDP is likely to be positive. According to data from the INS the unemployment rate in May 2012 was 17.6% compared to just 12.4% in 2007, before the global financial crisis. Our macroeconomic forecast suggests that returning to the pre-crisis unemployment rate will take to beyond 2020.

In the long-run, when the economy has returned to full capacity, the project would only affect GDP through its ability to affect aggregate supply. A number of factors suggest that the impact is likely to be positive, although formally quantifying the scale of these effects is beyond the scope of this report.

First, the investment by an IOC offers the opportunity for spillover benefits via knowledge transfers which should benefit key domestic suppliers [29]. These typically occur through the implementation of superior management

28 - Based on data for calendar year 2011 when government revenues totalled TND 16.6 billion excluding monies generated through the issuance of debt.

29 - Further detail on the likely channels of these effects can be found in Chapter 6.

and production techniques. Moreover, any training of local workers funded by the IOC will boost the stock of human capital within the economy which should feed through to higher labour productivity.

Second, it is likely that the increased availability of domestic oil and gas will reduce domestic energy prices particularly during the peak production years of the project (approximately 2025-35). The extent to which this effect might occur is highly uncertain and dependent on a number of factors including the size of the successfully extracted resource, the extent to which prices are regulated or set via the open market and the extent to which Tunisia continues to rely on energy imports.

A third avenue through which the resource play could boost GDP in the long-run is via the sectoral distribution of employment since a material proportion of direct activity will occur in the oil and gas sector, where productivity is significantly higher than the economy-wide average. Based on our macroeconomic forecast, taken across the project horizon direct and indirect jobs created will be over 2.5 times more productive than the economy wide average[30]. However, the project will also influence the structural composition of the economy in other ways which may be more harmful. As referenced in section 2.5.2, large resource finds typically trigger so-called "Dutch Disease" effects where the resulting inflow of foreign currency triggers an appreciation of the real exchange rate. Such a price movement reduces the external competitiveness of the tradables sector (primary industries, manufacturing and parts of services) and may result in a reallocation of labour from more to less productive sectors. In any case, managing the effects of such an exchange rate appreciation will be an important challenge for policymakers during the project.

30 - The following analysis excludes jobs supported via the induced effect. The rationale is that the induced jobs that form part of the economic contribution of the project are in a sense generic to any deployment of resources, so that if resources were employed in an alternative manner they would still generate employment and hence wage income that would be spent and therefore support activity across the sectors estimated here.

5. THE REGIONAL ECONOMIC IMPACT

This chapter provides background information about the regional economies where the project is set to be concentrated. Although oil and gas exploration is not as extensive as in neighbouring Algeria, it has generated significant benefits for certain regional economies over the past 30-40 years. The major oil producing fields are El Borma, Ashtart and Sidi el Kilani with gas also produced in El Borma and the offshore Miskar field.

A full decomposition of the economic impact reported in Chapter 4 would be extremely challenging given the availability of regional data and the length of the project's time horizon. Instead, information is presented to provide a guide as to the extent to which the economic benefits of the project may be felt locally, including data on the regional labour market, such as the sectoral breakdown of employment and unemployment rates, and a range of socioeconomic indicators.

Key Points

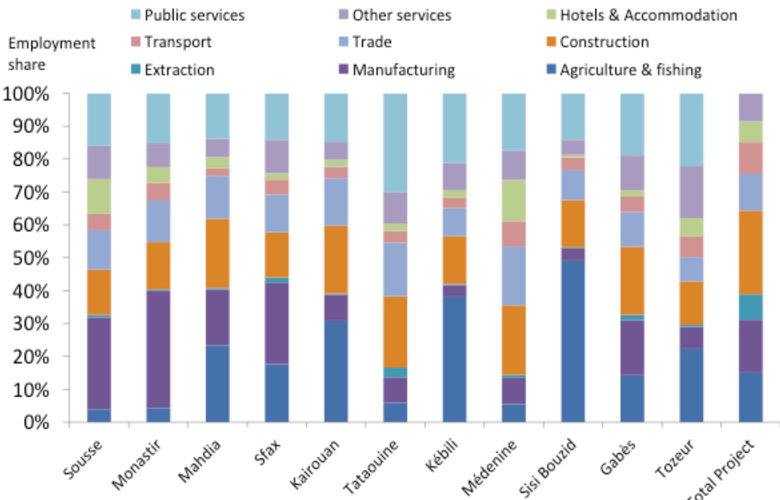
- The likelihood that a job generated by the resource play is located in the nearby regions will be affected by both the channel of impact (direct, indirect, induced) and the sector in which the job is created. Direct and induced jobs (those which are supported by the spending of a direct employee) are more likely to be located locally as are opportunities in service sector industries such as retail trade and hotels, food and accommodation services.
- For the purpose of this study, regional economic impacts have been modeled for eleven selected Governorates: Sousse; Sfax; Kairouan; Monastir; Mahdia; Sisi Bouzid; Kebili; Medenine; Gabes; Tozeur and Tatouine. Details on the likely implications for the labour market in each area are detailed in sections 5.1.1 and 5.1.2. It is worth noting that the success of a resource play has yet to be proven in Tunisia. These modeled results do not imply that only these Governorates could receive benefit, or that other Governorates would be excluded in the event of successful exploration.
- Socioeconomic indicators suggest a significant degree of regional inequality in living conditions across Tunisia. In particular, the Central West region (Kairouan, Kasserine and Sisi Bouzid) compares unfavorably across a range of metrics. Given this, considerable gains appear possible should the fiscal revenues generated by the resource play contribute to funding a well-managed regional development strategy.

5.1 Regional labour markets

Section 3.4 outlines the geography of the various resource plays. For the purposes of this section we focus on labour market data for Sousse, Sfax, Monastir, Mahdia, Kebili, Medenine and Tatouine. Chart 5.1 summarises the breakdown of regional employment in these seven regions according to official data for 2010[31] matched against the estimated sectoral decomposition of employment from the project inclusive of direct, indirect and induced impacts. Such a comparison is purely indicative as the regional breakdown refers to a static historical point (2010) whereas the employment impact from the project will occur over an extended horizon during which time the composition of these regional labour markets is likely to change considerably. Indeed, a successful resource play as described here would in itself alter the dynamics of the regional labour market. Nonetheless, the information provides a guide as to the nature of the opportunities that may arise in each region, particularly during the earlier stages of the project.

31 - The raw data was sourced from the INS. Part of the regional totals is designated as non-specified. These jobs were allocated to the official labour market industries based on their share of regional employment.

Chart 5.1: Comparison of regional and project sectoral composition of employment



Source: INS, Oxford Economics estimate

For the purposes of this analysis the estimated employment impact from the project is divided into eight sectors. The nature of sales and production has different implications about the likelihood of these jobs being located locally. This point is expanded upon in the bullet points below:

- **Agriculture and fishing**: the vast majority of jobs in agriculture are created via the induced effect with the spending of wage income on food and beverage products supporting the agricultural sector. Given the ability to transport agricultural products over long distances, the location of the resource play is unlikely to have much implication for the location of jobs supported in agriculture.
- **Manufacturing**: typically supported via indirect and induced effects. Similar to agriculture, the location of the resource play is unlikely to affect the region in which these jobs are created.
- **Extraction**: includes both the oil and gas sector and utilities. The vast majority of these jobs are created directly in oil and gas extraction. Here the location of the resource play will determine where the jobs will be created.
- **Construction**: over 70% of the estimated employment impact is expected to occur via the direct effect. Here, clearly the location of the resource play will be critical to determining the regions that will benefit from these jobs. For the indirect and induced effect the relationship is much less clear.
- **Trade**: the vast majority (90%) of the jobs will be supported via induced spending. Since people typically spend the majority of their income in their place of residence the location of the direct/indirect job that has supported the induced spending will be critical to determining where these job opportunities occur.
- **Transport**: jobs are split fairly evenly between the direct and indirect effects (around 40% each) with the remaining 20% occurring via the induced effect. Jobs generated directly and those via the induced effect which rely on direct employee wage spending are much more likely to be based locally.
- **Hotels, accommodation and food services**: around 1/3 are supported directly with the remaining 2/3 supported via the induced effect. For the direct jobs, the location of the resource play is crucial – Governorates with more developed hospitality industries will clearly be at an advantage here. Similar to trade, jobs supported by the induced effect will depend upon the location of the original direct/indirect job.
- **Other services**: a fairly nebulous category encompassing jobs in financial and business services, telecommunications, cultural and social activities. We expect that regional linkages will not be particularly strong for this category of jobs.

5.1.1 Resource play 1 – Central East and surrounding region

Resource play 1 takes place in the area marked in red in Figure 3.4. The plays centre on Sousse, Sfax and Mahdia whilst also overlapping into Kairouan, Sisi Bouzid and Monastir.

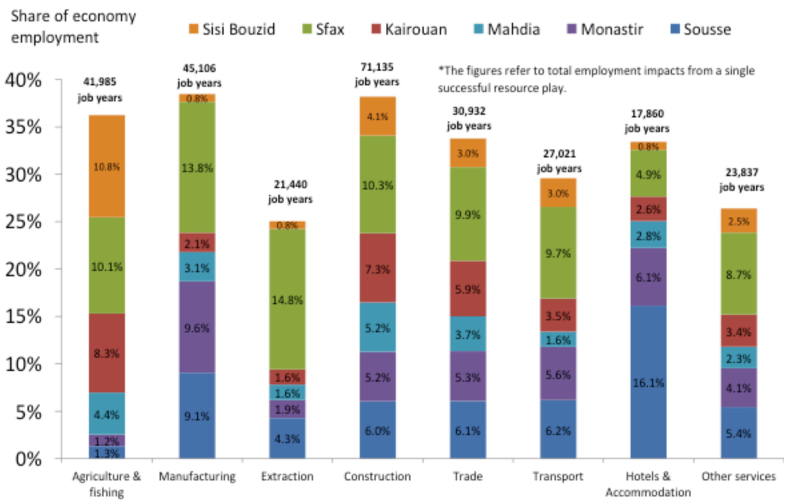
Sousse: as can be seen from the Chart 5.2, Sousse has a very well developed hospitality industry, with employment in the hotel, accommodation and food services sector accounting for over 16% of the Tunisian total. This, together with its central location, suggests that direct jobs created in this industry from resource play 1 would be more likely to be located here than in Mahdia or Kairouan. Elsewhere, it seems likely that some of the direct jobs in construction and extraction will reside in Sousse together with some of the induced activity in retail trade that is supported by direct employment.

Monastir: Although smaller than in Sousse, the hotels, accommodation and food services sector is fairly developed so some of these direct jobs are likely to be located here particularly should resource play 2 be successful.

Mahdia, Sisi Bouzid and Kairouan: as agriculture remains a key employer in both Mahdia and Kairouan we group these two Governorates together. Induced spending should spur employment in agriculture to some extent. Meanwhile, a higher proportion of the direct jobs in construction and extraction are likely to be located in Mahdia simply because of its more central position in the resource plays.

Sfax: the fairly extensive manufacturing base particularly in food, beverages and tobacco and textiles, clothing and leather sectors suggests that some of these opportunities created by indirect and induced impacts may benefit workers in Sfax. Elsewhere, a significant share of theconstruction and extraction direct employment is likely to be located in Sfax given the geography of resource play 1. A fairly sizeable agricultural sector should also benefit to some extent from the impact of induced spending.

Chart 5.2: Region's share of economy employment by sector*



Source: INS, Oxford Economics estimate

5.1.2 Resource play 2 – South East and South West regions

Meanwhile resource play 2, marked in blue in Figure 3.4, overlaps the Governorates of Tatouine, Medinine, Gabes, Tozeur and Kebili. As can be seen immediately from Chart 5.4, economic activity in these regions (particularly Tatouine and Kebili) is relatively undeveloped. Despite their large geographic size the regions of Kebili and Tatouine account for a very small share of Tunisian employment with much of the land uninhabited. Taking the three regions in turn:

Kebili: is an agriculturally-dominated area with the sector accounting for almost 40% of total employment, with construction and retail trade representing the other key employers. Meanwhile, the current manufacturing base is very small as are the hospitality and transport industries. Therefore, the regional employment impact is likely to depend significantly on the extent to which direct oil and gas and construction workers are based here compared to Medenine and Tatouine.

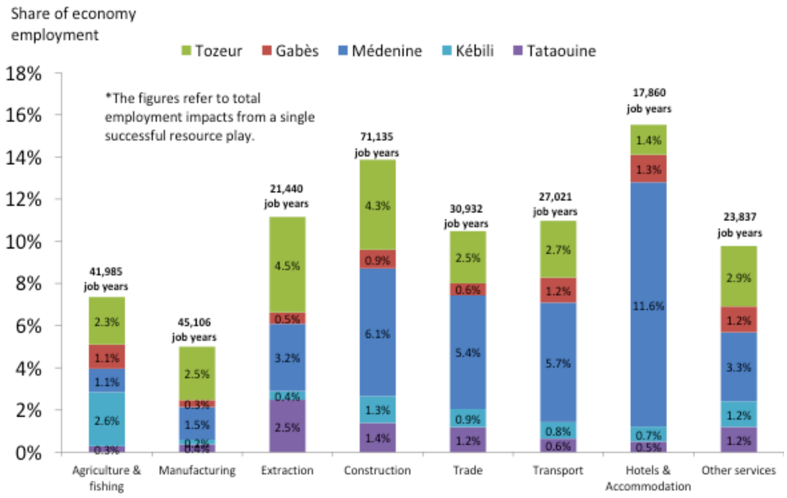
Medenine: has by far the largest hotels, accommodation and food services sector implying that direct jobs created by the need to accommodate workers on rigs are more likely to be located here. Meanwhile, given the geography of the play, most direct jobs in construction and extraction are likely to be technically located outside of the region although that does not exclude the possibility of existing workers from Medenine either commuting or migrating to Kebili and Tatouine.

Tatouine: similar comments apply as to Kebili, although agriculture is far less important as a source of employment. Some benefits should result for construction and extraction workers while the retail sector should also benefit from the induced spending of those direct workers.

Gabes: the service sector is a relatively important employer with agriculture and construction also key sources of jobs. The likely impacts will therefore depend on the extent to which induced spending benefits the agricultural and retail trade sector in Gabes.

Tozeur: in terms of the composition of the labour market a similar region to Gabes with the vast majority of employees located in the services, agricultural and construction sectors. Therefore, again the likely impacts will depend on the extent to which induced spending supports consumer-facing sectors.

Chart 5.3: Region's share of economy employment by sector*



Source: INS, Oxford Economics estimate

5.2 Regional inequality

Section 5.1 addressed the likely regional implications of employment creation from the project. An additional regional dimension could result from the fiscal revenue raised from the project which, as shown in chapter 4, will be considerable. How the government opts to spend these resources is of course highly uncertain and hence formally modelling the impact of such spending would be speculative. Therefore, we adopt a qualitative approach with descriptive statistics used to describe disparities in socioeconomic conditions in regions across Tunisia. Such analysis is not intended to be prescriptive.

The data are summarised in Table 5.1. The Central West region of the country encompassing the Governorates of Kairouan, Kasserine and Sisi Bouzid stands out as suffering from relatively deprived socioeconomic conditions across most metrics[32]. This is probably best summarised in the respective poverty rates which, albeit slightly out of date, are significantly higher than the rest of Tunisia. It is important to acknowledge the limits to which policy can help address these issues but in our view properly managed regional development programmes would contribute to alleviating some of the existing regional disparities in living conditions.

32 - Interestingly, the one metric where this does not hold true is for the unemployment rate which varies significantly across the region. Indeed, in Kairouan unemployment was actually below the economy-wide average in 2010 although over half of those employed were in the agricultural and construction sectors which suffer from very low productivity (and hence average earnings).

Table 5.1: Socioeconomic indicators by Governorate in Tunisia

Socioeconomic conditions in Tunisian governorates (2010)							
Region	Hospital beds per 1000 inhabitants	Infant mortality rate	clean drinking water (% share)	% of households connected to sewage system	Infant mortality rate	Unemployment rate (%)	Poverty rate (2005)
Tunis	3.85	12.8	99.7	96.0	12.8	14.2	6.9
Ariana	0.87	14.4	99.3	90.6	14.4	10.8	6.9
Ben Arous	0.42	13.9	98.1	95.1	13.9	12.2	8.0
Manouba	2.70	15.5	95.5	92.4	15.5	15.3	11.8
Nabeul	1.23	14.7	88.1	89.4	14.7	11.4	5.5
Zaghouan	2.78	18.5	73.6	92.5	18.5	4.9	19.5
Bizerte	1.69	17.9	83.3	97.5	17.9	12.8	15.9
Béja	1.74	17.6	68.0	98.9	17.6	11.5	14.4
Jendouba	1.35	19.2	57.8	87.4	19.2	17.7	10.8
Le Kef	1.78	18.3	66.4	90.5	18.3	12.4	14.1
Siliana	1.92	21.3	61.7	93.3	21.3	15.6	17.2
Sousse	2.48	13.4	98.8	95.9	13.4	13.0	6.3
Monastir	2.24	14.1	99.2	83.3	14.1	6.1	4.6
Mahdia	1.51	19.3	87.6	68.2	19.3	12.2	7.6
Sfax	1.77	13.2	86.0	69.2	13.2	7.4	7.8
Kairouan	1.24	21.9	72.6	89.4	21.9	10.6	23.2
Kasserine	1.43	25.5	59.4	77.0	25.5	20.7	27.2
Sidi Bouzid	0.91	23.4	54.6	59.2	23.4	14.7	27.5
Gabès	1.55	19.6	91.8	85.2	19.6	18.1	16.0
Médenine	1.59	20.6	87.8	26.4	20.6	13.9	10.1
Tataouine	1.79	28.5	89.3	60.2	28.5	23.6	18.2
Gafsa	1.65	20.0	86.1	66.9	20.0	28.3	13.1
Tozeur	3.04	20.4	98.0	86.7	20.4	17.0	13.5
Kébili	1.68	26.8	96.7	58.7	26.8	17.5	14.8
Tunisia	1.82	17.8	85.6	84.2	17.8	13.0	13.4

Source: INS and ITCEQ

6. WIDER CATALYTIC BENEFITS

To this point, this study has focused on the quantifiable economy-wide impacts of shale exploration. However, some of the industry's key impacts are more qualitative in nature and not easily quantifiable. This chapter addresses these more qualitative impacts.

Key Points

- An important benefit of shale liquids and gas extraction for Tunisia is the availability of a larger supply of oil and gas for local industry. This provides a lower and stable energy price for local firms, which has an especially beneficial impact on energy-intensive industries such as manufacturing.
- In Tunisia, a mixture of new access roads and upgrades to existing roads will be built as part of shale gas and liquids extraction plans. The direct, indirect and induced benefit of this expenditure in terms of GVA has already been captured in the impact analysis in chapter 4, but there are also microeconomic and macroeconomic spillover benefits to the greater economy.
- Foreign direct investment (FDI) by IOCs is often coupled with social investments that are complementary to the firm's and the country's socioeconomic goals. These programs provide valuable training and education targeted to underserved populations.
- Another way in which IOCs impact the countries in which they invest is through knowledge spillovers. Knowledge spillovers arise from efficiency gains by local firms associated with FDI. These efficiency gains may potentially be exploited in future unconventional resource projects in Tunisia and across the region.
- Finally, the potential for a significant increase in production could yield less tangible benefits in terms of enhancing energy security. Achieving a production surplus (as in Scenario 3) would clearly significantly reduce Tunisia's need to import energy products making the economy less vulnerable to supply disruptions in key producer countries due to, for example, natural disasters, international disputes or political instability. The future pattern of Tunisian energy imports (in terms of country of origin) is uncertain but it seems likely that trading patterns will continue to reflect geographical proximity with key trading partners likely to remain in the MENA and Southern European regions. Continued high political tension in the former region implies potentially considerable benefits from enhanced energy security

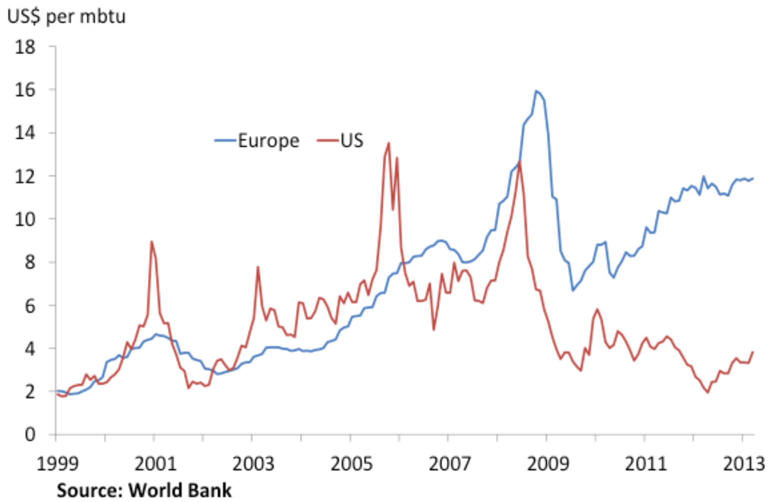
6.1 Enhanced availability of oil and gas

As demonstrated in Chapter 2, successful extraction of shale rich liquids and shale gas will materially enhance the availability of domestic energy. A number of benefits may stem from this including the potential to reduce energy prices to domestic companies.

Although not directly analogous, the recent experience of the US may be informative to some extent. Chart 6.1 documents the path of European and US gas prices since 1999 with a clear divergence apparent since 2008 largely as a result of the boom in production of shale gas in the US during that period. It is important to recognise that such a dramatic reduction in energy costs is unrealistic in Tunisia given differences in the scale of domestically available resources. However, some cost advantages seem likely given the implied reduction in transport costs.

In general, one would expect that such cost advantages would disproportionately benefit energy intensive industries. Unfortunately, data on energy consumption by sector for Tunisia is not available to a sufficiently disaggregated level to facilitate insightful conclusions on this issue. Therefore, instead references from the literature are taken from the US experience. For example, Global Insight (2011) investigate the implications of this price shift for US manufacturing. In total, they suggest that the reduction in energy costs as a result of the shale gas boom in the US will result in a long-run increase in the level of industrial production by 4.7%, due to the enhanced competitiveness of the industrial sector. The chemicals industry is likely to be a particularly large beneficiary given its sensitivity to energy price fluctuations. For example, the ethylene segment of the chemicals sector, energy makes up 95% of the total cost structure of the business, distributed as 60% in natural gas liquids, 25% as naptha and gas oils, and 10% as general energy costs. Meanwhile, the past few years have seen a surge in interest by large MNCs in the chemicals sector either increasing production at their existing US operations or investing in new plants. Another industry that has benefited from shale gas production in the US is the steel industry. Shale gas production has increased local demand for steel pipes, thereby giving a major boost to the industry, since pipes are used for a variety of upstream and downstream activities such as the drilling, production, transportation, and distribution of natural gas.

Chart 6.1: Natural Gas Price Trends in Europe and the United States: 1999-2013



While the US case is informative to some extent it is important to keep in mind some of the main distinguishing features between the US and potential Tunisian experiences. First, the extent to which the shale plays can act as a truly "transformative" driver of the energy market depends critically on the number of plays that move successfully to development phase. If limited, the likelihood is that any reduction in costs will be marginal. It is also important to note that a large proportion of hydrocarbon production may be oil. Therefore, sectors that will benefit disproportionately will be those that rely on petroleum products as an energy source compared to natural gas and electricity. Unfortunately, disaggregated data by sector for Tunisia is not available for either of these two factors. However, as the official Tunisian energy balances (for example see Chart 2.3) suggests that petroleum products currently account for around 50% of energy consumption by the industrial sector, it is clear that the potential benefit to certain parts of industry is likely to be substantial. In our view, based on discussions with in country experts, within Tunisia's manufacturing sector, the metallurgy, construction materials, and glass sectors stand to benefit the most.

6.2 Infrastructure investments

In Tunisia, a mixture of new roads and upgrades to existing roads will be built as part of shale gas and liquids extraction plans. The roads will mainly be local access roads. Local access roads can increase the efficiency of usage of the existing road network by serving as feeder roads to existing roads. The direct, indirect and induced benefit of this expenditure in terms of GVA has already been captured in the impact analysis in chapter 4, but there are solid grounds to expect further spillover benefits to the wider economy.

Such benefits can be generated through a variety of channels including improved safety, reduced travel time, lower maintenance costs etc. When combined with major road building programs, the benefits are even wider. For instance, roads play an important role in the geographic distribution of economic growth. Formally quantifying the scale of these effects is beyond the scope of this report. Rather, results from a range of studies in the literature are presented to illustrate the potential rates of return that could be generated on such investments.

For example, in a wide-ranging study covering road projects funded by the World Bank between the period 1983-1992, Canning and Bennathan (2000) estimate an average economic rate of return of 29%. Meanwhile a recent appraisal of a donor-funded road project in Tunisia by the African Development Bank (2010) found an economic rate of return of 25.1%. While local access roads may only make a modest contribution to GVA, they have a direct impact on the daily lives of the poor when they are built in poor rural and urban areas by directly lowering transport and other input costs. For example, Stifel et al (2012) found that the benefits of reducing transportation costs by USD 50 per metric ton for the most remotely located households would result in benefits worth approximately 35% of household consumption. This study also found that a hypothetical road constructed through the study area would have a rate of return between 12 and 34%.

Meanwhile, World Bank research using 1985 data estimated the rates of return to paved roads for a series of countries, finding a range of rates of return from -0.01% to 15.76%. [33] The authors also estimated the ratio of the rate of return to paved roads over the rate of return to capital, again finding a wide range from -0.02 to 37.09, where a ratio over 1 indicates that the rate of return on paved roads is higher than the rate of return on capital. The countries with the clearest benefits to paved roads were the middle income countries (classified as middle income in 1985). As an upper middle income country, this would suggest that Tunisia is among a group of countries that stand to benefit the most from road projects.

6.3 Social investments

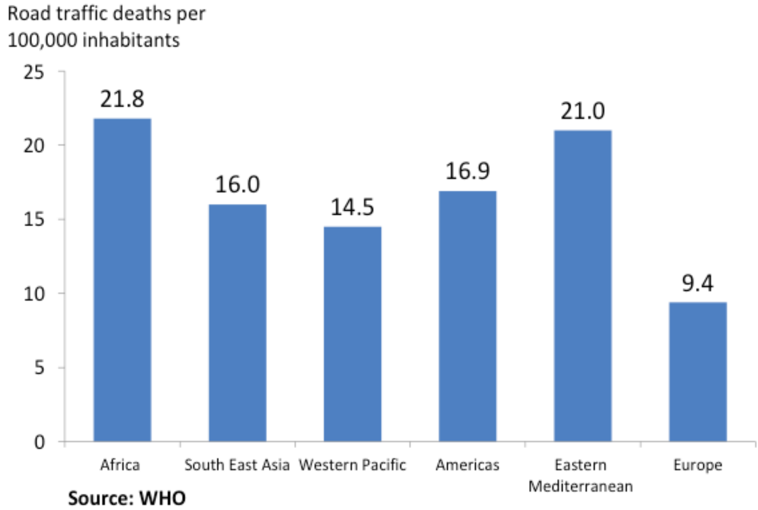
Foreign direct investment by IOCs is often coupled with social investments that are complementary to the firm's and the country's socioeconomic goals. For example, in 2011, ExxonMobil spent US$45.9 million in the Middle East/Africa region as a whole on social programmes and social giving. [34] This section uses experiences from Shell's previous investments in the MENA region in order to demonstrate the potential benefits that could result should an IOC develop the shale liquids and gas resource. The key areas in which Shell has invested in the region are:

- Capacity building and skills development with the aim of supporting young people in meeting skills requirements of the market
- Small and Medium Enterprise (SME) creation in order to support local economies' diversification and create job opportunities for youth
- Road Safety in an effort to raise awareness around road safety and decrease number of road casualties

In the area of road safety awareness, Shell in Qatar has launched the U-turn campaign to raise awareness among young Qataris on risky road behaviours. In Southern Iraq Shell is working on implementing a large education program on Road Safety aimed at children in primary schools and delivered by local teachers in association with the Traffic Department. This and other similar campaigns across the MENA region are important due to the high number of traffic deaths each year. In 2010, the governments of the world declared this the Decade of Action for Road Safety. Globally, there are 1.24 million traffic deaths each year[35] and the MENA region has the second highest regional average for traffic deaths per capita.

33 - Canning and Bennathan (2000).
34 - ExxonMobil, http://www.exxonmobil.com/Corporate/community_ccr_datacenter_ccrgeographic.aspx
35 - "Global Status Report on Road Safety 2013: Supporting a Decade of Action." World Health Organisation.

Chart 6.2: Road traffic deaths per 100,000 inhabitants by region



Source: WHO

More broadly, an important area for social investments is enterprise development and business training. Social returns to training may greatly exceed the private returns, so firms underinvest in training. This indicates the possibility of positive knowledge spillovers. These programmes have been extremely popular and have been implemented by governments, international financial institutions, NGOs and the private sector.[36] Enterprise development training tends to focus around financial literacy. For example, Injaz in Tunisia provides young people with mentorship from Arab business leaders to help inspire a culture of entrepreneurialism and business innovation. Other programs, such as Shell's Intilaqaah program (see below), go beyond simply raising awareness around financial literacy and targets the generation of a new business idea and the market plan needed to take a new product to market.

In terms of training for employment, Shell has successfully been implementing two programs in the MENA region. In Oman, Shell's Training for Development program provides training and secure employment for successful trainees. This programme works proactively with industry to identify relevant job opportunities for young unemployed people, and then trains prospective candidates in collaboration with potential employers. This means that successful trainees are guaranteed a position after the completion of their training. Thus far, 131 Omanis have received positions through this programme. In Egypt, Shell Egypt implements the Al Amal program in partnership with the Egyptian Geological Society to equip young geoscience graduates with the tools and skills to enable them to compete more effectively in the job market. Many of the trainees have gone on to join the Oil & Gas industry. Targeting general skill development, Shell has begun to implement an education program called FutbolNet for children and youth aged 7 to 16. Through football, this program promotes skills that make individuals more employable (teamwork, commitment, responsibility, etc).

In the area of SME creation and business skill development, Shell implements a training and support programme for entrepreneurs called Intilaqaah in Egypt, Oman and Saudi Arabia. This programme, originally called Livewire when first implemented in Europe, provides guidance and support to budding businesses as well as access to funding. The Intilaqaah programme in Saudi Arabia has had a number of successes from 2010 to 2012. It has trained over 5,000 entrepreneurs. Graduates of this programme have thus far set up more than 500 businesses (counting businesses with at least one year of operations). In turn, these businesses have created over 1,000 jobs (counting jobs with at least one full year of employment).

Experiments designed to test the effect of such training programmes measure results using a variety of metrics. These metrics include: survival rates of business, profits, and implementation of improved business practices. In terms of survival rates, Mano et al (2012) conducted a study on micro and small enterprises in Sub-Saharan Africa, finding a 9 percentage point increase in the likelihood of survival of firms receiving training one year after the training took place. On the implementation of improved business practices, Drexler et al (2012) found that rule-of-thumb training led to an increase in business owners reporting that a separation

36 - The evidence thus far is encouraging, however, not many of these programmes have been implemented using an experimental setting in order to precisely determine causality and most of them have been shown to lack the sufficient statistical power to infer the precise results.

of personal and business expenses, keeping accounting records, and formally calculating revenues, with the group receiving the training showing a 6 to 12 percentage point increase in the implementation of these business practices relative to owners who did not receive training. Bruhn and Zia (2011), in a study conducted in Bosnia and Herzegovina (another country with high youth unemployment) on young entrepreneurs found that the group receiving training were 17% more likely to put in place improved business practices and 11% more likely to inject new investment in their business. Some studies measure the increase in profits, although many experiments were unable to collect this type of data. Berge et al. (2011) find that training increases immediate profits by 24% and sales by 29% for men in a study conducted in Tanzania. In Peru, Valdivia (2012) finds a 20% increase in profits for the group receiving training and one-on-one technical assistance.

6.4 Knowledge spillovers

Another way in which multinational firms impact the countries in which they invest is through knowledge spillovers. Knowledge spillovers arise from efficiency gains by local firms associated with foreign direct investment (FDI). Gorodnichenkou et al (2007) define spillovers as a transfer of managerial practices, production methods, marketing techniques or any other knowledge embodied in a product or service. Knowledge spillovers for FDI can be classed into three areas:

1. Labour turnover from multinationals to domestic firms;
2. Technical assistance to suppliers and customers; and
3. Demonstration effect on domestic firms in the choice of technology, export behaviour, and managerial practices.

FDI can foster linkages with local firms. In the literature, this is known as vertical spillovers, or efficiency effects on upstream and downstream firms. IOCs have a strong incentive to improve the productivity of their suppliers. In terms of the economic benefit for suppliers, Gorodnichenkou et al (2007) find that a one percentage increase in sales of domestic firms to foreign firms in a sample of emerging European countries raises the rate of growth of efficiency of the domestic firms by 0.07-0.08%. Moreover, there is an indirect spillover effect from the interactions of other local firms with foreign firms, meaning that even firms that are not direct suppliers to foreign firms benefit.

In terms of the demonstration effect on management practices, Bloom et al (2013) ran a randomised controlled trial in India to test whether differences in management practices across manufacturing firms can explain differences in productivity. The researchers provided free management consulting advice and support to randomly chosen firms in a treatment sample and compared their performance to a set of control firms who did not receive consulting support. Firms who received management advice raised their productivity by 17% in the first year via improved quality, efficiency and reduced inventory and within three years this increased productivity led to firms opening more plants.

Another way by which local firms can receive management advice and support is by supplying goods and services to IOCs. High calibre management consulting is very costly. In the experiment run by Bloom et al, total consulting costs came to $1.7 million spread across 17 firms, which amounted to an average of $75,000 per firm in the first phase of the experiment. Had the firms procured this advice directly and not through a non-profit research project, it would have cost $250,000 per plant. Therefore supplying to IOCs can allow a local firm to access management support without cost.

6.5 Energy security

An altogether less tangible benefit, but important nonetheless, is the enhanced energy security that Tunisia would be able to enjoy particularly in an outcome such as Scenario 3 in which energy production is projected to run well ahead of consumption for a prolonged period. Achieving such a production surplus would clearly significantly reduce Tunisia's need to import energy products making the economy less vulnerable to events such as supply disruptions in key producer countries due to, for example, natural disasters, international disputes or political instability. The future pattern of Tunisian energy imports (in terms of country of origin) is uncertain but it seems likely that trading patterns will continue to reflect geographical proximity with key trading partners likely to remain in the MENA and Southern European regions. Continued high political tension in the former region would suggest potentially considerable benefits from increased energy security.

7. CONCLUSION

This report has assessed and quantified, where possible, the likely economic benefits of shale liquids and gas extraction in Tunisia. Modelling the project's economic impact over such an extended timeframe clearly provides methodological challenges and as such the figures presented should be evaluated within this context. However, in presenting three scenarios around the scale of the resource production opportunity, at least part of this uncertainty is accounted for.

The headline findings from the economic impact analysis, assuming that there is one successful resource play, are that the project is expected to contribute approximately TND 11.7 billion directly and some TND 13.0 billion in total (inclusive of indirect and induced impacts) across the project horizon. These figures translate into an average annual direct contribution to GDP of TND 244 million (0.3% of GDP) and TND 271 million in total. Moreover, we estimate that this activity will, on average, support 2,000 jobs per year directly and approximately 5,800 per year in total. These figures can be scaled up appropriately depending on the number of resource plays that successfully proceed to the development phase. The majority of the impacts are attributable to the Development phase of the project that occurs several years after the start of exploration activity as the project is de-risked.

Meanwhile, based on our projections, the oil and gas production balance is likely to deteriorate significantly in the medium-term in the absence of shale exploration. The situation is improved materially across all three scenarios considered, but in the case of Scenario 3 (four out of six successful resource plays) the impact is truly "transformative" with the country projected to run a sustained oil and gas production surplus during the peak production years of the project. Such energy independence should boost the country's trade balance, other things being equal, and make the economy less vulnerable to oil and gas price shocks that have become increasingly frequent over the past decade.

This report should be seen as contributing to part of the wider debate about the relative merits of shale liquids and gas production in Tunisia. Other considerations, particularly environmental, are of course worthy of full consideration and the reason for their neglect in this report is purely due to issues of scope. However, it is important that within the framework of any such debate that the full economic benefits are considered including not just its contribution to Tunisian economic activity for the duration of the project but also its potential to change the dynamics of the Tunisian energy market and generate considerable fiscal revenues that could support funding an effective regional development strategy.

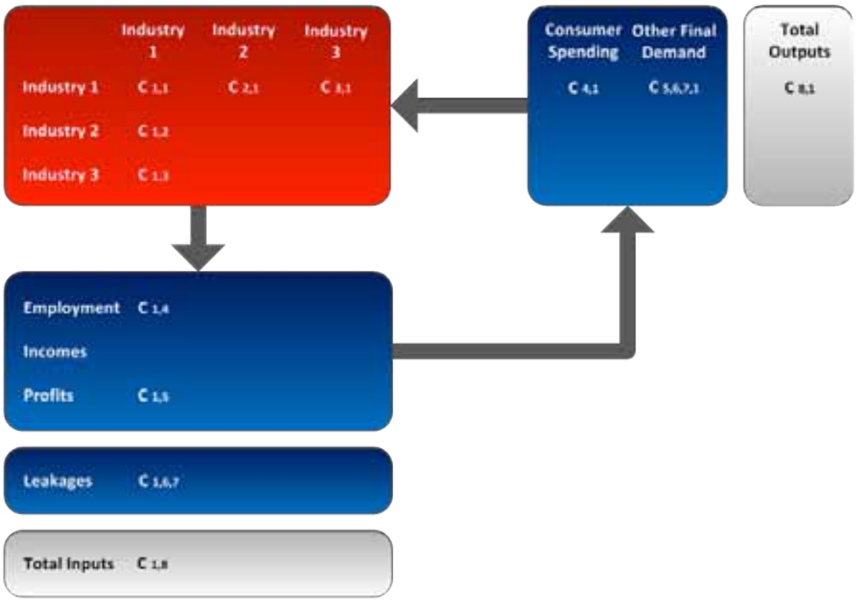
8. TECHNICAL APPENDIX

8.1 Economic impact analysis

8.1.1 Input output modelling

An input-output model gives a snapshot of an economy at any point in time. The model shows the major spending flows from "final demand" (i.e. consumer spending, government spending investment and exports to the rest of the world); intermediate spending patterns (i.e. what each sector buys from every other sector – the supply chain in other words); how much of that spending stays within the economy; and the distribution of income between employment and other forms such as corporate profits. In essence an input-output model is a table which shows who buys what from whom in the economy. Figure 8.1 provides an illustrative guide to a stylized input-output model.

Figure 8.1: A stylized Input-Output model



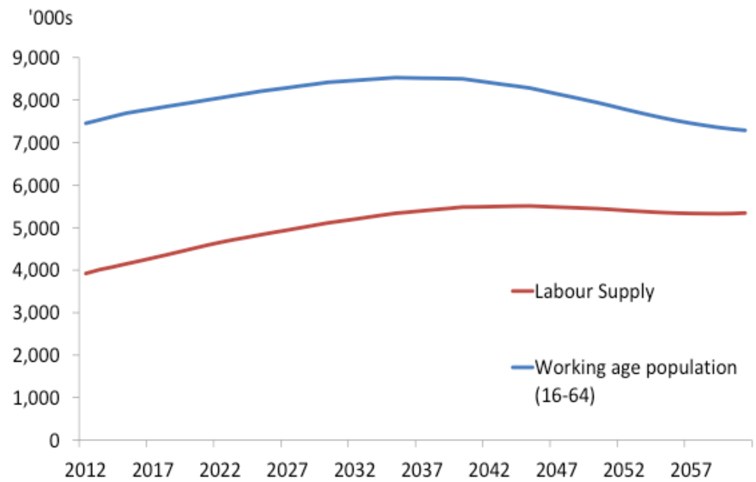
For the purposes of this project the 2008 input output table produced by the INS was used as the basis for modelling. The original version was refined slightly to suit modelling purposes. Specifically, the food and beverage manufacturing (C15) and tobacco manufacturing (C16) sectors and maintenance and repair (I50) and trade sectors (I51) were merged together in order to provide consistency with the official industry breakdown of GVA to which we had access. In addition, the technical coefficients for household spending were scaled down to reflect the fact that not all of wage income generated by direct and indirect workers would be spent on goods and services. Some would be taxed (this part is accounted for in our assessment of the fiscal contribution of the project) and some will be saved.

8.1.2 Adjusting for structural change

As exploration is expected to be carried out over an extended future period, it was necessary to adjust the 2008 input output model for projected economic structural change. In order to do so we followed the process adopted by Flegg et al (1995). Although, this was originally developed as a means to estimate regional input output models from a national baseline, the principles apply equally to adapting a national model for observed and forecast changes in size and structure. In summary, the relationships between different sectors embedded within the domestic use IO table are adjusted to accommodate changes in their relative size as a share of the Tunisian economy. This required the development of a long-term macroeconomic forecast for the Tunisian economy of nominal GVA, employment and earnings (disaggregated by sector to a similar format as in the IO model). For this, we relied upon a combination of the Oxford Economics bespoke macroeconomic forecast for Tunisia (which helped to underpin some of the wider assumptions), and collaboration with the panel of local experts who provided great assistance in helping to refine the forecast, Below, the development of the forecast is documented in more detail.

Our forecast was built on the premise that economic growth is the product of growth in employment and labour productivity (itself driven by a plethora of factors such as capital accumulation (both physical and human), technological progress, institutional improvements etc). In order to generate a coherent long-term employment forecast, we used working age population [37] forecasts from the UN, the OE forecast for the participation rate [38] and an exogenous assumption about the future path of the unemployment rate. Tunisia's working-age population is projected to grow steadily at a slightly decreasing rate until 2035, at which point it will start to decline by around 0.7% per annum for the duration of the project horizon. However, due to the assumed continued improvement in the participation rate, labour force grows at a consistently faster rate than the population of working age (Chart 8.1)[39].

Chart 8.1: Tunisia demographic forecast



Source: UN and Oxford Economics

In the long-run when unemployment rate is at its natural rate [40] changes in employment will reflect growth of the labour force (itself a product of changes in the working age population and the participation rate). In consultation with the local economists, it was agreed that 9.5% represented a realistic long run natural rate of unemployment, an assumption premised on continued labour market reforms. Based on the latest data available at the time of writing the unemployment rate in Tunisia is 17.6% [41], indicating a significant degree of spare capacity in the labour market. Therefore, the unemployment rate was assumed to fall gradually towards its natural rate. We assume that labour market reforms consistent with the 9.5% natural rate are implemented gradually so that unemployment falls to this level around 2035. The implication of this is that employment grows slightly faster than labour supply prior to 2035.

As indicated the rate of real GDP growth is a function of both employment and labour productivity growth. Therefore, it was necessary also to assess the extent to which Tunisia would be able to achieve labour productivity growth over the forecast horizon. During 2000-08 (the last full economic cycle) labour productivity growth averaged 2.2% per year. Based on discussions with local experts it was determined that it was realistic to expect a slightly better performance in the medium-term given that scope for catch-up growth remains

37 - The working age population is defined to range from 16-64.

38 - The participation rate is defined as the proportion of the working age population that form part of the labour force (i.e. are either employed or unemployed but actively seeking work).

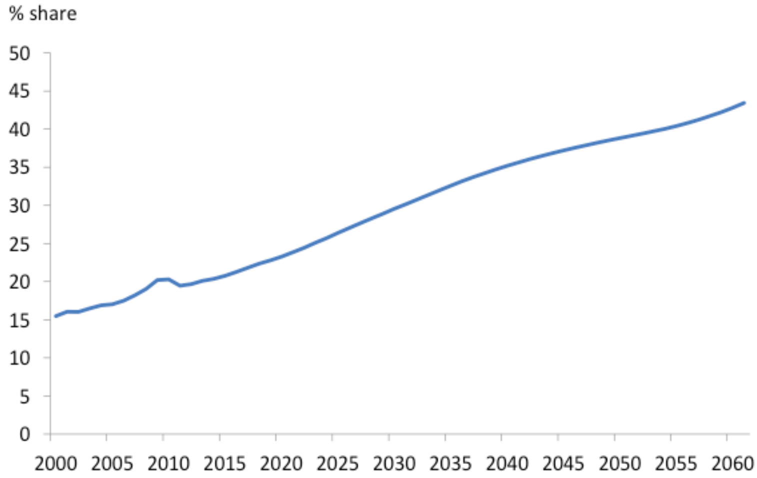
39 - At just above 50% the current participation rate in Tunisia is low by the standards of Western economies, for reference based on our forecast the rate will reach around 73% by 2061 similar to the current level in Spain.

40 - The natural rate of unemployment occurs when the labour market is in equilibrium consistent with non-accelerating inflation.

41 - Data was collected in January 2013 with the latest data point available applying to May 2012.

significant (we estimate that in 2012 GDP per capita in Tunisia was only 20% of the level in the USA (Chart 8.2)). Therefore, a trend labour productivity growth rate of around 3% per annum was assumed. Taken together our assumptions about employment and labour productivity growth imply that Tunisia will roughly maintain a real GDP growth rate of 5% between 2012-20 consistent with the previous economic cycle. Growth will gradually decelerate over the next 40 years reflecting a deteriorating demographic outlook.

Chart 8.2: Tunisia's GDP per capita 42 in relation to the USA



Source: Oxford Economics calculations

Meanwhile, in consultation with the local experts we assumed a long-run inflation rate of 3.5%, approximately in line with the average rate of price growth between 2000-08. However, in the near-term inflation is expected to be slightly higher reflecting the higher current rate of headline inflation [43]. Table 8.1 provides a full breakdown of the macroeconomic forecast for the key variables. For all metrics apart from the unemployment rate, the figures reflect the average annual growth during the specified period of the forecast.

Table 8.1: Summary of macroeconomic forecast

Long-term forecast summary (average annual growth unless stated)						
	2000-08	2012-20	2020-30	2030-40	2040-50	2050-61
Working Population	2.0	0.8	0.6	0.1	-0.7	-0.8
Participation Ratio	0.2	1.0	0.7	0.6	0.6	0.6
Labour Supply	2.2	1.7	1.3	0.7	-0.1	-0.2
Unemployment Rate (%)	13.9	15.7	12.4	9.9	9.5	9.5
Employment	2.7	2.3	1.7	0.8	-0.1	-0.2
Labour Productivity	2.2	2.9	3.1	3.1	3.0	2.9
Real GDP	5.0	5.2	4.8	3.9	2.9	2.7
Inflation	3.7	3.9	3.5	3.5	3.5	3.5
Nominal GDP	8.9	9.6	8.5	7.6	6.5	6.3

Sources: Oxford Economics, UN

Given these baseline macroeconomic assumptions it was then necessary to decompose the growth in employment and GVA sectorally based on the results of Faicel Zidi's bespoke CGE model of the Tunisian economy and some refinements based on our knowledge and experience of economic development patterns and discussions with local economists. The result is that both agriculture and industry decline as a share of GVA at the expense of commercial (private sector) services. Meanwhile, for employment it was assumed that given greater scope for efficiency savings that non-market services productivity was likely to grow faster than the economy-wide average over time. The results are summarised in Table 8.2.

42 - GDP per capita measured at constant 2005 prices and PPP exchange rates.
43 - In February 2013, the latest data point available at the time of writing, CPI inflation was 5.8%.

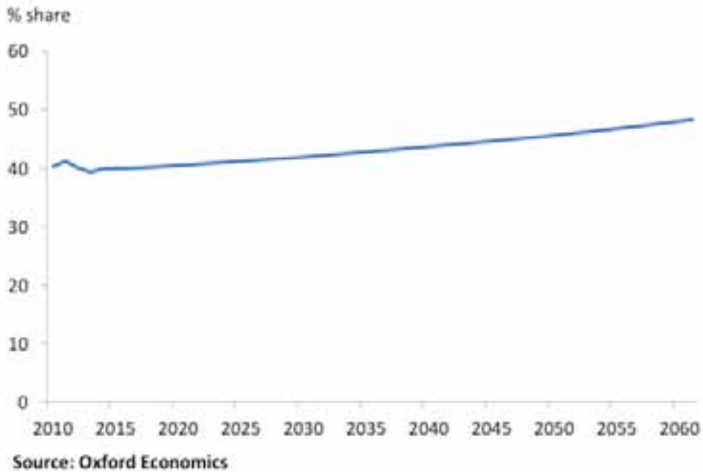
Table 8.2: Forecast sector shares of GVA and employment to 2061

Sectoral shares of total economy							
Metric	Sector	2008	2020	2030	2040	2050	2061
GVA	Agriculture	8.2%	6.9%	7.5%	6.9%	6.8%	6.8%
	Manufacturing	18.7%	17.7%	17.4%	17.1%	16.9%	16.9%
	Other Industry	15.5%	12.0%	10.1%	10.1%	10.2%	10.2%
	Commercial Services	42.4%	46.1%	47.6%	48.3%	48.6%	48.6%
	Non-Market Services	15.2%	17.4%	17.5%	17.5%	17.5%	17.5%
Employment	Agriculture	17.8%	14.8%	15.0%	15.4%	15.3%	15.0%
	Manufacturing	19.3%	17.4%	16.7%	16.1%	15.6%	15.6%
	Other Industry	13.9%	15.4%	14.6%	14.0%	13.5%	12.9%
	Commercial Services	30.5%	33.7%	35.9%	37.7%	39.3%	40.6%
	Non-Market Services	18.5%	18.7%	17.8%	16.8%	16.4%	15.9%

Source: Oxford Economics

Finally, a sectoral earnings forecast was developed based on the projected evolution of GVA. Since, earnings represent a large component of GVA, it would normally be reasonable to grow sector earnings in line with GVA. However, as earnings currently represent a fairly low share of Tunisian GVA (in comparison to more developed economies) it was assumed that in sectors where the current share of labour in GVA was low earnings would grow faster than GVA by a factor dependent on the current ratio of earnings to GVA. Chart 8.3 summarises the path of economy wide earnings as a share of GVA. By 2061, the share rises to just over 48% compared to around 40% in 2012.

Chart 8.3: Earnings as a share of GVA



8.1.3 Computing the economic impact

Based on this long-term economic forecast, input output models for each individual year of the project horizon (2014-61) were developed based on the original input output table (for 2008) sourced from the INS. The economic impact was then quantified in each individual year based on projections of in-country investment supplied by Shell. This was further decomposed into four main areas: exploration costs; well costs; facilities costs; and operational costs with an indication of how these expenditures would be split between different economic sectors consistent with the IO model. In addition, Shell indicated the extent to which these expenditures would be spent locally or on goods and services produced outside of Tunisia. For facilities spending, alternative expenditure compositions were assumed: initially for the first ten years of the project (up to 2024); and subsequently from 2025 onwards. In the latter period, it was assumed that the share of domestic spending was higher reflecting the development of local suppliers. These figures were calibrated and benchmarked on other studies which have analysed the economic impact of unconventional exploration in the US. Further detail on this benchmarking exercise can be found in section 8.2. Table 8.3 summarises the breakdown of total domestic expenditure consistent with sectors in the input output model:

Table 8.3: Decomposition of domestic capital expenditure for a generic unconventional scenario

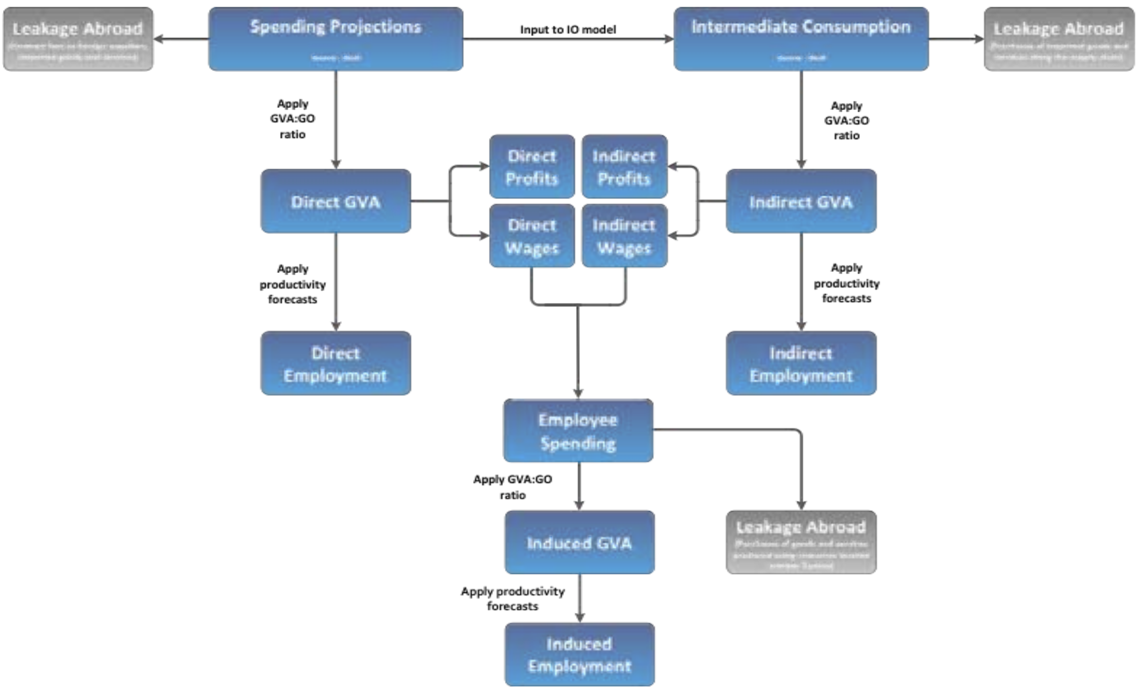
Breakdown of assumed allocation of domestic capital expenditure by sector						
Sector	Exploration well	Appraisal well	Development well	Facilities (now)	Failities (post-2025)	Operational Expenditure
F27. Mechanical and electrical manufacturing	-	-	-	-	16%	-
B11. Oil and gas extraction	65%	84%	92%	35%	39%	32%
H45. Construction	13%	8%	4%	60%	42%	-
I51. Trade, Maintenance and Repair	-	-	-	-	-	2%
I55. Hotels, accomodation and food services	2%	1%	0%	5%	3%	6%
I60. Transport	13%	4%	2%	-	0%	19%
I70. Other market services	7%	4%	2%	-	-	-
Spending on Personnel	-	-	-	-	-	41%

Source: Oxford Economics estimate

The domestic expenditure projections formed the basic input [44] into our IO model so that estimates were generated for the level of indirect and induced spending [45]. However, these figures represented our respective estimates of gross output rather than GVA. Therefore, they were scaled down using the relevant sectoral ratio of GVA to gross output [46]. GVA was then further separated into its two main components (compensation of employees and gross operating surplus) using our forecast of wages and GVA by sector.

Finally, employment estimates were generated by applying our forecast of sector productivity (defined as GVA per worker) to each sector's estimated GVA impact in the relevant year. Given our baseline assumption of continued labour productivity growth it is the case that during the lifetime of the project a given level of GVA supports increasingly fewer jobs. The computation procedure is summarised visually in Figure 8.2.

Figure 8.2: Overview of how the economic impact was quantified



44 - Projections of operating expenditure on personnel were excluded from the input to the indirect effect as they do not generate any supply chain impact. However, such employee compensation does directly contribute to the induced impact and so was included in the input to the model used to estimate this effect.

45 - When quantifying the size of the induced impact a downward scaling factor was applied to the coefficient of household spending in order to reflect the fact that not all employee income will be spent as a result of savings and taxes. Data supplied by Zouhair El Kadhi indicated that the savings ratio (as a proportion of household income) remained fairly stable between 2005-9 averaging 11.4%. Meanwhile, for taxes we derived a forecast of the effective tax rate on gross income, currently around 5% during the lifetime of the project (see section 8.1.4 for more detail on the methodology here).

46 - These ratios were estimated based on the decomposition of sector output in the IO table.

8.1.4 Modelling the fiscal contribution

A number of revenue channels were considered in our modelling: direct taxes paid by the foreign investor to the Tunisian government; other taxes on corporate profits; revenue raised on the direct taxation of employee income; and VAT receipts associated with the spending of wage income. Direct taxes paid by the foreign investor were supplied by Shell. Since these figures are commercially sensitive we are unable to provide any further detail on them in this section.

The current structure of Tunisian government revenue is summarised in Table 8.4. Between 2003-10 revenue [47]ranged between 22-25% of GDP. It rose slightly in 2011 to 25.4%. Of this, direct taxes on individual income and corporate profits typically generated around 10% of GDP with between 5-6% of GDP raised by VAT. The other 10% was raised through other taxes (customs duties, excise duties etc) and non-tax sources of income (grants, privatisation sales, gas pipeline royalties etc).

Table 8.4: Tunisian Government Revenue 2003-11

Tunisian Historical Fiscal Data										
	Direct taxes on individual income		Direct taxes on corporate income		Indirect tax: VAT		Other tax and non-tax revenue		Government Revenue	
Year	mn TND	% GDP	mn TND	% GDP	mn TND	% GDP	mn TND	% GDP	mn TND	% GDP
2003	1,309	3.7%	868	2.5%	2,006	5.7%	3,638	10.3%	7,821	22.1%
2004	1,437	3.7%	948	2.4%	2,258	5.8%	4,074	10.5%	8,717	22.4%
2005	1,524	3.6%	1,362	3.3%	2,301	5.5%	4,093	9.8%	9,280	22.2%
2006	1,717	3.8%	1,390	3.0%	2,466	5.4%	4,980	10.9%	10,553	23.1%
2007	1,949	3.9%	1,749	3.5%	2,661	5.3%	5,086	10.2%	11,444	23.0%
2008	2,145	3.9%	2,416	4.4%	3,309	6.0%	5,844	10.6%	13,714	24.8%
2009	2,379	4.0%	2,266	3.8%	3,400	5.8%	5,717	9.7%	13,762	23.4%
2010	2,600	4.1%	2,433	3.8%	3,750	5.9%	6,040	9.5%	14,823	23.3%
2011	2,890	4.4%	3,046	4.7%	3,818	5.8%	6,866	10.5%	16,620	25.4%

Source: Ministry of Finance

When modelling the likely fiscal impact it was suggested that the fiscal structure of Tunisia was likely to change materially during the lifetime of the project reflecting current policy objectives. In particular, it is anticipated that the total tax burden will rise and that relatively the incidence of taxation would switch away from labour income towards tax on corporate profits and indirect taxes on expenditure (such as VAT). It was agreed that government revenue as a share of GDP was likely to rise towards 40% of GDP in the long-term. Given that this represented a significant change in the country's fiscal structure it was most realistic to phase it in gradually. Therefore, we assumed that government revenue as a share of GDP rose to 40% by 2035, with the increase assumed to take place at a linear rate from 2015 onwards. Scaling factors were then used to ensure that the incidence of the rise in the tax share was disproportionately accounted for by direct taxes on corporate profits and VAT. The results are summarised in Table 8.5 [48]. We applied these effective tax rates to our estimates of gross compensation of employees and gross operating surplus respectively to estimate the expected level of tax revenue. For VAT, we applied the effective tax rate as a share of consumer spending to our estimate of induced gross output [49] and divided this between the direct, indirect and induced impacts based on their respective share of GVA.

47 - Figures presented here are exclusive of funds generated by public borrowing (both locally and internationally) as is conventional in fiscal accounting.

48 - As is evident from the table direct taxes on income continue to rise as a share of GDP whilst remaining constant as a share of earnings from 2040 onwards with the reverse true of direct taxes on corporate profits. This reflects our assumption that earnings will rise as a share of GDP.

49 - Our estimate of the induced gross output represents the estimated level of consumer spending associated with the project. The rationale for doing so is that the incidence of VAT falls on the final purchaser (the consumer) but the tax reflects payments on value added at each stage of the supply chain.

Table 8.5: Structure of government revenue 2012-61

Fiscal Projections 2012-61							
		2012	2020	2030	2040	2050	2061
Direct taxes on individual income	% GDP	4.4	4.7	5.1	5.4	5.6	5.9
	% earnings	11.9	12.3	12.9	13.1	13.1	13.1
Direct taxes on corporate profits	% GDP	4.7	5.7	7.3	8.0	7.7	7.4
	% corporate profits	8.2	10.1	13.4	15.1	15.1	15.1
Indirect taxes: VAT	% GDP	5.8	7.1	9.2	10.2	10.2	10.2
	% consumer spending	8.9	10.8	14.0	15.6	15.6	15.6
Government revenue	% GDP	25.4	29.6	36.5	40.0	40.0	40.0

Source: Oxford Economics forecast

8.2 Benchmarking the economic impact results

In order to check the validity of our economic impact results a thorough benchmarking process was undertaken against other impact assessments of shale liquids and gas plays. Given the existing geographic distribution of shale plays these were overwhelmingly located in the US although a detailed analysis of the Cuadrilla play in the UK has also been undertaken by Regeneris Consulting. The results were encouraging with the differences recorded readily explicable by factors such as the different structure of the Tunisian economy versus the US and the assumed composition of expenditure.

For the purposes of benchmarking we focus on several different metrics: the breakdown of project expenditure; the direct contribution to GVA; and the direct employment impact. The reason for focusing on the direct economic impacts is that the size and sectoral distribution of the indirect and induced effects will be driven largely by the significant structural differences between the US and Tunisian economy allowing not just for the alternative compositions of GVA but also the much more "closed" nature of the US (imports as a share of GDP are significantly lower than in Tunisia) which, other things equal, should result in higher multiplier effects in the US.

A number of recent reports have estimated the economic impact of various shale plays across North America. The focus of comparison here will be to a recent study by Global Insight (2011) which forecast the economic contribution of shale gas exploration across the US until 2035 and a study by Pennsylvania State University which quantified the economic impact of the Marcellus shale natural gas play in 2010 (Considine et al (2010)). Unfortunately, we were unable to benchmark the results from our study against an economic impact assessment of the Eagle Ford shale play, which would have been particularly analogous as the mixture of shale liquids and gas in the Eagle Ford play closely resembles that in Tunisia [50].

As a first step the composition of expenditure assumed in our modelling was compared to the projections in the Global Insight report. The comparison is summarised in Table 8.6. In general, the comparison suggested a fairly similar expenditure composition with the differences understandable given structural differences between the US and Tunisian economies. The major difference is in manufacturing where the Global Insight model assumes a much higher proportion of total expenditure will occur compared to in Tunisia. In our view, such assumptions are consistent with the size and structural diversity of the respective manufacturing sectors.

50 - An economic impact assessment was carried out by the Centre for Community and Business Research at the University of Texas. However, the sectoral decomposition of employment and GVA provided in the report is in a "top 10 industries affected" format which leaves a significant residual particularly for employment. This makes direct comparisons problematic.

Table 8.6: Comparison of the composition of expenditure with Global Insight report on shale gas

Comparison of allocation of shale exploration expenditure by sector		
	Global Insight	Oxford Economics
Other manufacturing	10.7%	0.0%
Chemicals	3.1%	0.0%
Manufacture of building materials, ceramics and glass	3.7%	0.0%
Mechanical and electrical equipment manufacturing	9.3%	3.5%
Oil and Gas extraction	54.8%	78.6%
Mining	3.1%	0.0%
Water	1.5%	0.0%
Construction	12.1%	14.0%
Hotels, accommodation and food services	0.0%	1.1%
Transport services	0.6%	1.5%
Financial services	0.6%	0.0%
Other markert services	0.5%	1.3%

Source: Oxford Economics, Global Insight

Table 8.7 compares the results of the three studies in terms of the sectoral distribution of the direct GVA and employment impacts across a group of eight broad industry categories that were used in the Global Insight report.

Table 8.7: Comparison of direct economic impact results with studies from the US[51]

Comparison of economic impact assessments						
	Direct GVA			Direct Employment		
	Global Insight	Oxford Economics	Penn State	Global Insight	Oxford Economics	Penn State
Agriculture	0.0%	0.0%	0.2%	0.0%	0.0%	0.5%
Mining	80.4%	83.0%	25.3%	48.8%	18.4%	13.2%
Construction	4.3%	4.3%	16.7%	18.2%	55.5%	22.9%
Manufacturing	12.0%	0.8%	1.7%	26.0%	2.2%	1.1%
Transportation and Utilities	2.5%	7.6%	4.0%	4.9%	11.8%	3.1%
Retail And Wholesale Trade	0.0%	0.8%	23.1%	0.0%	2.5%	23.9%
Services	0.8%	3.6%	28.5%	2.0%	9.5%	34.6%
Government	0.0%	0.0%	0.6%	0.0%	0.0%	0.7%

Source: Oxford Economics, Global Insight, Pennslyvania State University

Several interesting points revealed themselves from this analysis. Focusing first on the direct contribution to GVA, the Oxford and Global Insight studies share several similarities whereas the sectoral distribution of this impact in the Penn State study is fairly different. Below, we explore the reasons for such similarities and differences:

- In both the OE and Global Insight studies a very high proportion of direct GVA is generated in mining (including oil and gas extraction) which is probably what one would expect given the nature of direct activity. A similar proportion is registered in construction, transportation and services. The main point of difference is in manufacturing with the Global Insight results implying that 12% of direct GVA will be created in manufacturing compared with less than 1% in this study. In our view, this seems intuitive given the much more developed manufacturing base in the US.
- On the other hand, the Penn State study reported a much more even sectoral breakdown of GVA with just over a quarter of total value added generated in mining compared to over 80% in the other two studies. This was offset by a much higher share of GVA in the service sector including retail and wholesale

51 - The results for Penn State apply to their estimates for 2011.

trade. The reason for this is that a significant proportion of expenditure is on lease payments effectively resource transfers to private landowners from the oil and gas explorer. In contrast, in Tunisia, these land rights are effectively held by the state, hence the project's expected significant fiscal contribution quantified in section 4.4.

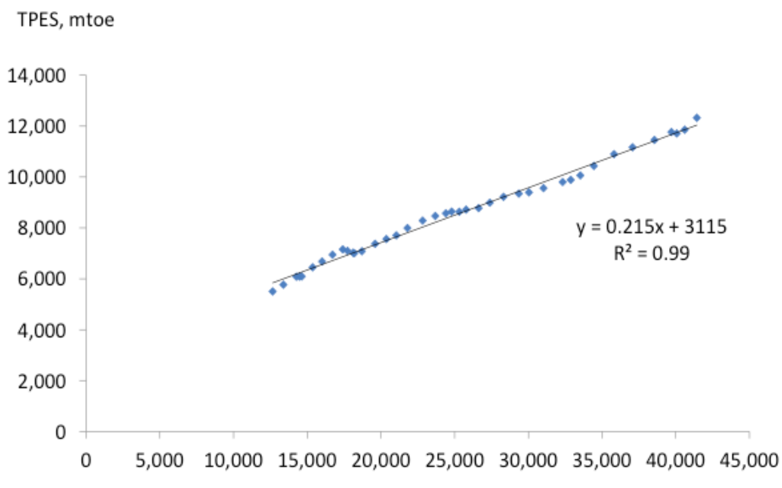
- Most of the differences observed in the various report's projected employment impacts can be explained with reference to the respective differences in the sectoral shares of GVA. The major discrepancy between the Global Insight and current studies is the relative employment shares of construction and mining. Although the overall pattern in both studies is the same (construction accounting for a significantly higher employment share relative to its share of GVA and vice versa for mining), the size of this effect is much more exaggerated in Tunisia. This is a reflection of the trend apparent in official Tunisian data. According to the INS, GVA per worker in oil and gas extraction was TND 199,750 compared to TND 5,167 in construction (both measured in constant 2012 prices) [52]. Therefore, jobs in oil and gas extraction were on average almost 40 times more productive than in construction. For reference, the same ratio in the US in 2011 was just 2.25 [53].

8.3 Energy forecasting

8.3.1 Demand

Our forecast of energy demand built on our development of our forecast for GVA by industry that was developed in order to help adjust for expected structural change in the economic impact analysis.

Chart 8.4: Global real GDP and energy consumption



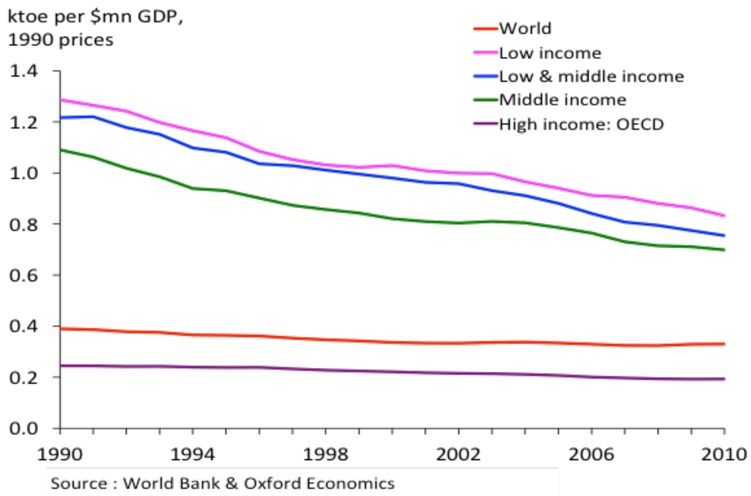
Source: World Bank

At a global level there is an unambiguous relationship between changes in real GDP and TPES as demonstrated by Chart 8.4 which tracks the relationship between the two metrics from 1971 to 2010. The R2 value of 0.99 indicates a very strong positive relationship between the two variables although the correlation does not necessarily imply causality. However, intuitively one would expect that a rise in volume of the production of additional goods and services (as is implied by real GDP growth) will require an accompanying increase in the level of energy consumption, other things being equal. It is also noticeable from the data that the level of energy intensity (as measured by the level of energy consumption required to support a given level of real GDP) has tended to increase over time. This is demonstrated in Chart 8.5 which shows that gains have been particularly strong in low and middle income economies.

52 - To help mitigate this effect to some extent it was assumed that the productivity of direct construction jobs created by this project was 20% higher than average.

53 - Based on data from the Oxford Economics global macroeconomic model. The original source providers were the Bureau of Economic Analysis (for GVA) and the Bureau of Labor Statistics (for employment).

Chart 8.5: Energy intensity of real GDP in selected economy groups



One difficulty that emerged in generating a forecast for energy demand was inconsistencies between data sets in terms of the level of energy consumption. For example, TPES in Tunisia according to the World Bank/ IEA data is typically around 15% higher than reported in the official Tunisian energy balances [54]. Further investigation suggested that the following items are not included as part of the Tunisian official statistics: biomass; hydro- and wind electricity; internal consumption by oil refineries; smuggled; non-energy uses of petroleum products (e.g. aerosol cans); bunkering; and gas flaring. In this instance, the main reason for the discrepancy is likely to be the exclusion of biomass which is used frequently in rural areas for heating and cooking. According to various publications this is likely to account for around 1,000-2,000 ktoe of "missing" energy consumption [55]. Therefore, an adjusted set of energy balances was estimated to account for the missing biomass. According to the IEA, in 2009 TFC of biomass was 1,024 ktoe, all of which was used by the residential sector. This figure was grown back for the 1997-2006 period using the base data on residential energy consumption. The results of this adjustment are summarised in Table 8.8.

Table 8.8: Adjusted Tunisian Energy Balances (1997-2006)

Tunisian Energy Consumption by sector (ktoe)								
	Industry	Transport	Residential	Adjusted Residential	Tertiary	Agriculture	TFC	Adjusted TFC
1997	1,541	1,453	724	1,420	422	317	4,457	5,153
1998	1,639	1,509	762	1,494	404	334	4,648	5,380
1999	1,710	1,604	806	1,580	417	345	4,882	5,656
2000	1,840	1,621	777	1,524	487	374	5,099	5,846
2001	1,942	1,648	809	1,586	502	387	5,288	6,065
2002	1,924	1,633	836	1,639	513	353	5,259	6,062
2003	1,939	1,662	920	1,804	510	374	5,405	6,289
2004	2,044	1,706	938	1,839	592	391	5,671	6,572
2005	1,927	1,752	964	1,890	594	398	5,635	6,561
2006	2,070	1,737	931	1,826	587	388	5,713	6,608

Source: IEA, DGE, Oxford Economics estimates

Estimates for TFC for 2007-12 were generated based on the observed pattern of real GDP growth and an assumed rate of energy efficiency. Based on the World Bank data, TPES [56] between 2007-10 grew on average around 1.4% per year slower than real GDP growth during the same period. We assumed this held over the

54- According to the World Bank, TPES was 9,427 ktoe in 2008, 9,045 ktoe in 2009 and 9,629 ktoe in 2010 while the IEA reports that TPES in 2009 was 9,200 ktoe. On the other hand, official data from Tunisia supplied by Ammar Jelassi suggests equivalent figures of 7,718 ktoe, 7890 ktoe and 8,343 ktoe respectively.

55- For example, the Agence Nationale de Maitrise de l'Energie (ANME) estimate that consumption of primary wood was 1,900 ktoe in 2006, the vast majority of which was consumed by households in rural areas (see http://pf-mh.uvt.rnu.tn/11/1/energies-alternatives-scenarios-tunisie-2030.pdf for more details). Meanwhile, the IEA estimates that biomass consumption by the residential sector was 1,024 ktoe in 2009 (the full breakdown can be found at http://www.iea.org/stats/balancetable.asp?COUNTRY_CODE=TN). Elsewhere, research by the Ministry of Agriculture suggested that biomass consumption was 927 ktoe in 1997 (see http://www.fao.org/docrep/003/Y2714F/y2714f16.htm for more details).

56- Of course, the point of interest here is TFC rather than TPES but as the former is significant component of the latter their growth rates are likely to be highly correlated.

2007-12 period and grew TFC accordingly based on the observed rate of real GDP growth. This was then split between sectors based on changes in their share of economy GDP with the industry sector acting as a residual in order to ensure that the sub-components summed to our estimate of TFC.

Along with TFC the other key component of TPES is power generation (oil and gas consumed to generate end-user products such as electricity). Data on TPES was available from a variety of sources. The most complete and consistent was the World Bank dataset which provided annual data through to 2010. In addition, full energy balances have been produced by the IEA for the year 2009 while official estimates for TPES were available for 2008-12 from DGE. As we had used the figure from the IEA data to adjust the TFC figures for biomass, we assumed that this figure was correct. We also used the official estimates from DGE for 2008 and 2010-12 adjusted for the inclusion of biomass consumption. For the pre-2008 period, TPES was grown back using the growth rates of the World Bank data set. Estimates of energy consumed in power generation were then formed by subtracting TFC from TPES. Table 8.9 provides a full breakdown of the results from this method for 1997-2012.

Table 8.9: Total Primary Energy Supply and its components in Tunisia (1997-2012)

Tunisian Energy Consumption by sector (ktoe)

	Industry	Transport	Residential	Tertiary	Agriculture	TFC	Power Generation	TPES
1997	1,541	1,453	1,420	422	317	5,153	611	5,764
1998	1,639	1,509	1,494	404	334	5,380	902	6,282
1999	1,710	1,604	1,580	417	345	5,656	837	6,494
2000	1,840	1,621	1,524	487	374	5,846	884	6,729
2001	1,942	1,648	1,586	502	387	6,065	1,037	7,103
2002	1,924	1,633	1,639	513	353	6,062	1,135	7,197
2003	1,939	1,662	1,804	510	374	6,289	1,105	7,394
2004	2,044	1,706	1,839	592	391	6,572	1,223	7,795
2005	1,927	1,752	1,890	594	398	6,561	1,097	7,658
2006	2,070	1,737	1,826	587	388	6,608	1,453	8,061
2007	2,217	1,805	1,903	617	386	6,927	1,398	8,325
2008	2,209	1,928	1,969	654	378	7,138	1,545	8,683
2009	2,161	1,932	2,090	668	407	7,258	1,942	9,200
2010	2,239	1,968	2,122	686	364	7,379	2,003	9,382
2011	2,353	1,633	2,092	655	393	7,127	1,903	9,030
2012	2,372	1,691	2,136	673	404	7,275	2,315	9,591

Source: IEA, DGE, Oxford Economics estimates

For the post-2012 period, a similar methodology was implemented to generate a forecast for TFC over the project horizon. An examination of the World Bank data suggests that improvements in energy intensity were greater in the last ten years compared to the pre-1990 period. This is not particularly surprising considering that average commodity price inflation was significantly higher during the former period (Table 8.10). Discussions with in-country experts indicated that it would be reasonable to assume that in the medium-term energy efficiency growth will increase at a rate slightly below that observed recently but significantly higher than during the 1990-2000 period. Therefore, up to 2025, it was assumed that energy intensity will decrease by 1.42% per year (the average of the rates observed between 1990-2010 and 2000-10 according to the World Bank data). It was assumed that this rate of decrease gradually would recede over the project horizon by 0.2 percentage points during each subsequent decade (i.e. the assumed energy efficiency growth rates were: 2012-25 (1.42%); 2026-35 (1.22%); 2036-45 (1.02%); 2046-55 (0.82%); 2056-61 (0.62%).

As an indication such assumptions about improvements in energy intensity imply that the Tunisian economy moves from consuming 285 toe of energy per US$1 million of GDP [57] in 2011 to 168 toe by 2061. For reference, according to World Bank data, the average for the same metric for high income OECD economies was 174 toe in 2010.

In order to decompose this TFC between the different sectors of the economy listed in Table 8.5, sector consumption in the base year (2012) was grown forward with economy-wide energy consumption adjusting for

57 - *Measured at constant 2000 prices.*

changes in the sector's share of GDP. This was based on the sector forecast of GVA quantified as part of the economic impact analysis (see section 8.1.2 for methodological detail). For the residential sector, we used a forecast of consumer spending as a proxy for activity.

Table 8.10: Tunisian real GDP, energy consumption and energy efficiency growth during selected periods[58]

Real GDP and Energy Consumption Growth (%yr)				
Period	Source	Total Primary Energy Use	Real GDP	Energy Intensity
1997-2006	INS	2.52	4.27	-1.75
1990-2010	World Bank	3.39	4.58	-1.19
1990-2000	World Bank	3.98	4.71	-0.74
2000-2010	World Bank	2.80	4.44	-1.64

Meanwhile, for electricity consumption and the primary energy requirements to produce this output we used production forecasts up to 2030 developed by STEG, which were supplied to us by Ammar Jelassi. These projections also contained forecasts of total demand for natural gas including that consumed by end-users as part of TFC. The STEG scenarios allow for an increasing role of renewable sources in power generation although the scale of this effect was not specifically quantified. We assumed that the share of renewables in power generation increased at a constant rate so that by 2030 it had reached 5%. Our assumption is that the majority of the increase in renewable energy will be generated from solar power although there is also scope for small-scale development of the wind power sector as STEG currently owns two windfarms with a combined energy capacity of 243 MW. For the post-2030 period, it was assumed that electricity demand would continue to increase at a slightly slower rate than TFC reflecting the trend implied by the STEG forecast up to 2030, with the associated primary energy requirement grown in line with electricity consumption. The extrapolation was completed by assuming that the share of renewables continued to rise at a linear rate reaching just over 20% by the end of the forecast horizon. The option of developing nuclear energy sources has been vigorously debated in Tunisia in recent years with STEG investigating the possibility. However, following the nuclear accident at the Fukushima power plant in Japan the option has become less politically viable. Our baseline case assumes that no nuclear option is pursued during the project horizon.

Finally, it was necessary to break down the remaining part of TPES into demand forecasts for different products. Up to 2030, the forecasts for both electricity and natural gas demand from STEG were used. The remaining part of TPES was then split between petroleum products and biomass. This was based on historical estimates together with an assumption that, as a relatively inefficient energy source, the role of biomass is likely to decline in future. Demand for petroleum products was used as a residual to ensure that consumption of all resources summed to TPES. Post-2030, demand for biomass was extrapolated assuming that its share of residential TFC continued to decline at a constant rate. For reference, this implies that by 2061, just over 11% of residential TFC of energy is from biomass compared to just over 50% in 2012. Elsewhere, demand for petroleum products was assumed to grow in line with TFC with demand for natural gas (outside of power generation) acting as the residual so as to ensure that the breakdown summed to our forecast level of TPES.

8.3.2 Supply

For the supply-side forecast we are heavily indebted to Ammar Jelassi, who provided invaluable support, advice and data provision. Separate methodologies were used for oil and gas while our analysis of the potential scope for shale resources (both liquid rich shales and gas) was based on direct projections from Shell under alternative success rate scenarios.

For conventional oil and gas, it was assumed that the rate of increase of new discoveries decreased at a fixed annual rate of 3.7% and 1.1% respectively [59] with production rates assumed to grow in proportion to remaining reserves. For gas, reserve forecasts from ETAP up to 2030 (inclusive of reserves from prospects, leads in concessions and permits).

58 - The INS figures refer to TFC rather than TPES.

59 - It could be argued that fiscal incentives may be sufficient to boost the discovery rate as was the case in the previous decade. However, in our view the most likely case is that represented in the baseline forecast.

8.4 Bibliography

- African Development Bank (2010), "Road Project VI Project Appraisal Report: Tunisia", April 2010
- Bloom, N, Eifert, B, Mahajan, A, McKenzie, D and Roberts, J (2013) "Does Management Matter? Evidence from India," The Quarterly Journal of Economics, 128(1): 1-51.
- Bruhn, M and Zia, B (2011) "Stimulating Managerial Capital in Emerging Markets: The Impact of Business and Financial Literacy for Young Entrepreneurs," World Bank Policy Research Working Paper 5642.
- Canning, David and Bennathan, Esra (2000), "The Social Rate of Return on Infrastructure Investments", World Bank Policy Research Working Paper 2390, July 2000.
- Canadian Society of Unconventional Resources (2012), "Unconventional Resource Development and Hydraulic Fracturing", a presentation for the Red Deer Watershed Alliance, October 2012
- US Department of Energy (2009), "Modern Shale Gas Development in the US: A Primer", Office of Fossil Energy, April 2009
- Drexler, A, Fischer, G and Schoar, A (2012) "Keeping it Simple: Financial Literacy and Rules of Thumb," Mimeo. LSE.
- US Energy Information Administration (2013), "Technically Recoverable Shale Oil and Shale Gas Resources: An Assessment of 137 Shale Formations in 41 Countries Outside the United States", US Energy Information Administration, June 2013
- European Union (2011), "Impacts of shale gas production on the environment and on human health", Directorate-General for Internal Policies, 2011
- Flegg et al (1995), Flegg A. T., Webber C. D. and Elliott M. V, "On the appropriate use of location quotients in generating regional input-output tables", Regional Studies (29), 547–61
- Global Insight (2011), "The Economic and Employment Contributions of Shale Gas in the United States" prepared for America's Natural Gas Alliance, December 2011
- Gorodnichenkou, Y, Svejnar, J, and Terrell, K (2007) "When Does FDI Have Positive Spillovers? Evidence from 17 Emerging Market Economies," University of Michigan Ross School of Business Working Paper.
- Mano, Y, Iddrisu, A, Yoshino, Y and Sonobe, T (2012) "How Can Micro and Small Enterprises in Sub-Saharan Africa Become More Productive? The Impacts of Experimental Basic Managerial Training," World Development, 40(3): 458-68.
- Stifel, David, Minten, Bart and Koro, Bethlehem (2012), "Economic Benefits and Returns to Rural Feeder Roads: Evidence from a Quasi-Experimental Setting in Ethiopia", Ethiopian Development Research Institute, May 2012
- Valvidia, M (2012) "Training or technical assistance for female entrepreneurship? Evidence from a field experiment in Peru," Mimeo. GRADE.
- World Health Organisation (2010), "Global Status Report on Road Safety 2013: Supporting a Decade of Action", 2010
- Wood Mackenzie (2012), "Global Oil Supply Tool Insight", October 2012

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