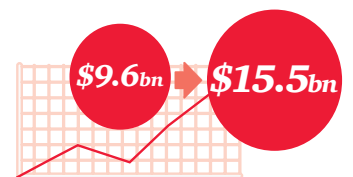


Dana Gas and Crescent Petroleum Gas Project in Kurdistan Region of Iraq

Socio Economic Benefits Report



Downstream economic
impact assessed to be



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Executive summary

PwC has been commissioned by Dana Gas and Crescent Petroleum to undertake an assessment of the societal benefits generated by their investment in the Dana Gas and Crescent Petroleum Gas Project (“DGCP Project”) in the Kurdistan Region of Iraq (“KRI”). The Kurdistan Regional Government (KRG) gave prominence to the development of Petroleum in the KRI and the Dana Gas and Crescent Petroleum Gas Project represents a major contribution towards the development of KRI’s gas extraction, production and transmission infrastructure in order that a high proportion of the country’s energy requirements can be met by affordable natural gas. Given this context, the Dana Gas and Crescent Petroleum Gas Project has and will continue to make a substantial contribution towards KRI’s economic and social development, and help KRG meet its strategic policy and development priorities at the regional, national and international levels. This report represents the assessment findings as of December 2014.



Contributing to the overall development of the Kurdistan Region of Iraq



The Dana Gas and Crescent Petroleum Gas Project

In April 2007, Dana Gas PJSC (“Dana Gas”) entered into agreement with the Kurdistan Regional Government of Iraq for the appraisal and development of two major gas fields (Khormor and Chemchemical) in the Region. Under the terms of the agreement Crescent Petroleum Company International Limited and Dana Gas (together “Joint Operators”) were given exclusive rights to appraise, develop, process, market and sell petroleum from the substantial Khor Mor and Chemchemical Gas Fields, and as a first phase to provide natural gas supplies to fuel two major domestic electric power generation plants being built in Erbil and Chemchemical, as well as for local industries and export.

Further planned major investments in the fields and in various social impact projects are on hold due to a dispute with Ministry of Natural Resources (MNR) since May 2009. The resolution of the dispute will enable full and proper development of these fields for the benefit of the people of the Kurdistan Region of Iraq. Currently these fields produce over 80,000 barrels of oil equivalent per day including Gas production of 320MMscf/day.

Dana Gas and Crescent Petroleum have to date, with their European partners OMV & MOL,¹ invested more than \$1.1 billion under the agreement with KRG in building major gas transmission pipeline and processing facilities, which makes this one of the largest private sector investments in Iraq’s Oil and Gas sector.

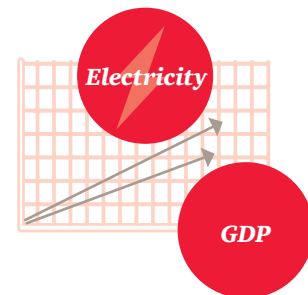
¹ OMV, Austria’s largest listed industrial company, and MOL Hungarian Oil and Gas Company, Hungary’s largest listed company, are two of Europe’s most dynamic integrated oil and gas companies.

DGCP Project

Total Investment to date

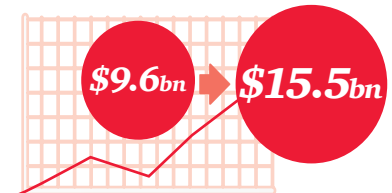


Electricity and GDP



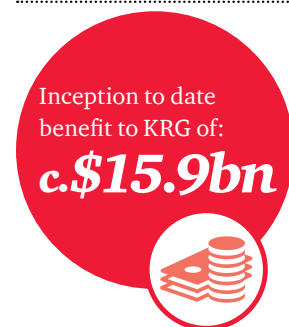
Increased availability of electricity from 8 hours to 22 hours within KRI (while other parts of Iraq continue to lack adequate supply of power) fuelled additional private sector investment in the KRI of over \$30bn with resulting significant GDP growth.

Downstream Project Benefits



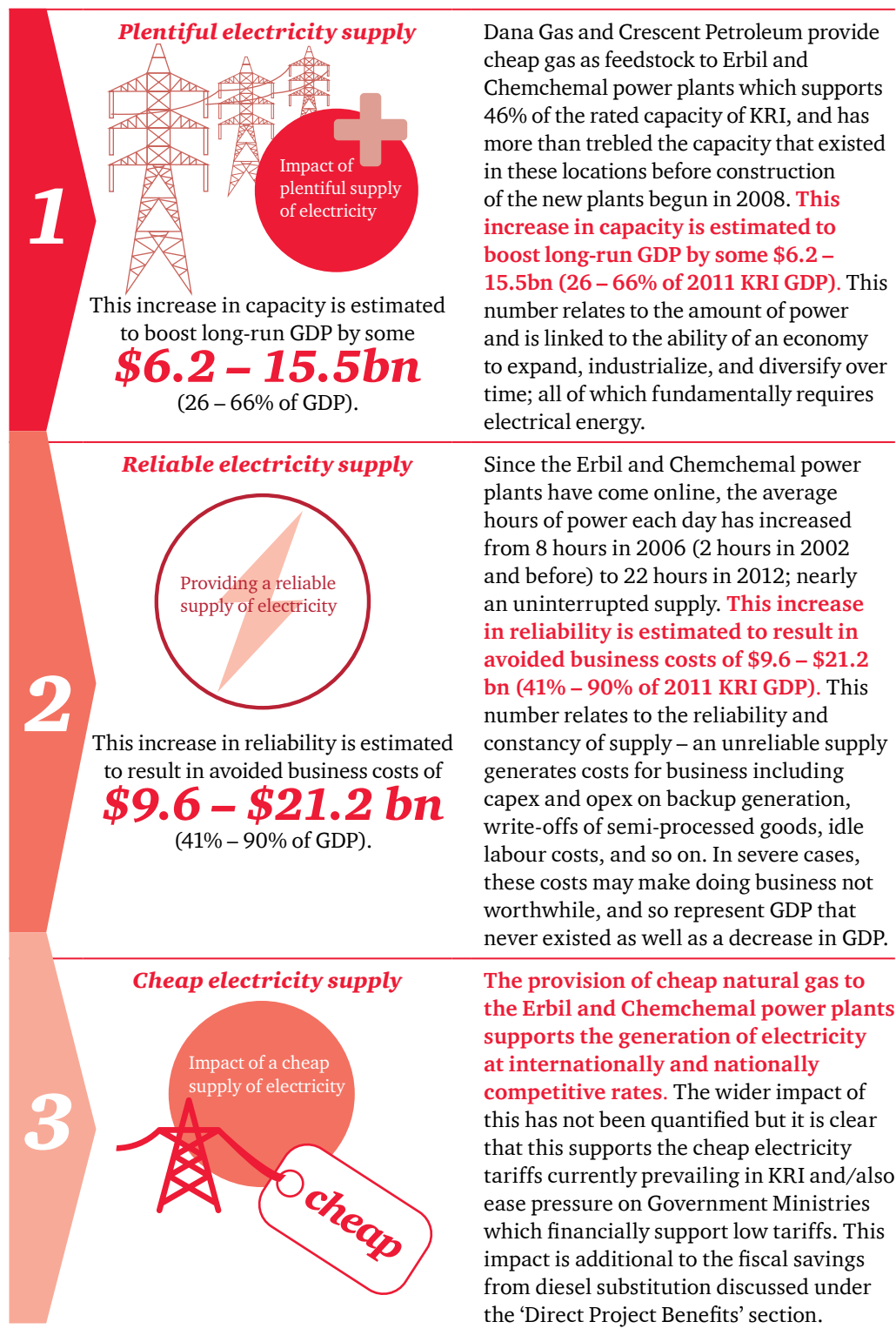
Downstream economic impact assessed to be \$9.6bn to \$15.5bn (range 40% – 66% of GDP of Kurdistan Region of Iraq).

Direct Project Benefits (Diesel Substitution)



Downstream Project Benefits

Whilst this Project generates significant direct benefits to KRI (discussed separately in this report), it should be recognised that the more substantial and long term benefits of this investment arise through its downstream impacts. This section quantifies the downstream economic impacts generated by Dana Gas and Crescent Petroleum through the provision of gas to the Erbil and Chemchemical power plants. Based on an extensive review of the international evidence, interpreted in the context of the KRI, our findings are multi-fold:



It is pertinent to note that all these economic benefits have been quantified with the current gas production of c. 320MMscf/day from the KhorMor field alone and do not address the substantial added benefit that would have been realised had Dana Gas and Crescent Petroleum's gas development plan pursuant to their agreement not been stymied as a consequence of the unresolved dispute of May 2009 with KRG as outlined above. These substantial benefits would accrue to the KRI economy in the form of uninterrupted power, spurt of growth across various industrial sectors, an increase in the overall GDP of the economy, and a resultant increase in the per capita income for the people of KRI. The most likely range of downstream benefits to KRI is summarized in the picture overleaf.

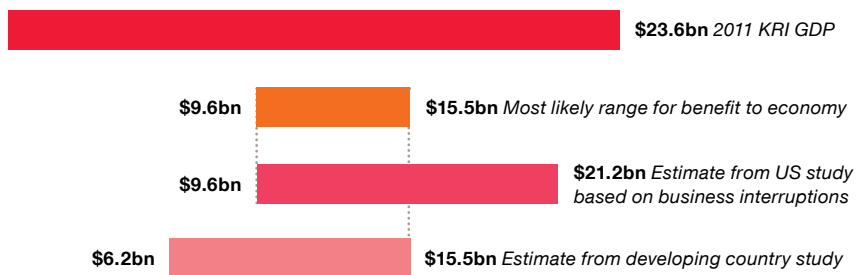


Supplies to two power plants providing 1,625MW of cost effective electricity

DGCP's Gas pipeline – to the power stations



Summary of downstream economic benefits to KRI from gas supplied by DGCP Gas Project to Erbil and Chemchemical power plants



Source: PwC analysis. Note: These impacts represent different types of economic impact and are not additive. They are complementary analyses that suggest that the economic impact is likely to be at least 40% of KRI GDP in 2011.

Therefore, it is important to emphasise that whilst the construction phase of the Project generated significant benefits to the KRI economy, the much more substantial societal contribution of the Project is, and will continue to be, generated through its impact in providing an increased and more reliable supply of electricity to support the growth of the KRI economy. These downstream impacts could be an order of magnitude greater. This is because the power sector is traditionally one

of the most interlinked with the rest of the economy. Electricity provides the key primary input to a range of industrial processes, and electricity consumption has been associated with faster economic growth at the macro level. Moreover, businesses cannot operate in an environment where power supplies are unpredictable and erratic. In a developed economy, the costs to business of power interruptions can quickly run into the billions of dollars.

Energy and growth in Iraq and KRI

Iraq in general and the KRI are fundamentally short on power. Peak demand in Iraq in 2011 was 15 GW, but available capacity only 9GW. Similarly, in the Kurdistan Region maximum demand (2,900 MW) exceeded the maximum load (1,900 MW) by 45% in the winter of 2012.

Rolling blackouts are not unusual in Iraq and even KRI (with the most advanced infrastructure and the smallest relative shortfall) continues to lack power for 2 hours on a typical day.

Within this context, recent economic growth has been impressive; for KRI 2011-12 growth was estimated at 12%. For Iraq as a whole, growth in 2011-12 was around 9.5% on a total GDP of \$216 billion.

Nonetheless, there is widespread evidence that the power bottleneck is holding back economic growth and broader socio-economic development. Small and Medium Enterprises (SMEs) in particular have spoken out about the lack of reliable power, claiming it has had a “severe effect” on business. Stakeholders in the construction sector in KRI (accounting for 21% of regional GDP) claim that power is the main impediment to development. Regional and National Governments recognise this, and are pushing ambitious plans for the expansion of generation, transmission and distribution. A key part of this strategy is to increase the role of natural gas in KRI generation, from 63% in 2012 to 75% in 2020; in the process, diesel is planned to be eliminated as a primary fuel in power plants.





Case Study: Impact of electricity availability in KRI

Over the past decade, KRI has undergone a major transformation, with double-digit economic growth propelling a rapid rise in KRI's living standards. The energy revolution that has taken place within the KRI lies at the heart of this economic transformation. Back in 2006, the KRI relied on electricity imports from other parts of Iraq, Turkey and Iran for close to all of its electricity needs.¹ With intermittent power supplies and an average of 8 hours of electricity availability per day, economic activity was severely constrained. Fast forward to today, and thanks to the DGCP Gas Project, the KRI enjoys an average of 22 hours of electricity availability per day and could be on track to become an energy exporter by 2016.²

The KRG Prime Minister has attributed the rapid economic progress taking place partly to the energy revolution, stating that one of the key elements to KRI's success is because they

“have taken bold and creative steps in the area of energy development and foreign investment to ensure that international companies, including blue-chips, establish a presence here and help us develop our energy resources.”³

The investment of US\$ 1.1 billion in the DGCP Gas Project has enabled the provision of locally produced natural gas⁴ at a low cost resulting in increased availability of electricity (industrial and retail) in the region and has contributed to the KRI economy multi-fold. Some of the direct implications of this vastly improved energy supply are illustrated below:

- Since 2003, the KRI has experienced an incredible 1400% growth in per capita GDP;⁵ growth rates for economy has also been highest in the region
- Two international airports (Erbil & Suleymania) have been significantly expanded in the last few years

- Gas from the DGCP Gas Project has been used to power up the local economy across multiple sectors
- Availability of sufficient electricity has resulted in increased real estate activity in the local real estate market⁶:
 - Erbil's robust infrastructure continues to fuel the residential real estate market; (USAID – value of construction sector in Erbil \$ 2.8 billion)
 - Tourism infrastructure and leisure offerings of the City and the hospitality sector is growing and expanding
 - Demand for office space in Erbil is being fueled by the increasing number of businesses
 - Increased levels of disposable income, and considerable stability is attracting more visitors causing the retail sector of Erbil to experience substantial growth

1 Kurdistan Invest in Group, 2013

2 Kurdistan Invest in Group, 2013

3 The Review, Kurdistan, Invest In Group, September 2013, p23

4 The Review, Kurdistan, Invest In Group, September 2013, p56

5 Overview: Kurdistan Region of Iraq, Economy (Invest In Group, 2013)

6 Ernst & Young – Overview of Erbil real estate market, 2014

*Total production of
320MMscf/day*



DGCP's Amine unit, LPG Plant

A photograph of an industrial facility, likely a water treatment plant, featuring large tan-colored storage tanks, a complex network of white pipes, and a tall light pole with multiple lamps. The sky is clear and blue.

Annual recurring savings to KRG of \$3.4bn from diesel substitution

Avoided Greenhouse Gas emissions of c.\$300m per year; inception-to-date \$1.4bn

Direct Project Benefits

In terms of direct benefits from the DGCP Gas Project, there are four primary mechanisms through which economic and social benefits are generated as a result of vastly improved supply of electricity. These include: (i) Diversification of the industrial base, (ii) Support for entrepreneurship and business growth, (iii) Wider social impacts for residents, and (iv) Financial savings to KRG.

It follows that one of the key economic rationale for the Project is to provide supply of natural gas feedstock to KRG's two power stations (Erbil and Chemchemical) within the ambit of DGCP's agreement with KRG. The agreement embodies further gas development for industry and export as part of KRG's wider programme of investment in economic infrastructure to help diversify the economic base of KRI and help shift KRI onto a pathway for sustainable economic growth.

*Investment of more than **\$1.1bn***

*Enabling infrastructure by supplying **cheap and reliable gas***

*Providing **employment** to locals*

Supplying gas to two power stations**, resulting in uninterrupted power supply **from 2 hrs (prior to 2002) to 22 hrs today

***Investing in tomorrow** through Community Action Programme (CAP)*

*Protecting the environment by **substituting polluting diesel fuel with Natural Gas***

These benefits have been assessed against each of KRG's four strategic priorities: (i) Enabling Infrastructure, (ii) Economic Growth, (iii) Social Well-Being, and (iv) Environmental Protection.

(Note that these benefits are currently stifled due to the ongoing dispute and will expand significantly after resolution of the ongoing dispute).

KRG's priorities



Enabling Infrastructure



Economic Growth



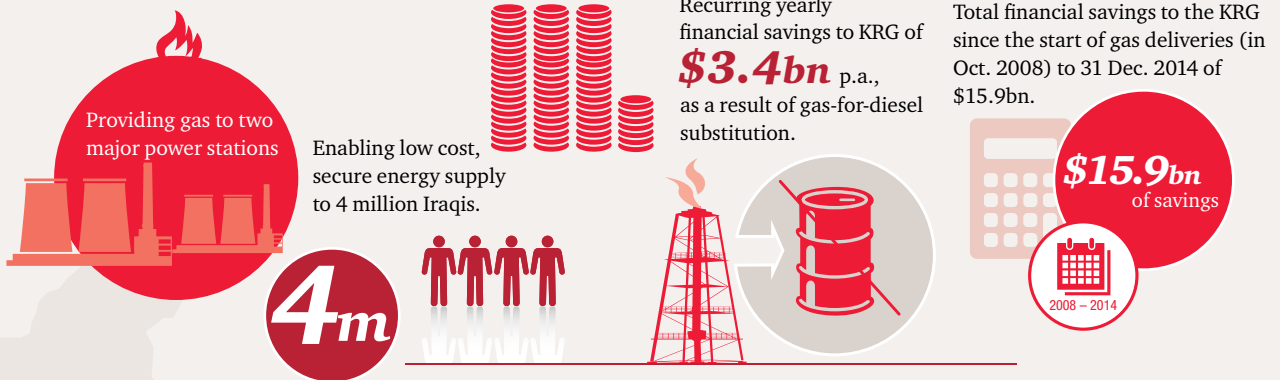
Social Well-Being



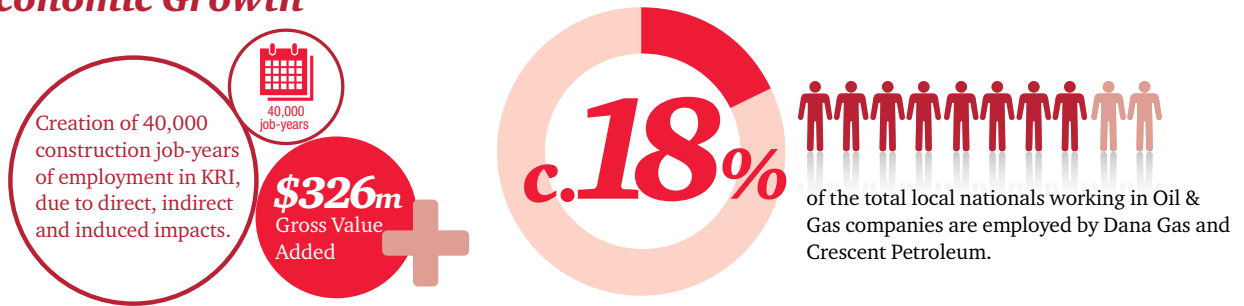
Environmental Protection

Dana Gas and Crescent Petroleum Gas Project benefits

Enabling Infrastructure



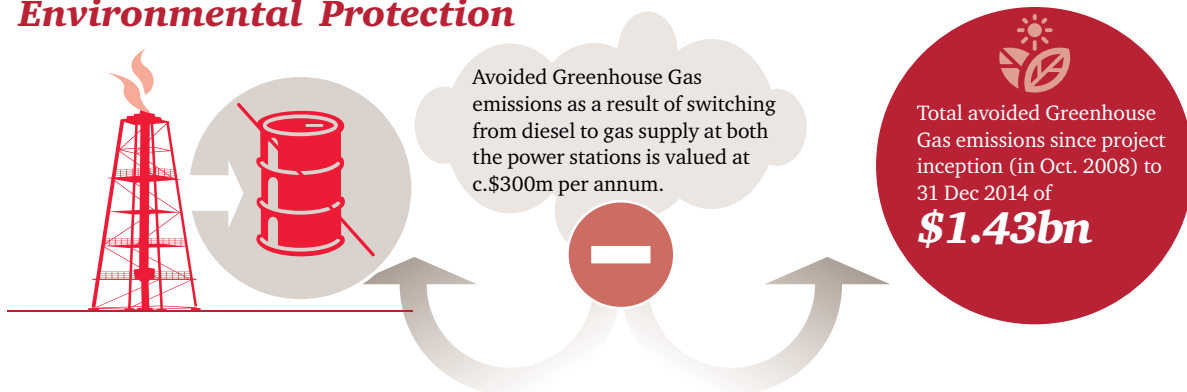
Economic Growth



Social Well-Being



Environmental Protection



Energy and Growth



Providing low cost, secure and more reliable energy to 4 million citizens and industries

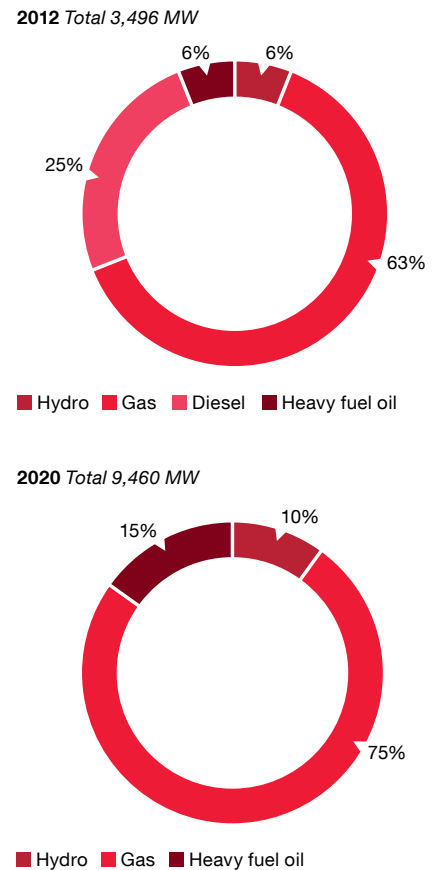
Energy in Iraq

Iraq is fundamentally short on power; in 2011 the International Energy Agency (IEA) estimated that peak demand in Iraq in 2011 was 15 GW, but available capacity only 9GW. This implies that Iraq needs 70% more net power generation capacity to meet demand fully. The IEA also asserts that “prolonged power cuts are still being experienced on a daily basis in many parts of the country”¹. Although planned power plants are expected to bring the market close to equilibrium in the near future, this relies on construction projects finishing on-time. Given the extensive delays on project implementation across the country this is not guaranteed by any means. Furthermore, demand growth is expected to exceed 13% every year to 2020, making investment in generation, transmission and distribution an ongoing necessity.

The IEA favours natural gas playing a substantial role in the power generation mix on account of its domestic availability, low fuel cost, high thermal efficiency, and lower corrosiveness than oil (which reduces maintenance downtime).

The Kurdistan Regional Government (KRG) area runs on a separate transmission grid, but faces similar pressures. In the winter of 2012, power demand in KRI exceeded 2,900 MW but only 1,900 MW of capacity was available. KRG is encouraging investment in 5,964 MW of new capacity by 2020, including 736 MW of hydro and 1,209 MW of Heavy Fuel Oil (HFO) generation (see Figure 1). However, the lead times for construction are substantial; the largest hydro plant for example is expected to take up to 8 years². Recognising this as well as the themes discussed above, KRG Strategy includes a strong role for natural gas in power generation in both the short-run and the long-run; an additional 4,893 MW of gas-fired capacity is factored into KRI’s plans by 2020.

Figure 1: Current and planned power generation mix, KRI (Rated Capacity)

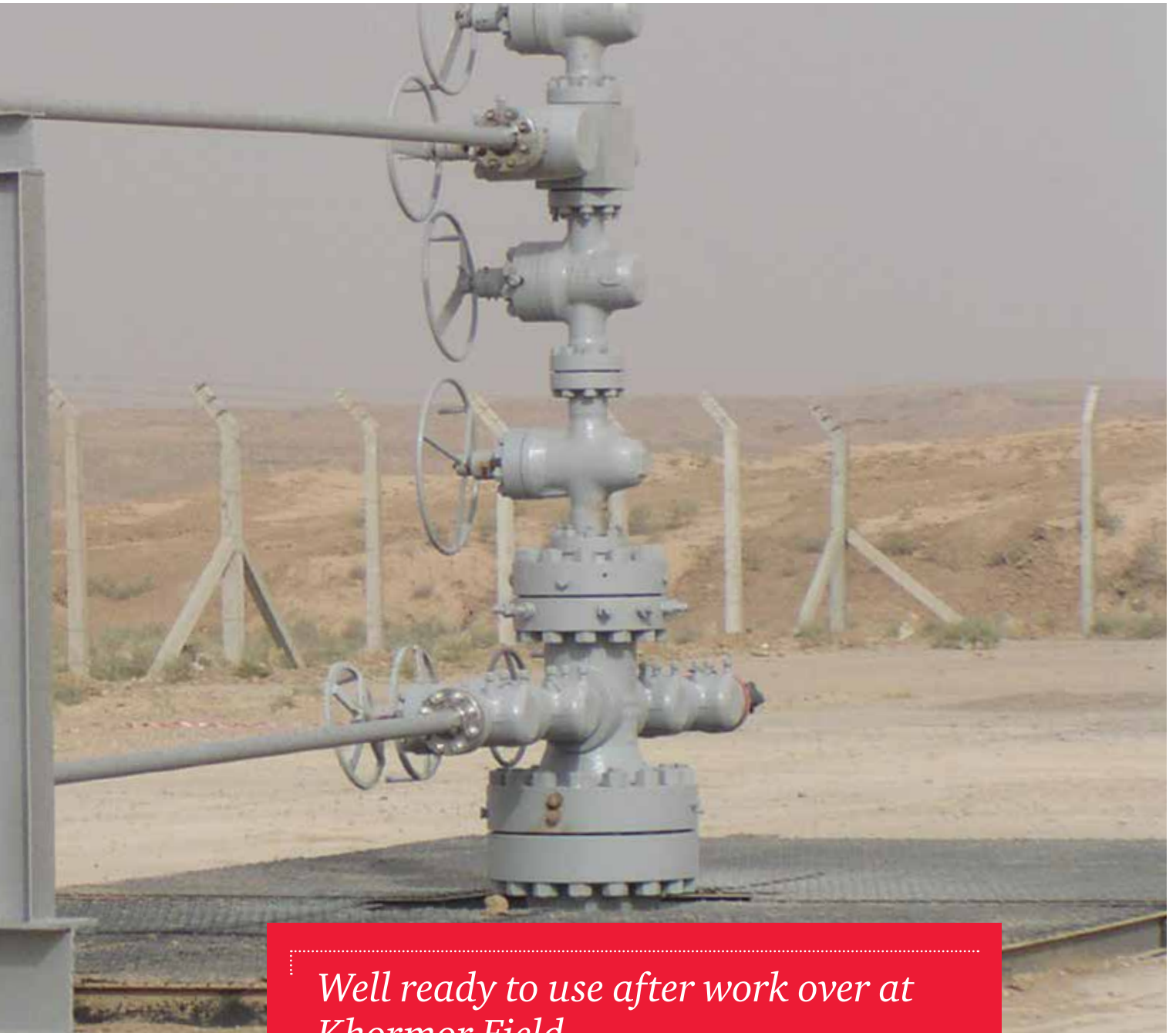


Source: Kurdistan Regional Government, Ministry of Electricity presentation at CWC Oil and Gas conference, Erbil, Dec 2012

1 International Energy Agency, WEO Special Report: Iraq Energy Outlook, November 2012

2 Ministry of Electricity Presentation to IEEJ, June 2012 (available at <http://eneken.ieej.or.jp/data/4502.pdf>)





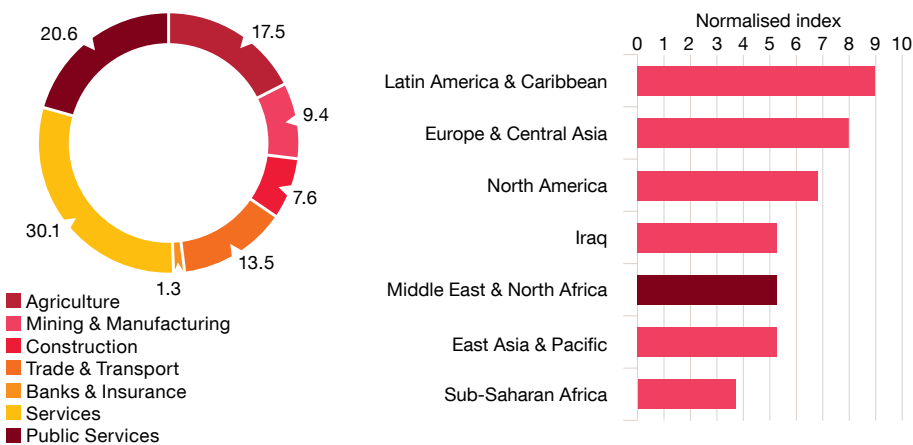
Well ready to use after work over at Khormor Field

The economy and energy use

The Iraqi economy is typical of the Middle-East with hydrocarbons dominating GDP and government revenue. Industry, including mining, accounts for 65% of GDP, followed by services (32%), and agriculture just 3%³. KRI has a higher value-add economy in some respects than Iraq as a whole; public and private services account for the majority of output,

per capita incomes are higher than the Iraq average, and extractives contribute a significantly smaller share of GDP. Much faith is also being placed in tourism as a growth engine of the future⁴. However, the agriculture sector is significantly larger (17.5% of GDP) and the mining and manufacturing sector in total is only 13.5% (see Figure 2).

Figure 2: Structure of the KRI Economy (2011, %)



Source: Kurdistan Board of Investment

Source: World Bank World Development Indicators

Recent growth performance has been quite reasonable: KRI growth was estimated at 12% over 2011-12 on a GDP of \$24 billion. For Iraq as a whole, growth in 2011-12 was around 9.5% on a total GDP of \$216 billion.

The use of energy to generate GDP is typical internationally and is also very similar to the Middle East and North Africa region as a whole (see Figure 2). As with other economies, it forms a key primary input into production of goods and services, especially manufacturing and to a lesser extent, services. In its absence major economic disruption can be expected. Indeed, there is plentiful local evidence that the current situation of energy infrastructure is inhibiting business growth and economic activity:

- The impact on entrepreneurs and Small and Medium Sized Enterprises (SMEs) is substantial. USAID surveyed SME owners in Kirkuk in 2010, and found that an unreliable electricity supply had a “severe effect” on nearly half of all SME operations⁵.

- In Iraq as a whole, unreliable electricity supply was cited as the number one infrastructure issue affecting small – and medium-sized businesses⁶.
- The United Nations has said that the “lack of reliable electricity ... reduces the ability of Iraqi entrepreneurs to compete” with imports from other countries in the region, undermining the development of Iraqi capability⁷.
- The Erbil Contractors’ Union and the director general of the Ministry of Construction agree that the lack of adequate electricity is the construction industry’s biggest problem and the main impediment to development in the KRI⁸.

In the absence of specific local quantitative evidence of the link between electricity and economic performance, it has been necessary to draw upon a range of international literature to understand how, and how much, electricity can influence GDP.



3 CIA World Factbook

4 See e.g. <http://www.worldfolio.co.uk/region/middle-east/iraq/n-2011-kurdistans-economic-growth-driven-by-more-than-oil>

5 USAID, Market Assessment: Business Constraints and Opportunities at the Business Enabling Environmental and Firm Levels for the province of Kirkuk, Iraq, Tijara Provincial Economic Growth Program, March 2010

6 USAID, Market Assessment: Business Constraints and Opportunities at the Business Enabling Environmental and Firm Levels for the province of Anbar, Iraq, Tijara Provincial Economic Growth Program, October 2009

7 United Nations University Entrepreneurship in Iraq: Understanding the Constraints (http://www.wider.unu.edu/publications/newsletter/articles/en_GB/Entrepreneurship-article-1109/)

8 USAID, Economic Development Report, Region of Kurdistan, December 2008



Plant construction work in progress

*4,411 job-years of direct
employment in KRI during
construction phase*



*Demining activities at
Khormor Field*

International evidence on the link between power and the economy

We have conducted an extensive review of the international literature to help infer what the quantitative impact might be of expanding electricity generation in Iraq/KRI (see Table 1 and Table 2 in Appendix 3).

Our review has resulted in a number of findings. Reliability in the supply of electricity is one of the most important factors affecting economies globally. It impacts on businesses of every size and type and is seen internationally as a significant obstacle to investing or doing business in a country. Within the appendices we have outlined evidence from a number of sources detailing cost estimates for: particular blackout events around the world; and, the cost per hour of outages on businesses segmented by size and industry. Small and medium sized enterprises are particularly impacted by power outages as the investment required for a backup generator as percentage of sales is relatively larger than for bigger firms. Energy intensive firms are hit the hardest by outages though, as the cost of emergency power and/or lost production time are proportionally higher. Outages can also have a significant social impact.

There have been a very wide range of macro-economic studies on the causality between electricity (or energy) and economic growth (GDP). Opinions are split as to whether one drives the other, or whether they are both linked but there is a large body of evidence that suggests energy drives GDP, particularly in middle income economies, and that this dependency increases at higher stages of development; and that, conversely, absence of energy is a limiting factor in economic growth. Modelling in Brazil suggests that a 9-10% increase in electrification can result in a 9 point gain in the United Nations Human Development Index and reduce poverty by 5%. Studies in South Africa found that electrification of communities raised female employment by 9.5% in 5 years and increased the number of hours worked by both men and women, and raised men's earnings.

In summary, experience from other emerging economies indicates how important the power sector is in promoting economic growth. In Turkey it has been demonstrated that the supply of electricity was “vitaly important” in sustaining growth over the latter half of the twentieth century, whilst in Sri Lanka it has been estimated that for every 1MWh increase in supply, around USD 1,120-1,740 worth of output was enabled. Based on key studies focussing on a number of countries (including Turkey, Pakistan and Hong Kong) we estimate that in general, the elasticity of GDP with respect to electricity consumption lies between 0.4 and 1.2 (i.e., for each one-percent increase in electricity consumption, GDP increases by between 0.4 and 1.2 percent) (see Table 2 in Appendix 3).

In summary, the international literature suggests that a crucial power generation investment may create impact for its downstream customers in three separate, but related, ways:

1. At a macroeconomic level, electricity consumption is statistically linked with economic growth due to its supply-side impact on industrial productivity and diversification.
2. A more reliable power supply avoids a range of business costs and encourages establishment of more businesses, particularly SME's.
3. A cheap energy supply makes energy-intensive industry cost-competitive, domestically and especially in global export markets.

In the following sections we examine each of these areas in turn, looking at how the generation capacity, supported by Dana Gas and Crescent Petroleum, impacts downstream economic activity in the KRI and also provides other direct benefits to society from the Dana Gas and Crescent Petroleum Gas Project in line with KRG's priority areas of Enabling Infrastructure, Economic Growth, Social Well-being and Environmental Protection.

Project Context

The Dana Gas and Crescent Petroleum Gas Project is the largest private sector investment in the KRI and is spearheading the Kurdistan Regional Government's investment in providing a low cost, secure and reliable energy infrastructure for the KRI, which provides the platform for delivering a substantial economic transformation programme for KRI.



Providing the platform to deliver an economic transformation programme for KRI

Economic impact of 40% – 66% of KRI's GDP in 2013

Strategic Context

Iraq is a middle income country whose economic prosperity is currently driven by its oil and gas production. Following a significant period of political and economic instability, Iraq is now in a transitional phase of economic growth with substantial investment in infrastructure underway to help shift the country towards a pathway for economic diversification and prosperity. Iraq's National Development Plan emphasises the importance of underpinning this economic transformation through developing its market economy and attracting private sector and foreign direct investment. Iraq has also made commitments to support the achievement of the UN's Millennium Development Goals (MDGs), which were developed and adopted by world leaders in the Year 2000 to provide concrete, numerical benchmarks for tackling extreme poverty⁹.

Within Iraq, the autonomous region of KRI is expected to play a key role in the major economic transformation process currently underway. The KRG recognises that its oil and gas industry, and achieving a low cost, secure and reliable source of energy,

is integral to realising its strategic economic development priorities. KRG is at the forefront of the country's diversification and rebuilding efforts.

Electricity supply is the driving force of the economy given its role in supporting all activities within the economy. Prior to the Dana Gas and Crescent Petroleum Gas Project the authorities in KRI were unable to provide adequate electricity to residents, many of whom had access to electricity for only 2 hours of the day. However, the Dana Gas and Crescent Petroleum Gas Project has substantially transformed the picture with a much improved and reliable supply of electricity to KRI's residents and businesses since the project, commissioned by Dana Gas and Crescent Petroleum, started to generate gas supplies in 2008 and increased supplies thereafter. According to KRG figures, in 2012 the electricity supply had increased to 22 hours per day in KRI, compared with 2 hours per day in 1991 and 8 hours per day in 2008. The situation in the rest of Iraq, however, still remains substantially worse than in the KRI.

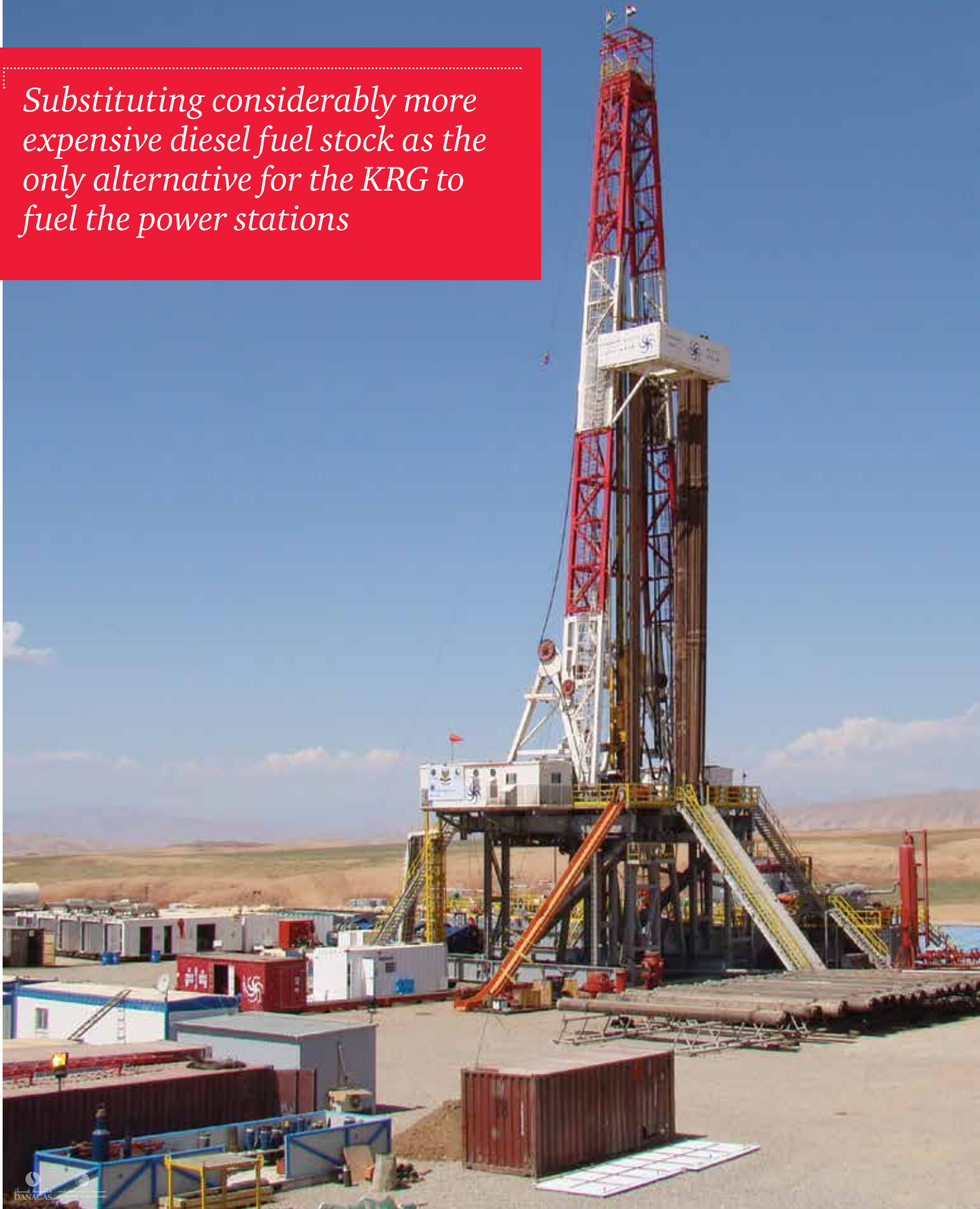
The Dana Gas and Crescent Petroleum Gas Project

Up to 2007 the KRI was facing an acute energy supply crisis with the absence of locally generated energy. This was the catalyst for the KRG to award the construction of two power stations in Erbil and Chemchemical in 2005, and entered into agreements with Dana Gas in April 2007 for the appraisal and development of two major gas fields (Khormor and Chemchemical) in the KRI (HOA). Under the terms of the HOA (as amended) Dana Gas and Crescent Petroleum (together "Joint Operators") were given exclusive rights

to appraise, develop, process, market and sell petroleum from the substantial Kor Mor and Chemchemical Gas Fields to initially provide natural gas supplies to fuel domestic electric power generation plants in Erbil and Chemchemical as well as for export and use by local industries. The agreement was subsequently assigned to Pearl Petroleum Company Limited, which is a joint venture between Dana Gas, Crescent Petroleum and two major European petroleum companies, OMV and MOL.

⁹ Further details on the UN's Millennium Development Goals (and post-2015 Sustainable Development Goals) are provided in Appendix 1

Substituting considerably more expensive diesel fuel stock as the only alternative for the KRG to fuel the power stations



Drilling rig



Managing difficult terrains



Stockpiling Pipes at Erbil

As a result, Dana Gas and Crescent Petroleum together with their partners, OMV and MOL, have to date invested more than USD 1.1 bn in developing and producing gas, and in building (and operating) a major gas transmission pipeline and processing facilities, and have developed a major infrastructure project in the KRI. The investment has resulted in the supply of over 320MMscf/day of affordable natural gas, and considerable quantities of associated LPG and condensate. Deliveries of gas to the two power stations in the KRI (Chemchamal and Erbil) began in October 2008. The low-cost electricity generated through the burning of gas at each facility is subsequently delivered to end users. This has a major impact on the perception and reality of working and living in KRI, and has provided the KRG with the platform for a substantial economic transformation programme for the KRI that has led to the creation of new jobs, businesses, and wider social and economic development benefits. These have been significantly curtailed as a result of the KRG preventing Dana Gas and Crescent Petroleum to continue various other planned projects in aid of achieving these wider social and economic development benefits for the KRI.

Initial gas supplies were delivered by Dana Gas and Crescent Petroleum in October 2008, which represented an extremely rapid delivery compared to industry benchmarks. As a consequence there has been an acceleration of the socio-economic benefits generated by the Project, which has been advantageous to residents and businesses in KRI widely.

One of the key economic rationale for the Project is to provide 4 million Kurdistan Iraqis with cheaper reliable electricity supply, significant, tangible, socio-economic benefits contributing to the achievement of Iraq's national MDGs, and the overall economic development of the KRI.

The Kurdistan Region of Iraq is expected to benefit more specifically from the Project in a number of ways which are aligned with KRG's strategic priorities through:

- **Enabling infrastructure :** generating economic growth through the supply of secure and low cost electricity to KRI which helps diversify the industrial base and address a key constraint on the growth of Iraqi businesses, and realising financial savings through substituting considerably more expensive diesel fuel stock as the only alternative for the KRG to fuel the power stations;
- **Economic growth :** the generation of new employment opportunities, during both the construction and operational phases, and the impact of catalysing local economic development through the use of local contractors and suppliers and attraction of inward investment and enabling businesses and industries to transform;
- **Social wellbeing :** positive social impacts generated by investment in training programmes for local people to maximise the uptake of new employment opportunities, the provision of higher quality jobs as demonstrated by above average wage levels, and investment in a range of community programmes. The Dana Gas and Crescent Petroleum Gas Project is also directly supportive of Iraq's contribution towards meeting the UN's Millennium Development Goals (MDGs); and
- **Environmental protection:** environmental benefits generated through carbon emissions reductions as well as reduced SOx and NOx emissions, brought about by replacing diesel with gas fuel supplies for the two power stations.



Full view of the plant

Study Objectives

PwC have been commissioned by Dana Gas and Crescent Petroleum to undertake a societal benefits assessment of their investment in the Dana Gas and Crescent Petroleum Gas Project and how the electricity generation capacity that Dana Gas and Crescent Petroleum support may support downstream economic activity in the KRI. The key objective of this study is to analyse the socio-economic and wider benefits of the Dana Gas and Crescent Petroleum Gas Project that is underpinned by robust and evidence-based analysis. The benefits generated by the Project are both large and diverse, and relate to both the construction and ongoing operational phases of the Project. However, the ultimate socio-economic contribution of the Dana Gas and Crescent Petroleum Gas Project is measured in terms of how it contributes towards setting the KRI's economy on a new pathway to sustainable economic growth and improved quality of lives for its people.

The nature of these benefits is that they will be generated over a sustained period of time and some of them are difficult to measure in quantitative terms given the availability of existing data. Dana Gas and Crescent Petroleum recognise where this project is, within its life cycle, and that its full social and economic impacts can only be identified and measured over a longer time frame. Dana Gas and Crescent Petroleum have established a monitoring and evaluation framework for measuring the project's ongoing contribution towards the KRI's on-going social and economic development.

This study focuses on those impacts already generated by the Dana Gas and Crescent Petroleum Gas Project, which relate to the construction and continuing operational phase of the Project which have been curtailed as a result of the dispute with MNR. The bulk of the analysis was carried out in 2011 but as part of the process put in place by Dana Gas and Crescent Petroleum for monitoring and evaluating the project, the report is updated to reflect financial and operational data for the period up until December 2014.

Over time subsequent phases of work which seek to further deepen and broaden the socio-economic and wider benefits assessment of the Dana Gas and Crescent Petroleum Gas Project will be undertaken.

Our socio-economic benefits assessment has consisted primarily of reviewing the socio-economic data and operational information, obtained from various sources including those provided by Dana Gas and Crescent Petroleum, supported by use of third party research and other documentation as appropriate. Further details on the assessment framework are contained in Appendix 2.



Benefits to KRI: Enabling infrastructure

Overall, the Dana Gas and Crescent Petroleum Gas Project has provided vital enabling infrastructure for KRI, shifting the Region onto a pathway for sustainable economic growth. A secure supply of natural gas to KRG's two major power stations will ultimately support the shift to a more diversified industrial base, allow businesses to grow, and generate positive consumer and social impacts. KRG in turn has and will continue to enjoy substantial cost savings, as a result of substitution of more expensive diesel by cheaper gas fuel for the two power stations. In fact, gas-for-diesel substitution has generated total annual cost savings of USD 3.4 billion pa. Total savings since project inception amount to USD 15.9 billion.

However, these impacts are arguably only the “tip of the iceberg” and the downstream impacts could be an order of magnitude greater. This is because the power sector is traditionally one of the most interlinked with the rest of the economy. Electricity provides the key primary input to a range of industrial processes, and electricity consumption has been associated with faster economic growth at the macro level. Moreover, businesses cannot operate in an environment where power supplies are unpredictable and erratic. In a developed economy, the costs of business of power interruptions can quickly run into the billions of dollars. Therefore, our analysis suggests that provision of cheap natural gas to local power plants may enable approximately 40% of GDP in the KRI.

It should also be noted that these economic benefits have been quantified with the current gas production of c. 320MMscf/day from the KhorMor field alone. They do not address the substantial added benefit that would have been realised had Dana Gas and Crescent Petroleum's gas development plan pursuant to the HOA not been thwarted as a result of the unresolved dispute of May 2009 with KRG.



Producing over 80,000 barrels of oil equivalent per day (boepd)

Nature of the impacts

The Dana Gas and Crescent Petroleum Gas Project is one of the largest private-sector investment currently undertaken in the KRI. It involves the development of the KM gas field, the construction of 180km of a major pipeline and LPG plant with two trains. The Project supplies the two power plants that provide 1,625MW of cost-effective electricity to 4 million Iraqis.

Dana Gas and Crescent Petroleum currently supply 320 MMscf/day to the two power stations in KRI. The provision of a reliable electricity supply to the KRI is helping to meet long-term infrastructure and development challenges.

Benefit estimation

Rapid and diversified economic development in KRI requires an abundant, cheap and reliable electricity supply. This has not been the situation in KRI, and power blackouts were common. This represented a key constraint on productivity, competitiveness and therefore economic growth in the KRI. Addressing these constraints required that the energy requirements of the

KRI are fulfilled, which the Dana Gas and Crescent Petroleum Gas Project helps achieve, by providing cheap gas supplies for use in the power stations in Erbil and Chemchamal. Experience from other emerging economies indicates how important the power sector is in promoting economic growth, as illustrated by the case study from Brazil.

Case Study: Development Effects of Electrification in Brazil

Recently, an MIT study, using a Brazilian engineering/economic model, estimated that the electrification of Brazil over the period 1960–2000 had a large positive effect on socio-economic development. Overall, the authors found that the UN Human Development Index for Brazil was boosted by 17% (the HDI uses wider development measures than GDP, such as income, education, life expectancy etc).

The main mechanism through which this impact was generated was a broad-based improvement in labour productivity. Some of the key results of full electrification included:

- a 22% drop in the illiteracy rate
- a 19% decrease in the proportion of the population with less than four years of education
- a 45% rise in the average years of schooling

Combined with a large increase in tertiary education, these raised the stock of human capital by 53%. The increases in labour productivity were of a similar size **across all sectors and both rural & urban areas.**

Part of the Plant being transported



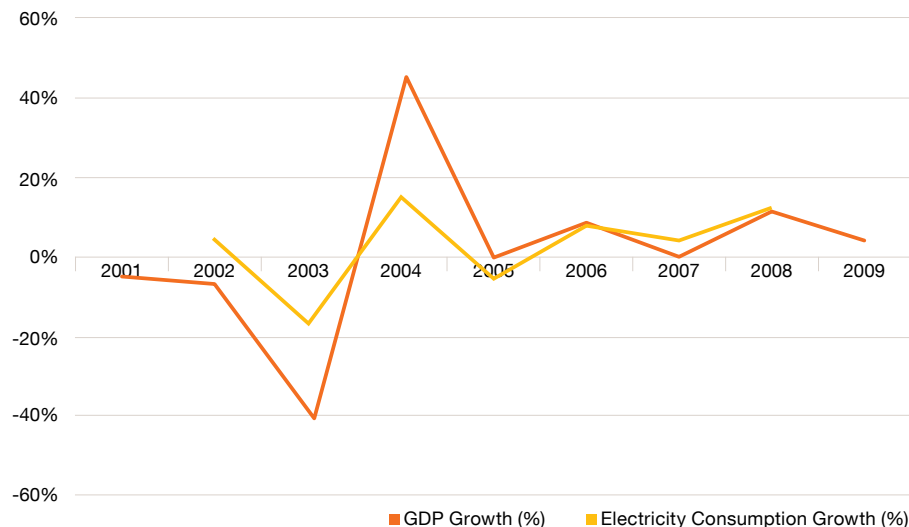


*Bringing world class
technology to KRI*



Figure 4 suggests the existence of a similarly strong link between macroeconomic growth and the electricity supply in Iraq based on World Bank data.

Figure 4: GDP and Electricity Consumption in Iraq 2001-2009



Source: World Bank

At a microeconomic level, there are four primary mechanisms through which these economic and social impacts are generated through an improved supply of electricity as follows:

- Economic diversification:** a lack of reliable electricity supply is a bottleneck to basic industrial production. Power outages require investment in standby generators running on (expensive) alternative fuels (such as diesel), result in lost production (e.g. semi-processed raw materials) and incur clean-up costs. More fundamentally, factories have to be configured and managed to reduce vulnerability to volatility in the power supply, rather than to optimize profit margins¹⁰. The knock-on impact of reliable electricity production in terms of leading social and economic growth was cited as the primary rationale for the Asian Development Bank's investment in the sector in nearby Azerbaijan¹¹, and a similar investment by the World Bank in Kazakhstan¹². These arguments also apply to the economic development needs of KRI.
- Entrepreneurship and Business Growth:** the impact on entrepreneurs and Small and Medium Sized Enterprises (SMEs) will be substantial. USAID surveyed SME owners in Kirkuk in 2010, and found that an unreliable electricity supply had a "severe effect" on nearly half of all SME operations¹³. In Iraq as a whole, unreliable electricity supply was cited as the number one infrastructure issue affecting small – and medium-sized businesses¹⁴. The United Nations has said that the "lack of reliable electricity reduces the ability of Iraqi entrepreneurs to compete" with imports from other countries in the KRI, undermining the development of Iraqi capability.¹⁵
- Financial savings to KRG:** the substitution of expensive diesel with much cheaper natural gas provided by the Dana Gas and Crescent Petroleum Gas Project has saved KRG an estimated USD 15.9 billion since the date of commencement of gas supply (October 2008) until December 2014. Ongoing future savings are of the order of USD 3.4 billion per annum. This frees up public finance resources which can be further invested in the KRI, thereby reinforcing the other economic growth benefits of the project. Further details on the calculation of these financial savings are presented in Appendix 7.

- **Social Impacts:** the provision of a reliable electricity supply has wider social benefits for the 4 million residents of the KRI. The Asian Development Bank has found that the value to consumers of not having unexpected powercuts, and not having to invest in backup generators (or simply having no power), was worth over four times the price paid per unit¹⁶. HTC, a charity, point out that electricity is a crucial input into the agricultural and water industries (essential for land preparation, fertilization, irrigation, agro-processing and water collection, distribution, and purification respectively), both of which have crucial social impacts in terms of serving rural communities and meeting basic human needs¹⁷. This impact clearly extends far beyond the economic output contribution to the economy. Lastly, the advantages of children having light to study by in the evening, and ICT (Information Communication Technology) facilities in schools etc. are enormous in terms of improving the quality of education. If this flows through to Iraq's long-term stock of human capital, this would further boost the rate of economic growth in KRI and Iraq as a whole.

Downstream economic impacts – energy and growth

1. The impact of a plentiful supply

Dana Gas and Crescent Petroleum are providing substantial volumes of natural gas (up to 320 MMscf/day) that support the generation of new affordable electricity in KRI. In fact, the combined capacity of the Erbil and Chemchemal plants accounts for 46% of the rated capacity of KRI, and is more than double the capacity that existed before construction began in 2008 (see Figure 6; or Appendix 5 for a full overview).

The increasing consumption of electricity goes hand-in-hand with economic growth. Increased electricity supply drives industrial productivity, the manufacture of new processes and products, diversification across sectors and the emergence of service activities including leisure and tourism. Based on the results of our international literature review, we estimate that for each 1% increase in electricity consumption, GDP increases by between 0.4 and 1.2

percent. The economies from which these estimates are derived – Turkey, Pakistan and Hong Kong are clearly diverse economies with differing structures and trade patterns. But, they do provide a reasonable lower and upper bound of the potential impact within an emerging market context in the Middle East. Historically, Turkey in particular, is often drawn as a comparator with the KRI today, and this accounts for half the data in our estimate.

Figure 9 at the end of this section illustrates how the provision of a stable electricity supply facilitated by the Dana Gas and Crescent Petroleum Gas Project generates business benefits at a sectorial level within the KRI economy, drawing on the discussed mechanisms. The diagram illustrates the anticipated importance of electricity supply reliability to each industry sector, and how this impact can be measured in quantitative and qualitative terms, demonstrating the wide ranging nature of the anticipated contribution of enhanced electricity supply to the economic and social development outcomes for KRI. This stream of benefits began in October 2008 when the natural gas supply started flowing to the two power stations, and these benefits can be expected to increase significantly over the longer term. This longer term downstream impact of the project through the increased supply of electricity and enhanced reliability of supply is discussed in more detail below.

The increasing consumption of electricity goes hand-in-hand with economic growth. Increased electricity supply drives industrial productivity, the manufacture of new processes and products, diversification across sectors and the emergence of service activities including leisure and tourism. Based on the results of our international literature review, we estimate that for each 1% increase in electricity consumption, GDP increases by between 0.4 and 1.2

The increase in generation attributable to 1,625 MW of additional capacity in KRI installed since 2008 is therefore estimated to boost long-run GDP by some \$6.2 – 15.5bn (26 – 66% of GDP)¹⁸. This number relates to the volume of power and is linked to the ability of an economy to expand, industrialize, and diversify over time; all of which fundamentally require electrical energy.

- 10 Asian Development Bank Summary of Economic Analysis: Janub Gas Fired Power Plant Project (<http://www.adb.org/Documents/RRPs/AZE/43406/43406-01-aze-ea.pdf>)
- 11 Asian Development Bank Report and Recommendation of the President to the Board of Director: Proposed Loan for Power Transmission Enhancement Project (Azerbaijan) August 2008
- 12 World Bank Supports a Safe and Reliable Electricity Supply in Kazakhstan (<http://web.worldbank.org/WBSITE/EXTERNAL/NEWS/0,,contentMDK:22767221~menuPK:34463~pagePK:34370~piPK:34424~theSitePK:4607,00.html>)
- 13 USAID, Market Assessment: Business Constraints and Opportunities at the Business Enabling Environmental and Firm Levels for the province of Kirkuk, Iraq, Tijara Provincial Economic Growth Program, March 2010
- 14 USAID, Market Assessment: Business Constraints and Opportunities at the Business Enabling Environmental and Firm Levels for the province of Anbar, Iraq, Tijara Provincial Economic Growth Program, October 2009
- 15 United Nations University Entrepreneurship in Iraq: Understanding the Constraints (http://www.wider.unu.edu/publications/newsletter/articles/en_GB/Entrepreneurship-article-1109/)
- 16 World Bank. 2005. Project Appraisal Document on a Proposed Loan in the Amount of \$48 Million to AzerEnergy with the Guarantee of the Republic of Azerbaijan for a Power Transmission Project
- 17 Humanitarian Technological Challenge Reliable Electric Power for Developing Countries (http://www.iecehtc.org/files/Reliable_Electricity_Challenge_Description.pdf)
- 18 The full calculation is provided in Appendix 4.

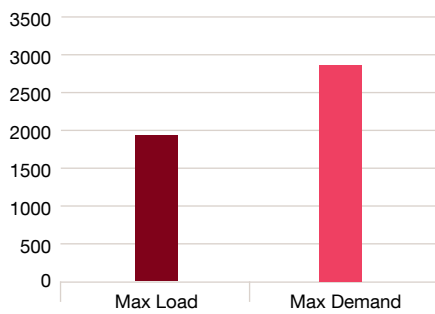


Pipe laying across the river



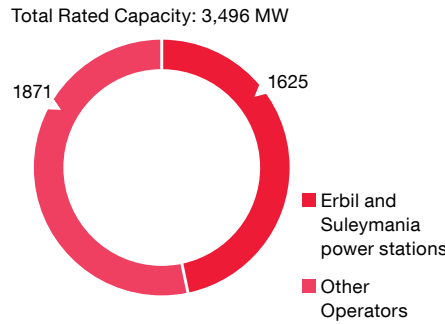
Pipeline welding in progress

Figure 5: Electricity supply and demand, KRI, Winter 2012



Source: Ministry of Electricity

Figure 6: The share of Rated Capacity attributable to Erbil and Suleymania power stations



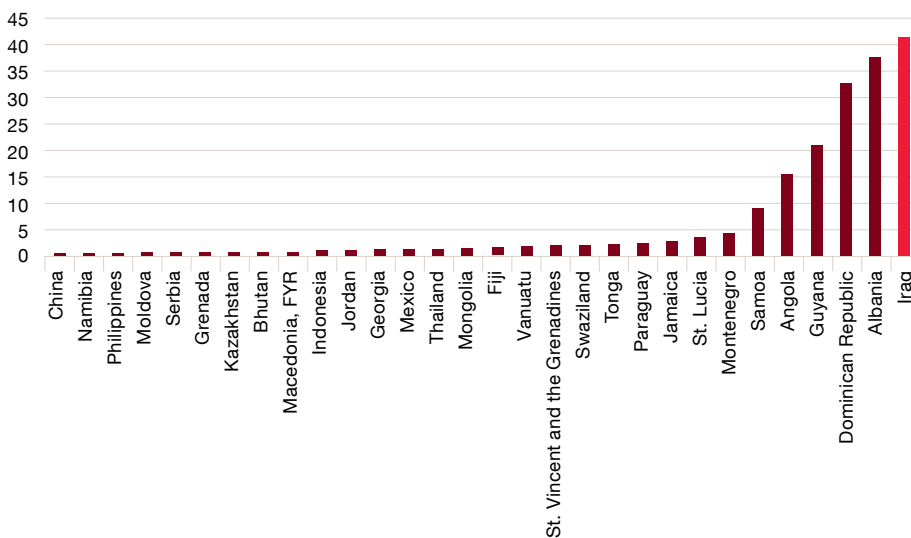
Source: Crescent Petroleum, Ministry of Electricity

(2) The impact of a reliable supply

As discussed, prolonged and often unanticipated power cuts across Iraq are highly disruptive to economic activity. These entail serious costs to businesses such as restart costs, write-offs of semi-processed raw

materials, idle labour costs, backup generator costs, and so on. As Figure 7 demonstrates, Iraq has the highest number of monthly power outages in a peer group of low/middle-income countries around the world.

Figure 7: Number of power outages a month, selected countries, average 2006-13



Source: World Bank. Sample group defined as GNI per capita between \$2,000 and \$10,000/year

Grid disruption in KRI has lessened significantly in recent years. In the early 1990's electricity was only provided for around 2 hours a day. By 2007-08 the average supply was around 8 hours a day¹⁹. Since the construction of the natural gas pipeline from Khor Mor to the two power plants fuelling 1,625 MW capacity, operating hours are averaging 22 hours a day.

A United States' survey of Utility Customers between 28 studies of customers of 10 US Utilities over the period 1989-2005, quantified the typical costs of an interrupted supply to industrial and commercial users. Based on this, and taking into account

the differing energy intensity profile of the Iraqi economy, we have estimated a range for what the reduction in these costs might be in KRI due to the additional 1,625 MW capacity²⁰.

Our estimate is that the avoided business costs due to an increase in operating hours from 8 hours to 22 hours, over 1,625 MW of demand which is fuelled by c. 320 MMscf/day gas from the KhorMor plant, lie between \$9.6bn and \$21.2bn (41% – 90% GDP), with the likely value towards the lower end of this range. Since these are direct business costs they can be interpreted as potential losses in GDP.

19 Source: Ministry of Electricity

20 The full calculation is provided in Appendix 4

(3) The impact of a cheap supply

Dana Gas and Crescent Petroleum entered into a contract with Kurdistan Regional Government, which requires them to provide certain volumes of natural gas ‘free of charge’ to the Independent Power Producers at Erbil and Chemchamal. Although the cost of generation at this plant remains confidential from international knowledge on the costs of gas generation it is extremely likely that the generation cost will be less than 3-4¢/kWh²¹, with free fuel.

This is critical as the end-user tariffs in Iraq and KRI are regulated and generally low by international standards (see Figure 8). The facilitation of cheap power generation alleviates pressure on the national and regional government budgets that underpin these low tariffs. In turn, this supports long-run competitive tariffs for businesses and households.

We would draw attention to the revolution in US Manufacturing currently taking place on account of the historically low natural gas prices following the Shale Gas boom. Here, cheap energy has boosted the prospects for petrochemicals to the tune of \$7bn²². Similar pro-competitiveness effects for electricity-intensive industries, such as metal electrolysis or water desalination, can be expected in Iraq.

It should also be noted that these economic benefits have been quantified with the current gas production of c. 320MMscf/day from the KhorMor field alone and do not address the substantial added benefit that would have been realised had Dana Gas and Crescent Petroleum’s gas development plan pursuant to the HOA not been thwarted as a consequence of the unresolved dispute of May 2009.

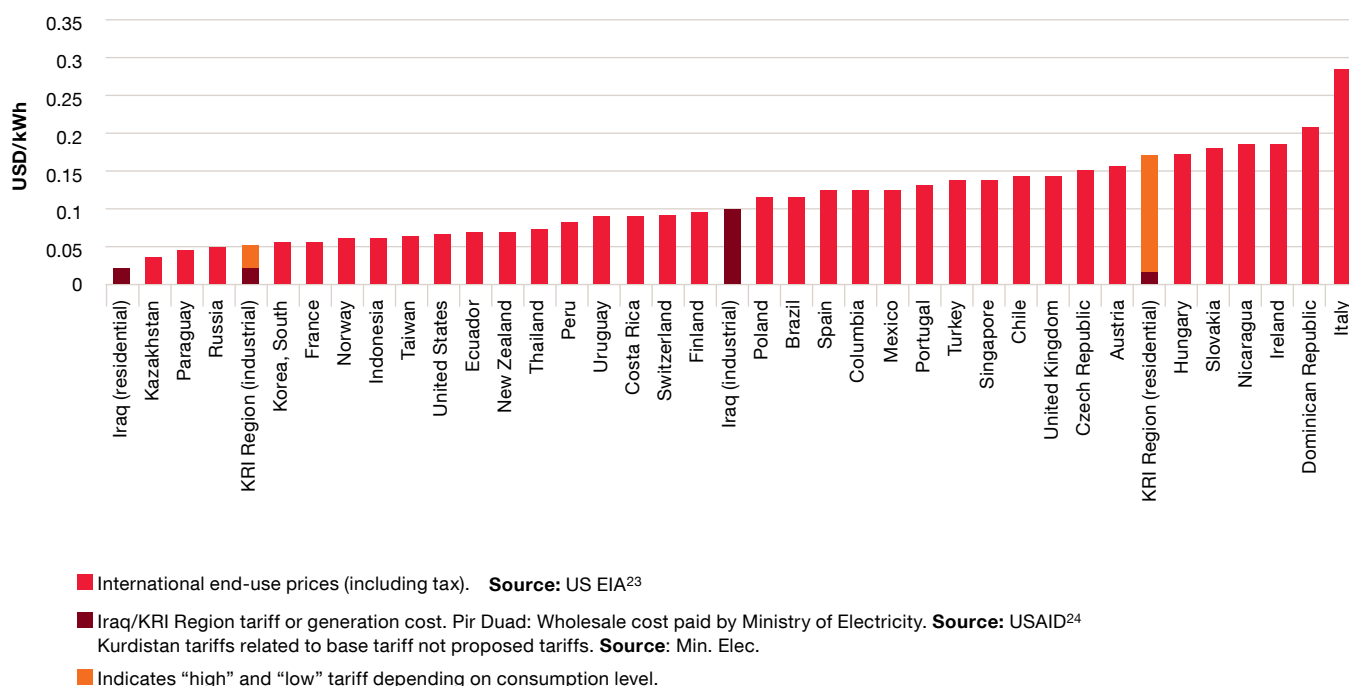
21 The IEA estimates that typical gas-fired generation costs 4-6.5¢/kWh, of which fuel cost is around 70%. In the context of a free fuel supply, even with higher-than-average capital costs, this implies the levelized cost of generation would remain below 2-3¢/kWh. Source: <http://www.iea.org/textbase/npsum/ElecCostSUM.pdf>

22 Source: IHS Global Insight America’s New Energy Future: The Unconventional Oil and Gas Revolution and the US Economy (September 2013)

23 http://www.eia.gov/countries/prices/electricity_industry.cfm

24 USAID, Economic Development Report, Region of Kurdistan, December 2008

Figure 8: Regional, national and international electricity prices



We note that the estimates in this section are necessarily quoted within a broad range, and driven by a series of key assumptions, including international proxies and other data. The true impact is highly uncertain given the absence of data on electricity generation, transmission and distribution data in KRI/Iraq and even elementary macroeconomic data for KRI. However, the ranges are indicative of the potential scale of the impact when supported by other enabling factors such as finance, skills, good regulation and other business-friendly policy.

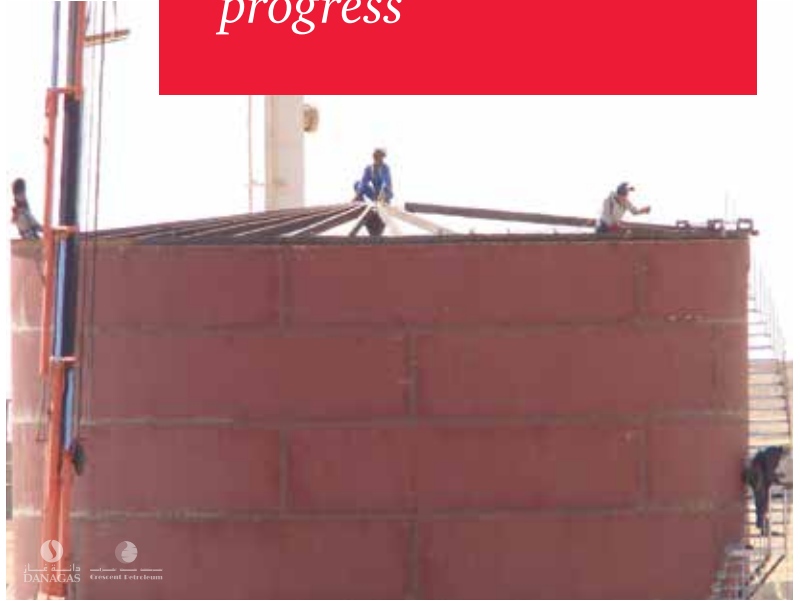


Erbil Power Plant

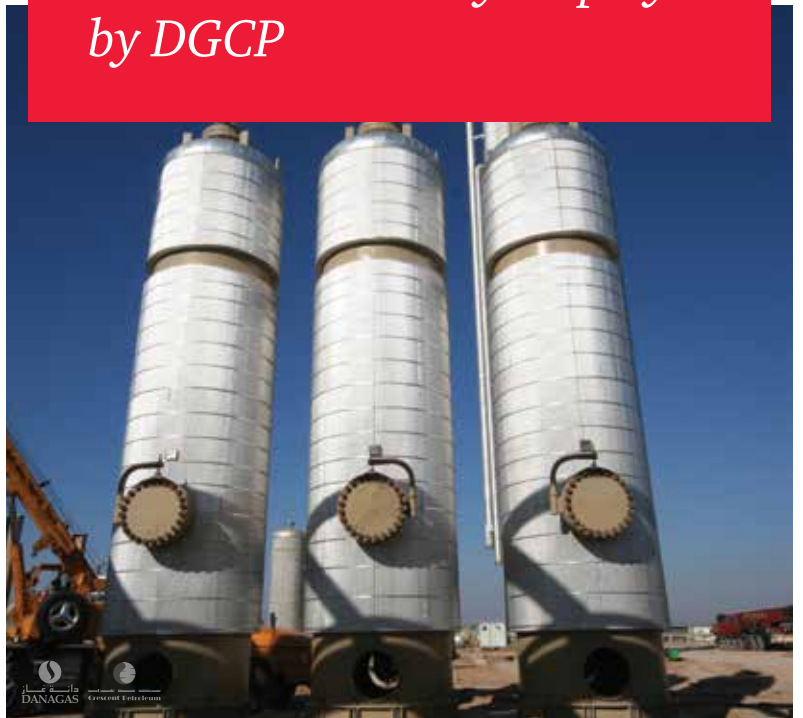
*1000 MW Erbil Power Plant
powered by gas from DGCP project*



Tank construction in progress

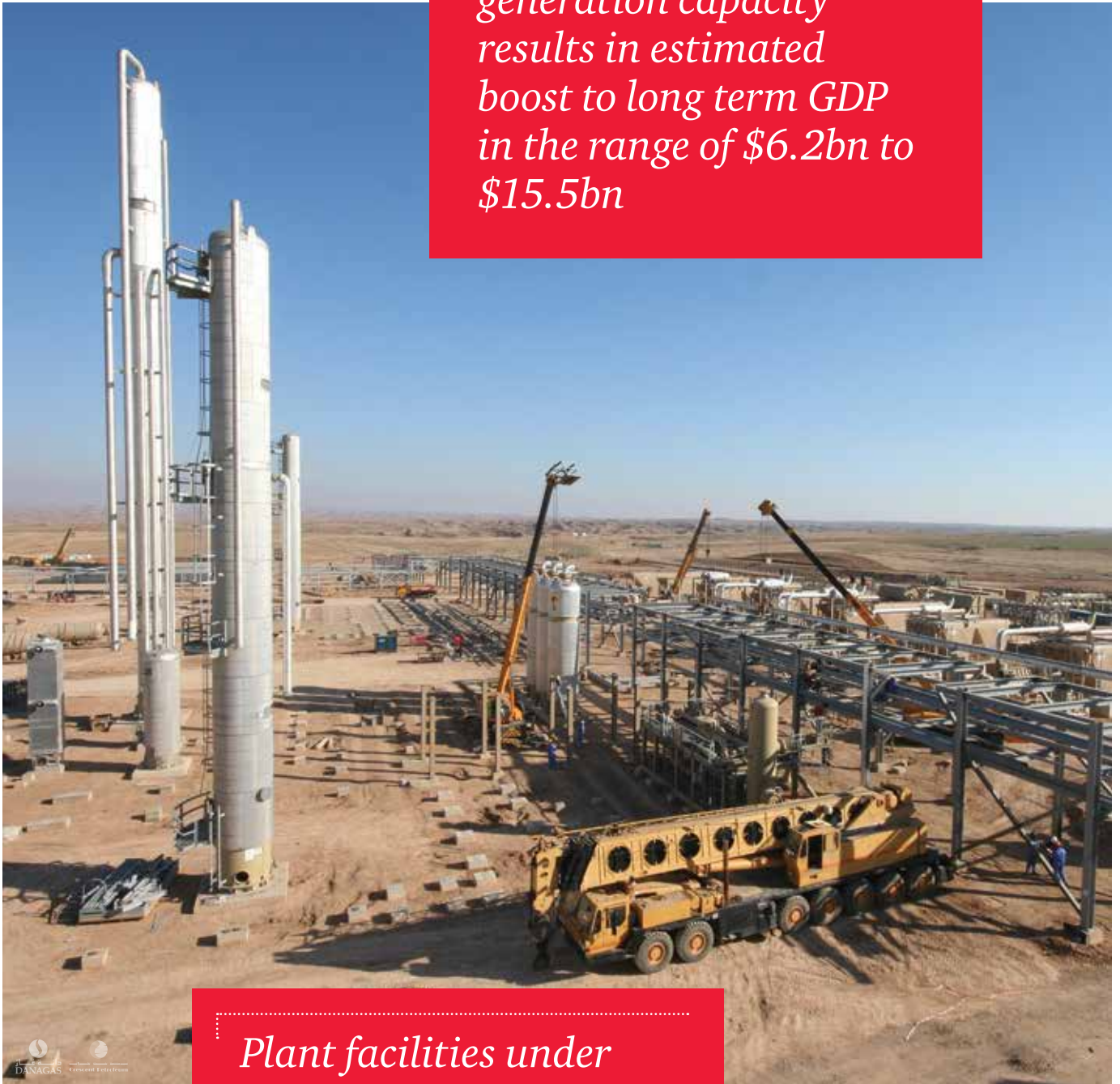


Empowering local capacity building c.18% of the Kurdish people working in Oil & Gas industry employed by DGCP



Plant facilities in operation

Increase in power generation capacity results in estimated boost to long term GDP in the range of \$6.2bn to \$15.5bn

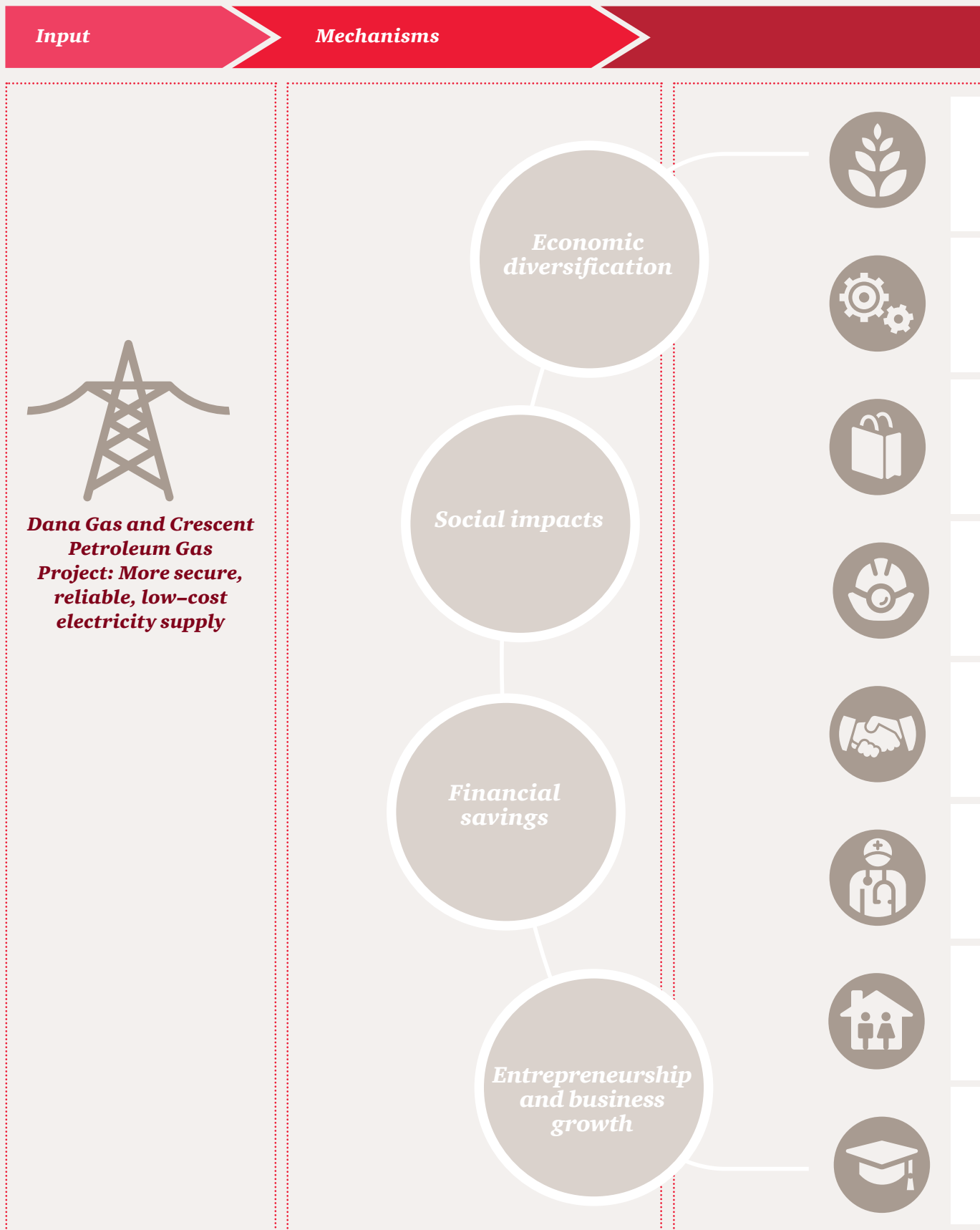


Plant facilities under construction

Reliable power supply results in avoided business interruption costs estimated in the range of \$9.6bn to \$21.2bn (US study)



Figure 9: How the provision of a stable electricity supply generates economic value in other sectors



Sectoral Outputs (selected)

Outcomes

Agriculture

- Number of irrigation system powered ('000)
- Quantity of fertilizer generated (Mt)
- Heat and power supply to farm buildings (MWh)

Manufacturing

- Lost production avoided (% Sales)
- Cleanup costs avoided (USD m)
- Growth of energy-intensive industries and enabled industries (%)

Retail and wholesale trade

- Increased opening hours (hrs)
- Increased shelf-life of perishable goods (days x IQD)
- Increased labour productivity (GVA/man hour)

Mining and Quarrying

- Enabled high-voltage mining operations (tonnes excavated)
- Enabled infrastructure to carry output (tonne – km)
- Increased labour productivity (GVA/man hour)

Public Sector

- Saved financial costs (USD m) from diesel fuel substitution
- Improved public services delivery (citizen satisfaction)
- Increased labour productivity (GVA/man hour)

Healthcare

- Increase in access to high end medical facilities (lives saved measured in USD)
- Improved household air quality due to reduced use of stoves and fumes from private diesel generation

Hotels and Restaurants

- Increased opening hours (hrs)
- Quantity of perishable goods saved (Sale value USD m)
- Number of foreign tourists ('000)

Education

- Number of computers per classroom ('000)
- Hours of work enabled after daylight hours (hrs)
- Improved child educational performance (various measures)

Economic & Social Development of KRI and Iraq (measured in terms of GVA, employment and a range of qualitative impacts)



DGCP Khormor Gas Plant – providing electricity to power KRI's industry



Benefits to KRI: Economic Growth

The Dana Gas and Crescent Petroleum Gas Project is making a substantial contribution to the economic growth prospects of KRI and Iraq as a whole. By December 2014, the Dana Gas and Crescent Petroleum Gas Project had spent USD 313 million on local construction workers and suppliers, as well as a further USD 188 million of operational expenditure within Kurdistan Region of Iraq. This in turn has led to the creation of 39,952 job-years (direct, indirect and induced) of employment and USD 326 million of additional Gross Value Added in KRI. These figures exclude the considerably wider economic footprint of the USD 1.1 bn spent on Dana Gas and Crescent Petroleum Gas Project.



*Creation of 39,952 construction
job-years of employment in KRI
(direct, indirect and induced)*

Nature of the impacts

Ultimately the economic contribution of the Dana Gas and Crescent Petroleum Gas Project is demonstrated through the sustainable supply of cheap, secure energy, which underpins the economic competitiveness of the KRI's businesses and improve the quality of life for the KRI's citizens. At present the Project construction has been fully completed vis-à-vis the Initial Services Plan agreed with KRG and so its key measurable impact relates to the economic impact of this construction phase and the consequent and ongoing operations, which is the aspect of the Dana Gas and Crescent Petroleum Gas Project's economic impact that is primarily considered within this study.

The construction impact of the Dana Gas and Crescent Petroleum Gas Project was by its nature short

term. Nevertheless, the scale of the construction expenditure undertaken by Dana Gas and Crescent Petroleum and the fact that the investment has taken place at a critical stage in the economic growth of KRI means that the economic contribution of the construction phase of the Dana Gas and Crescent Petroleum Gas Project assumes significant importance. In particular, the impact of the Project in acting as a catalyst for training and generating large numbers of jobs locally, helping to equip larger numbers of local people with new skills, and stimulating local suppliers to support the construction process is a significant benefit and legacy of the Project. The operational phase continued the economic support provided by the construction phase in a sustainable mode involving long term job creation and systemic stability.

Benefit estimation

The Project policy was and is to give preference to the employment of local people in KRI to the extent they have the technical capability and appropriate experience required to perform the tasks. Therefore, the USD 313 million of the total Project expenditure that was spent locally up until the end of December 2014²⁵ is estimated to have created 4,411 job-years²⁶ of direct employment in KRI²⁷. In addition, an operational spend in the Gas sector and on Business Services of USD 188 million up until the end of 2014 has resulted in a direct employment effect of 14,063 job-years. Total direct job creation in the KRI up until the end of 2014 therefore stands at 18,474 job-years, with the vast majority of these jobs being filled by local people.

The contribution to Gross Value Added of the direct employees to KRI is USD 245 million.

Over and above the direct employment impact of the Project is the economic benefits arising from the increased employment associated with suppliers to the construction and operational processes in KRI (indirect impact) and the jobs created through the spending on local services of workers employed on site and in the supply chain to the project (induced impact). Taking all these impacts into account, the total employment effect in KRI is 39,952 construction job-years and a GVA contribution of USD 326 million. For KRI, the employment multiplier is calculated at 2.16 and the GVA multiplier is 1.33. Clearly this employment and economic output impacts represent substantial economic benefits for KRI. The impacts for Iraq as a whole are even greater.

²⁵ Refer to Appendix 8.

²⁶ This is equivalent to generating work for 4,411 employees working for one year each, or 2,205 working for two years each.

²⁷ Refer to Appendix 9.



Cross section of employees – our assets

Benefits to KRI: Social Well-Being

On average, the Dana Gas and Crescent Petroleum Gas Project pays wages to local people that are much higher than the minimum wage and even average wages in Iraq. This should allow even the lowest paid employees to support decent livelihoods for themselves and their families. In addition, the Dana Gas and Crescent Petroleum Gas Project's Community Action Programme has helped tens of thousands of people in villages, schools & businesses in KRI to improve their well-being and directly contribute to achieving the Millennium Development Goals.



Investing in tomorrow

Nature of the impacts

The Dana Gas and Crescent Petroleum Gas Project's Community Action Programme (CAP) contributes employee time and financial resources to local villages, businesses and schools in supporting the standard of living, health, well-being, security and stability and the development of human capital in KRI. The table below summarises the social benefits of the CAP. More details about each programme can be found in Appendix 10.

Activity	Beneficiaries	Relevant impact areas	Relevant MDGs
Drilling Waterwells in drought area in Qader Karam, Shoresh and Chemchemical	10,000 people	Standard of living, Health & well-being, Security & stability	 4  5  7
Replacing Chemchemical Water Tanks	10,000 people	Standard of living, Health & well-being, Security & stability	 4  5  7
Providing Shwan Sub-District with Water Treatment system	200 people	Standard of living Health & well being	 4  5  7
Mobile Health Team	5,000 people	Health & well being	 5  4  6  8
Construction of X-ray room in Alton Kopree Hospital	10,000 people	Health & well being	 5  4  6  8
Handover of a Health Centre Caravan to Grdasoor-Quashtapa	500 people	Health & well being	 5  4  6
Construction of a 4-classroom school in Garachewar-Qadirkaram	Students in the villages	Human capital	 2
Donated educational materials to Chemchemical & Qader Karam Schools	600 students	Human capital	 2
Donated 19 water coolers to Altun Kupri Schools	1,000 students	Standard of living Human capital	 7  8
Granted 7 Scholarships for Master Degree in the American University in Suleymania	7 MBA students	Standard of living Human capital	 1  2
Donated a 250 KV generator to Qadirkaram town	Qader Karam & Sangaw	Standard of living Security & stability	 1  8
Construction of four soccer fields in Qader Karam, Shoresh, Chemchemical and Rezan	Youth in the areas	Health & well being, Community cohesion, Human capital	 2  4

Activity	Beneficiaries	Relevant impact areas	Relevant MDGs
Supporting Qadirkaram Community with kerosene	100 families	Standard of living, Community cohesion, Security & stability	
Supporting Community in Qandel district	95 families	Standard of living, Community cohesion, Health & well being	
Provision of Generator Set in district of Sangaw	Sangaw district	Standard of living, Community cohesion, Security & stability, Health & well being	
Supporting maternity hospital in Chemchemical	Chemchemical district	Standard of living, Community cohesion	  
Donation of AC units	Qader Karam district	Standard of living, Health & well being	
Hiring Vehicles and providing transportation to schools	Students in the villages	Standard of living, Health & well being	
Supporting Qadir Karam and Chemchemical societies	Chemchemical & Qadir Karam districts	Community cohesion, Security & stability, Health & well being	 
Literature support to a writer	Book writer	Community cohesion, Standard of living	 
Supporting orphans along with Barzani Charity Foundation	1000 orphans	Community cohesion, Security & stability, Standard of living	  
Financial support to a hospital in KRI	KRI Region	Community cohesion, Health & well being	  
Provision of free electricity to 5 villages in Qadir Karam town	Houses, Government building & shops in these villages (276 in total)	Standard of living, Health & well-being, Security & stability	  

Over and above the investment in community programmes through the Dana Gas and Crescent Petroleum Gas Project, major social impacts are anticipated through the employment generation process described above, and in particular the quality of jobs created for local people and the impact this can be expected to have on improving the quality of lives for communities across KRI. The activities under CAP have been impacted significantly as they have been curtailed due to the ongoing dispute with KRG.



Social welfare project – Qader Karam village

Benefit estimation

We have compared the average wages paid by the Dana Gas and Crescent Petroleum Gas Project to local employees during the construction and active operations (Figure 10), and found that:

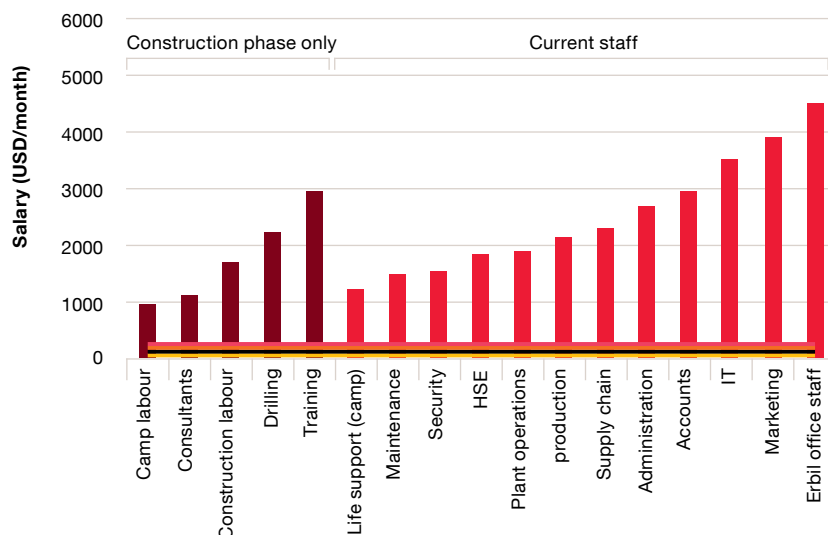
- **All workers** earn wages above the minimum and mean wages in the country.
- **Unskilled labourers** such as those working in camp, construction and security earn at least eight times the minimum wage for unskilled labour in Iraq.
- All wages range from **4 to 17 times** the mean wage.

- Wages paid by the Dana Gas and Crescent Petroleum Gas Project allow all employees to live well above the national average standard of living. Even the lowest paid employees would be able to **afford to pay for the basic needs of around 17 people**.

It should be noted that these benefits have been quantified based on gas production from the KhorMor field alone and do not address the substantial added benefit that would have been realised had Dana Gas and Crescent Petroleum's gas development plan pursuant to the HOA not been thwarted as a consequence of the unresolved dispute of May 2009 with KRG.

Figure 10: Comparison of average wages²⁸

Average monthly wages of local operations staff (USD)



Source: PwC analysis

- Salary, construction only (2011)
- Salary, current staff (2013)
- National Mean Income (\$271)
- Minimum wage, skilled (\$252)
- Minimum wage, unskilled (\$126)
- National Poverty Line (\$66)

In addition, other social well-being benefits that the Dana Gas and Crescent Petroleum Gas Project is expected to deliver but have not been assessed include:

- Impacts of community initiatives (i.e. what has changed as a result of CAP initiatives being implemented);
- Impacts of non-estate public services (e.g. education, water, electricity, health, security and infrastructure) in remote areas of KRI where access is not available for workers and their families; and
- Impact of people development and working conditions practices and policies in the Dana Gas and Crescent Petroleum Gas Project's plant and supply chain.

²⁸ Refer to Appendix 11 for a complete list of data sources.

Benefits to KRI: Environmental Protection

The estimated greenhouse gas emissions avoided from the replacement of diesel fuel with natural gas by the Dana Gas and Crescent Petroleum Gas Project from October 2008 to December 2014 are 16.47 million tonnes of CO2 equivalent. The associated avoided social cost of carbon across this period is estimated to be USD 1.43 billion. Average annual avoided social carbon costs are c.USD 300 million per year.



Committed to the highest HSSE standards

Nature of the impacts

The Dana Gas and Crescent Petroleum Gas Project has enabled the substitution of diesel fuel with natural gas at KRG's two major power stations in the KRI from October 2008. This has

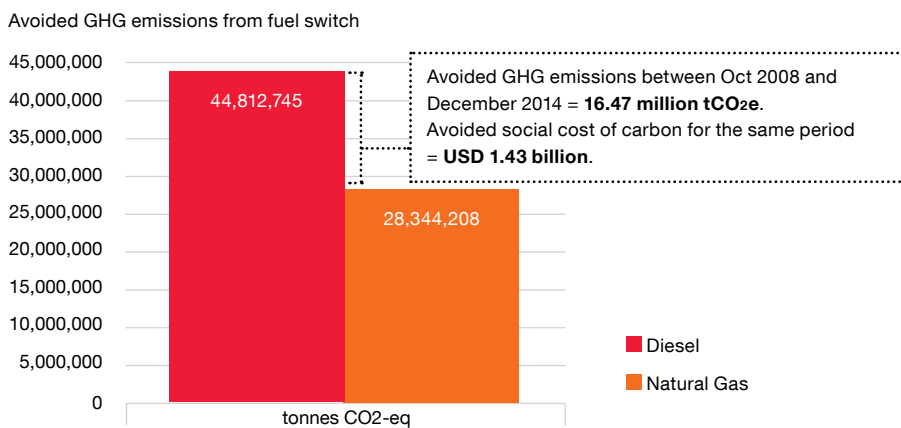
resulted in a significant Greenhouse Gas (GHG) emissions reduction and the avoidance of the associated social costs of carbon.

Benefit estimation

Figure 11 below indicates that the estimated GHG emissions avoided from the replacement of diesel fuel with natural gas between October 2008 and December 2014 are 16.47 million tonnes CO₂-equivalent²⁹. This figure includes an annual saving of

3.52 million tCO₂e in 2014. Based on a Social Cost of Carbon (SCC) of USD 87 per tCO₂e, the associated avoided SCC is estimated at USD 1.43 billion. Of this figure, USD 306 million in avoided social carbon costs were accrued in 2014³⁰.

Figure 11: Diesel substitution emissions analysis (October 2008 – December 2014)



²⁹ Carbon dioxide equivalency (measured in tCO₂e) describes the mass of carbon dioxide (in tonnes) that would have the same global warming potential as a given mixture of greenhouse gases. This mixture of greenhouse gases may include a whole range of chemical species, including carbon dioxide, methane and nitrous oxide.

³⁰ Refer to Appendix 12.



*Protecting the environment in Kurdistan
Region of Iraq*



Appendices

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Appendix 1

Strategic Context

Project Background

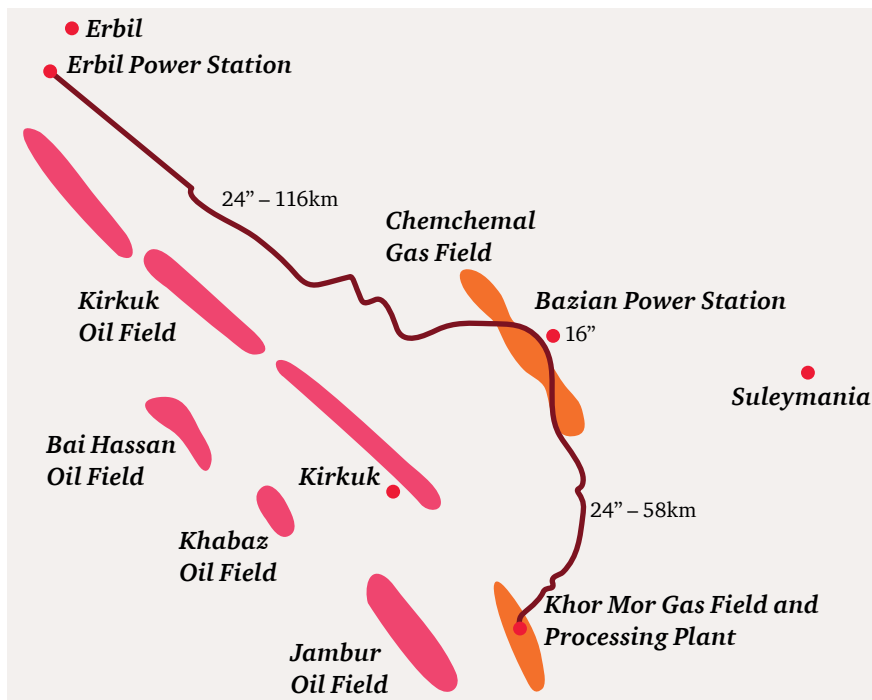
In April 2007, Dana Gas PJSC (“Dana Gas”) entered into agreements with the Kurdistan Regional Government (KRG) of Iraq for the appraisal and development of two major gas fields (Khormor and Chemchemical) in the KRI (HOA). Under the terms of the HOA (as amended) Dana Gas and Crescent Petroleum Company International Limited (together “Joint Operators”) were given exclusive rights to appraise, develop, market and sell petroleum from the substantial Kor Mor and Chemchemical Gas Fields and as a first phase to provide natural gas supplies to fuel two major domestic electric generation plants being built in Erbil and Chemchemical as well as for local industries and export. (see map below). Further development of the gas reserves were also planned to supply natural gas as feedstock and energy for local industries and also for export. The agreement was subsequently transferred to Pearl Petroleum Company Limited, which is a joint venture between Dana Gas and Crescent Petroleum, two major European petroleum companies, OMV and MOL. OMV, Austria’s largest listed industrial company, MOL Hungarian Oil and Gas Company, Hungary’s largest listed company, are two of Europe’s most dynamic integrated oil and gas companies and the original architects of the Nabucco gas pipeline project.

The first stage of the Kor Mor Field development involving the hook up, testing and re-commissioning of existing gas wells, acquiring 2D seismic, installing gas separation and treatment facilities and installation of

180kms of pipeline was completed in a record time of 15 months and first gas deliveries to Erbil commenced in October 2008 with the help of an Early Production Facility (EPF). The gas is pumped via the 180km pipeline to two power plants in Erbil and Suleymania. The pipeline passes close to other gas fields and will have spare capacity to transport additional volumes of gas at a later stage. The second stage which involved the installation of a 2-train liquid petroleum gas (LPG) plant has also been completed in 2011. The ultimate gas production capacity of the LPG Plant is 300MMscf/day, and further processing capacity can be added to handle additional gas quantities as they become available. The two LPG plants along with the EPF help supply 320MMscf/day of gas to the power stations. Total investment to date in the Dana Gas and Crescent Petroleum Gas Project is over USD 1.1 billion.

These projects comprise the largest private sector oil and gas project to be implemented in the KRI for several decades.

The Company also launched plans for Kurdistan Gas City, a major new gas-utilisation industrial complex, which was abruptly terminated by the KRG as a result of the ongoing dispute, designed to promote private sector investment in a variety of gas-related industries that will benefit the Iraqi people through job creation, training and the promotion of general economic activity.



The Kurdistan Region of Iraq

Economy

Within Iraq is the autonomous Region of Kurdistan, comprised of three governorates (Dohok, Erbil and Sulaymaniyah) with a population of over 4 million in 2010. In recent years the KRI has experienced an increasing degree of economic prosperity and relative stability which have allowed the government to better concentrate on addressing its development challenges. GDP grew at 7% pa in 2010, and 1.15 million people were employed in the KRI labour force which represents about 15% of the total for Iraq as a whole.

There is limited specific data for the KRI with regards to economic, social and development statistics, however, the data available suggests that the KRI faces many of the issues faced by the rest of Iraq, albeit to a lesser extent. For example, income per capita is 33% higher in KRI than rest of Iraq, with the GDP per capita in 2010 standing at USD 4,800 compared with USD 3,600 for Iraq as a whole. This figure also

reflects a significant period of growth in both Iraq and KRI over recent years – GDP per capita stood at USD 465 in 2003 for Iraq.

Within the KRI economy the Non Oil Manufacturing sector experienced escalating growth during the period 2004-2008, with growth of over 114%. However, its contribution to GDP for that period only came to 1.1%, which is relatively low in comparison with the contribution made by some other economic sectors, or with the same sector in other countries. The reason for the modest GDP contribution made by non-oil manufacturing and extractive activities is likely to be attributed to a number of factors including the relative shortage of supply of electric power and gas to factories.

Energy sector

Extractive industries (crude oil, natural gas, and mining), and especially the petroleum sector, are seen by many as the engine that drives the commercial growth in the KRI. Linked with this is the crucial enablement of a reliable and adequate power supply to the KRI's businesses and population. Electricity supply is the driving force of the economy given its role in supporting all activities within the economy.

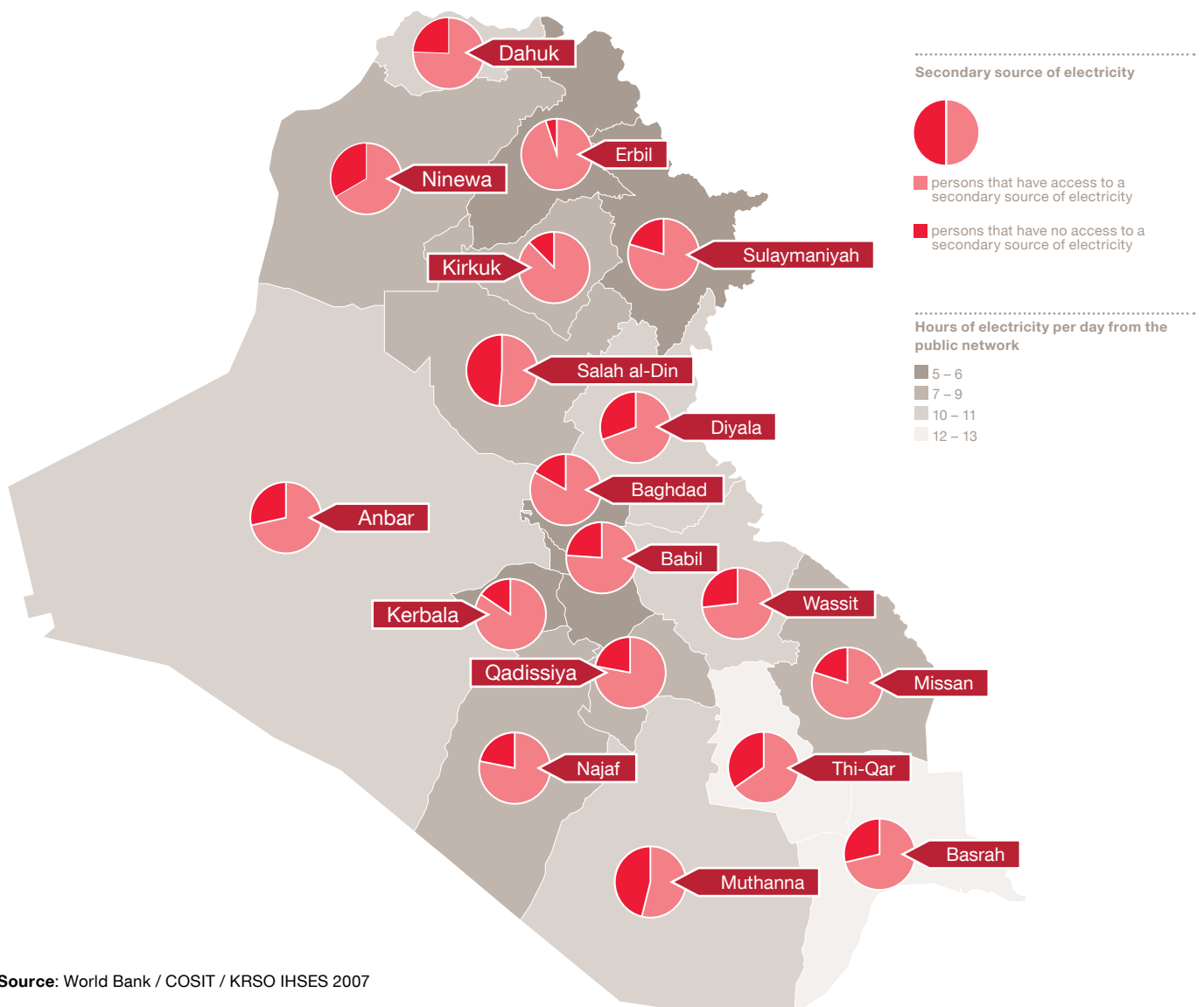
Prior to the Dana Gas and Crescent Petroleum Gas Project the Kurdish authorities were unable to provide adequate electricity to residents, many of whom had access to electricity for only 2 hours in a day (as presented below³¹). Based on the Ministry of Electricity figures, demand for electric power demand grew by 12.4% pa over the period 2004 – 2009, but in 2009 demand for electric power outstripped supply of power by 30%.

Also, there exists significant variance in the distribution of electric power across KRI with the governorates of Erbil receiving 39% of electric power produced, 19% in Duhok and 42% in Sulaymaniyah.

However, the Dana Gas and Crescent Petroleum Gas Project has substantially transformed the picture with a much improved and reliable supply of electricity to KRI's residents and businesses since the project started to generate gas supplies in 2008 and became fully operational in 2011. In 2010 the electricity supply has increased to over 20 hours per day in KRI, compared with 2 hours per day prior to 2002. The situation in the rest of Iraq however still remains substantially worse than in KRI. The value of lost productivity due to power outage is likely to be much higher than the current value of electricity supplies.

31 Inter-Agency Information and Analysis Unit (August 2010) Electricity in Iraq Factsheet

Electricity received from the public network and use of second electricity source



Source: World Bank / COSIT / KRSO IHSES 2007

Kurdistan Regional Government (KRG) priorities

Iraq's 'National Development Plan for the Years 2010-2014' has allocated 17% of total government investment (equivalent to USD 17 billion) to the KRI Region. This follows a period of significant investment in KRI of over USD 14 billion since 2006. In 2009 KRG invested over USD 3 billion of its own resources on infrastructure investment.

The KRI development strategy is concentrated in four major areas which are aligned with those of Iraq:

- 1. Economic** – strengthening the foundations for comprehensive economic growth;
- 2. Infrastructure** – activation of the private sector, particularly through creating enabling infrastructure;
- 3. Social** – improvement of the quality of life through provision of basic services;

- 4. Administrative Development** – administrative reform and workforce creation and training.









The oil and gas industry is integral to achieving the strategy's objectives as it is expected to represent the cornerstone of the KRI's economy. In particular the KRG have identified the shortage of energy to support the economy as one of its key strategic challenges, and the ambition is to achieve self-sufficiency in the supply of its electric power needs and increasing per capita electric consumption to 3,000 kWh within the next 5 years (from 2,500 kWh in 2009). KRG has a stated policy goal of meeting increased future demand for electricity, which is estimated at 12.5% pa, and the Dana Gas and Crescent Petroleum Gas Project directly helps KRG to address this objective.



Khormor plant piping work in progress

UN Millennium Development Goals

The UN's Millennium Development Goals (MDGs) were developed and adopted by world leaders in the year 2000 to provide concrete, numerical benchmarks for tackling extreme poverty and are set to be achieved by 2015. If these goals are achieved, world poverty could be cut by half, with tens of millions of lives saved, and billions more people having the opportunity to benefit from the global economy. The eight MDGs are broken down into 21 quantifiable targets and are measured by 60 indicators.

Millennium Development Goals, Indicators & Year ³²	Status	Target (for 2015)
 1 Eradicate extreme poverty and hunger % of population living on < USD 2.2 per day; 2007	23%	16%
 2 Achieve universal primary education % of 6-11 year olds in primary education; 2007	85%	100%
 3 Promote gender equality and empower women % of women in national parliament; 2006	27%	50%
 4 Reduce child mortality Infant mortality per 1000 births; 2006	35	17
 5 Improve maternal health % of skilled supervised births; 2006	89%	100%
 6 Combat HIV/AIDS, malaria and other diseases Tuberculosis prevalence rate per 100,000; 2008	110	42
 7 Ensure environmental sustainability % of households with access to sustainable water ; 2006	79%	91%
 8 Global Partnership % of families owning a PC; 2007	12%	10%

At the Rio+20 Conference in June 2012, an agreement was reached by UN member states to begin the development of a new set of Sustainable Development Goals (SDGs), which will “build upon the Millennium Development Goals and converge with the post 2015 development agenda.”

³² The Millennium Development Goals in Iraq (June 2010) – http://www.iauihq.org/documents/393/MDG_booklet_English.pdf

United Nations Sustainable Development Knowledge Platform – <http://sustainabledevelopment.un.org/index.php?menu=1300>

Appendix 2

Socio-Economic Benefit Assessment Framework

In order to capture the full range of contributions to sustainable development from the Dana Gas and Crescent Petroleum Gas Project, PwC developed an analytical framework to be used to assess the project's socio-economic benefits. This framework demonstrates that Dana Gas and Crescent Petroleum are looking strategically at its socio-economic contributions in a wide range of areas linking to Iraq's and KRI's development priorities. The identification of key impact areas will also inform the identification of the most appropriate

methodologies to measure and value the Dana Gas and Crescent Petroleum Gas Project's on-going economic and social development contributions.

Our framework to analyse the Dana Gas and Crescent Petroleum Gas Project's contribution to national development priorities has considered some of the elements proposed in the Oxfam Poverty Footprint Methodology³³, set out in figure below.

Company impact areas

Macro-economy: How a company's economic contributions, including distribution of profits, shareholder dividends, investments, taxes and employment, support the countries where they operate.

Value chains: How a company's procurement, manufacturing and distribution practices influence how easily poor people can find good-quality employment, earn a living wage, sustain a business or participate in the market.

Local environmental practices: How a company's environmental practices affect the livelihoods and health of poor people in communities where they operate. This includes the communities' own access to natural resources and the risks they face from natural disasters.

Product development and marketing: How a company's products and services affect the health and well-being of consumers and communities and their overall ability to overcome poverty.

Policies and institutions: How a company's lobbying and relationships with other institutions (such as trade associations) affects government policies and oversight relevant to poverty issues—trade, finance, labour, essential services, etc.

Dimensions of poverty

Livelihoods: Good-quality jobs, training, research and development, access to credit, markets that support adequate livelihoods, and a predictable and stable income.

Health and well-being: Health care, education and social services are essential to general well-being.

Diversity and gender equality: Equal access to jobs, training, advancement, benefits and other rights for women and minorities, as well as opportunities to maintain cultural identity.

Empowerment: Having a voice in decisions, policies and practices affecting poverty.

Security and stability: Access to resources that help people endure shocks to their livelihoods, personal disasters (such as job loss or illness), weather-related disasters, war crimes and violence.

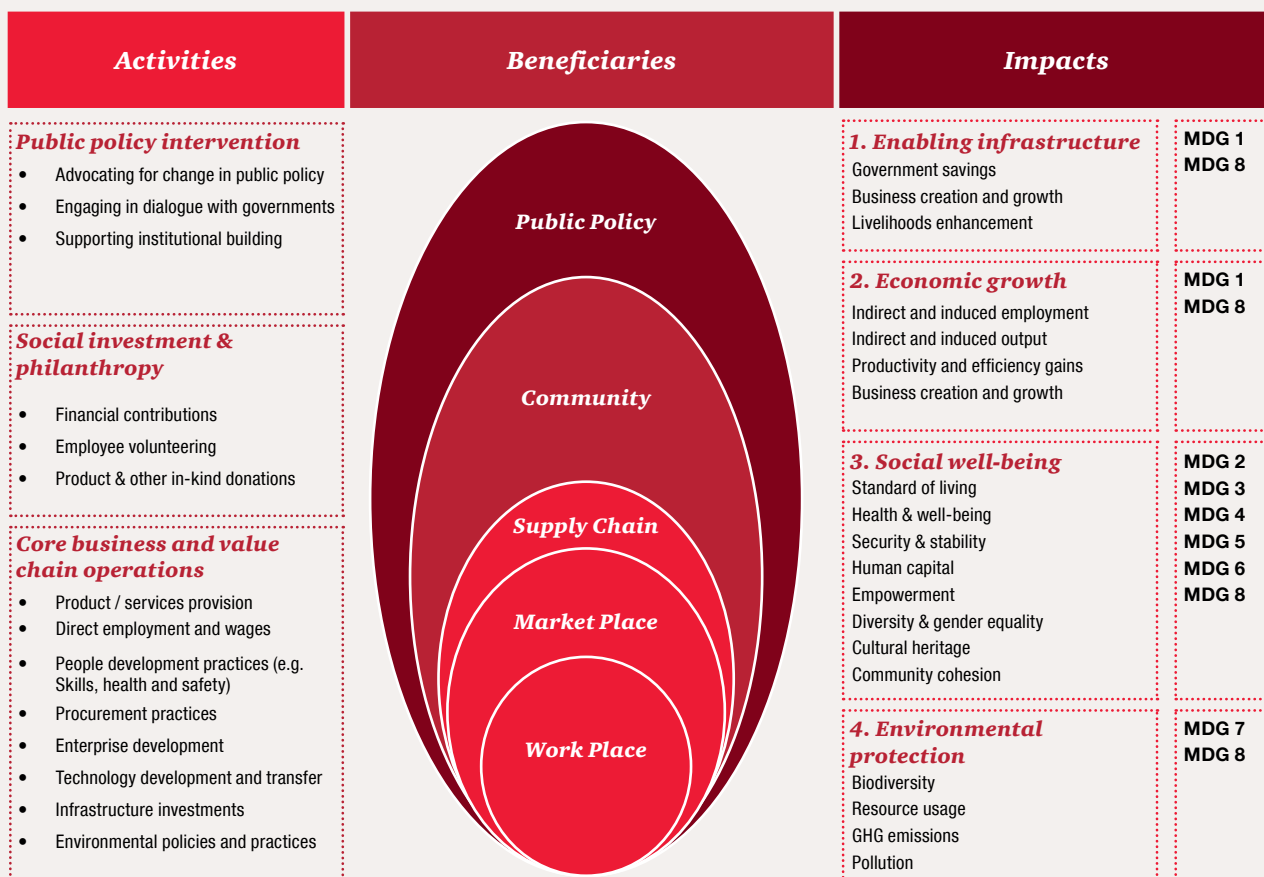
Oxfam's Poverty Footprint Methodology

³³ <http://www.oxfam.org/en/policy/poverty-footprint>. Interpretation of impacts requires Oxfam's expertise and PwC has not aimed to implement its methodology but rather to learn from it.

Our assessment framework:

- builds on generally accepted frameworks;
- captures the development contributions from the Dana Gas and Crescent Petroleum Gas Project’s core business and value chains, social investments and philanthropy, and public policy interventions;
- considers impacts on a wide range of beneficiaries including the public sector, communities associated with the Dana Gas and Crescent Petroleum Gas Project’s operations, customers in the marketplace, suppliers in the supply chain and workers in the workplace; and
- considers the impact of these activities under four headings linking to KRI’s development priorities in terms of enabling infrastructure, economic growth, social well-being and environmental protection. In the framework we have identified the relevant MDGs against each of the four impact areas.

The framework is illustrated below.



Dana Gas and Crescent Petroleum Gas Project’s Socio-Economic Benefits Assessment Framework

Appendix 3

Literature Review on the Economic Impacts of Energy

This Appendix contains a selection of the results of our literature review on the economic impacts of electricity and energy. This Appendix is split into 3 parts:

- Table 1 contains some of the key papers to give an idea of the themes running through the literature (this is only a sample of the total number of papers reviewed, but a representative one).
- Table 2 contains the results of specific statistical studies looking at the cause-and-effect relationship between energy and the economy (which causes which?) and the likely magnitude of this relationship.
- Table 3 provides a summary from one of the papers that reviewed the disruptive effects of blackout events around the world from 1990 to 2010 (this formed the introduction to a consideration of the effects in Africa specifically).



Pipe laying in progress

Table 1: PwC Review of international evidence on the economic impact of electricity provision (general)

Title	Scope of report	Methodology	Conclusion / Findings
'A Dynamic Equilibrium of Electricity Consumption and GDP in Hong Kong: An Empirical Investigation', Chun-Yu Hoy, Kam-Wing Siuz (September, 2006)	Investigates the relationship between electricity consumption and GDP in Hong Kong		An increase in electricity consumption drives an increase in real GDP and there is a significant adjustment when the supply is interrupted (i.e. paucity or decline in supply). Ensuring stable supply is key for growth.
'Causality between energy consumption and GDP: Evidence from 30 OECD and 78 non-OECD countries', Jaruwan Chontanawat, Lester C. Hunt and Richard Pierse (June 2006)	Tests for causality between energy and GDP using a consistent data set and methodology for 30 OECD and 78 non-OECD countries.	Modelling and report comparisons	<p>There are 3 options:</p> <ol style="list-style-type: none"> 1. Energy is a limiting factor in economic growth. 2. If causality only runs from GDP to energy consumption this implies that an economy is not energy dependent and a lack of energy will have no adverse effect on growth and employment. 3. If, on the other hand, there is no causality in either direction (referred to as the 'neutrality hypothesis'), it implies that energy consumption is not correlated with GDP <p>Energy to GDP causality is more prevalent in the OECD countries than the non-OECD countries. The results suggest that the degree of causality from energy to GDP is generally less in the developing world than the developed world (or alternatively causality from energy to GDP generally increases at higher stages of development).</p>
'Development Effects of Electrification: Evidence from the Geologic Placement of Hydropower Plants in Brazil', Molly Lipscomb, Ahmed Mushfiq Mobarak, Tania Barham (March 27, 2011)	Estimates the development effects of electrification across Brazil over the period 1960-2000	Modelling	<ul style="list-style-type: none"> • 9% increase in electrification of households leads to a 9 point gain in UN Human Development Index (UN HDI) • Infrastructure investment in electricity is nearly always planned so growth causality is hard to measure. • Household energy expenditure in developing economies is very high (24% in Cambodia) • 10% increase in electrification reduces poverty by 5% (mean) • Full electrification leads to a 14 point increase in UN HDI education score • 10% increase in electrification of households leads to a 4% increase in employment conditions • 27% of rural Brazilians lack access to electricity • Unreliable supply of electricity is a significant obstacle to doing business.
'The Effects of Rural Electrification on Employment: New Evidence from South Africa', Princeton University, Taryn Dinkelmann (August 2010)	This paper estimates the impact of electrification on employment growth in South Africa	Several new data sources and two different identification strategies	<ul style="list-style-type: none"> • Electrification of communities significantly raises female employment (9.5%) within 5 years. It increases the number of hours worked for both men and women, and increases men's earning. Electrification acts as a shock labour saving tool and can increase migration.
International Energy Agency	WEO Special Report: Iraq Energy Outlook, November 2012	Energy technology bottom-up model	Iraq needs to "install around 70GW of generation capacity and move away from a predominantly oil-fired power mix to more reliance on efficient gas-fired generation: without this transition, Iraq would forego around \$520billion in oil export revenues and domestic oil demand would be more than 1m b/d higher in 2035".
Investment Climate and Employment Growth: The Impact of Access to Finance, Corruption and Regulations Across Firms', <i>Inter-American Development Bank Research Department</i> , Reyes Aterido, Mary Hallward-Driemeier, Carmen Pagés (October 2007)	Impact of finance, corruption, regulation and infrastructure on 70,000 companies in 107 countries.	Econometrics and Meta-Analysis	Smaller firms are more likely to be in areas without access to electricity or to be dependent on an unreliable public grid, given that they lack the scale economies to make a generator cost effective. The frequency of outages hits small and medium firms hardest. The costs of these outages, as a percentage of sales, are relatively larger for micro and small firms. They are less likely to have alternative sources of electricity (given the costs of owning and operating a generator
The Economic Costs of Unsupplied Electricity: Evidence from Backup Generation among African Firms', Musiliu Oseni & Michael Pollitt	Impact of electrical blackouts on the economy	Survey of other literature	This report provides a summary of the estimated economic impacts of electricity supply disruptions and blackouts around the world between 1990 and 2010. See Table 3.

Table 2: PwC PwC Review of international evidence on the economic impact of electricity provision (statistical causation studies)

Studies	Countries	Period	Results
Kraft & Kraft (1978)	USA	1947-74	GNP-> E
Ebohon (1996)	Nigeria	1960-81	E-> GNP, GDP ->E
Murray & Nan (1996)	Colombia, El Salvador, Indonesia, Kenya and Mexico	1970-1990	GDP -> Elec
Soytas & Sari (2003)	Turkey	1950-92	E->GDP
	Japan	1950-92	E->GDP
	Argentina	1950-1990	E->GDP
Lee (2005)	18 developing countries	1975-2001	E->GDP
Wolde-Rufael (2005)	Algeria, Congo DR,	1971-2001	GDP->E
	Egypt, Ghana, Ivory Coast	1971-2001	E->GDP
	Cameroon, Morocco, Nigeria, Gabon, Zambia		
Hoy & Siuz (2006)	Hong Kong	1996-2002	1%Elec->0.94%GDP
Galip and Karagoal 2005	Turkey		E->GDP
Yoo (2004)	South Korea		E <-> GDP
Yoo (2005)	Malaysia & Singapore		E<->GDP
	Thailand & Indonesia		GDP->E
Squalli (2006)	8 OPEC countries		GDP->E
Emeka (2010)	Nigeria		E->GDP
Stern & Enflo	Sweden		E->GDP
Abaidoo	Emerging Economies		1%GDP->2%E
Acaravci (2010)	Turkey	1965-2005	1%Elec->0.37%GDP
Chen et al (2007)	10 Asian countries		E->GDP
Morimoto and Hope (2003)	Sri Lanka		E->GDP (1MWh->USD1120-1740 output)
Saatci and Dumril (2013)	Turkey	1960-2008	Elec. -> GDP 1% Elec -> 0.45% GDP before 1997 1% Elec -> 0.54% GDP after 1997
Ahmad et al. (2012)	Pakistan	1973-2006	E. -> GDP 1% Elec -> 1.23% GDP after 1997

Bold font indicates that these estimates were used in the calculations in this report (see Appendix 4)

Notes:

E-> GDP: A cause-and-effect relationship was uncovered from Energy Consumption (or Elec. = Electricity) to GDP

GDP --> E: A cause-and-effect relationship was uncovered from GDP to Energy Consumption

GDP <-> A bi-directional causal effect was uncovered between GDP and Energy Consumption

Table 3: Some Historical Blackouts in the World

Country, year	Type of incident	Consequences in the power system	Number of end-users interrupted	Stip. Duration, energy not supplied	Estimated costs to whole society in 2010 prices
Sweden/Denmark, 2003	Disconnect short circuit followed by double busbar short circuit	Loss of all lines and generation separation of Southern Sweden/Denmark, voltage collapse	1.6 million in Sweden and 2.4 million in Denmark	2.1 hours, 18 GWh	(US\$206.22 – 256 million)
France, 1999	Two consecutive storms, extreme wind	Extensive outages, 0.4 % of the total network length damaged	1.4-3.5 million	2 days – 2 weeks, 400 GWh	(US\$14.13 billion)
Italy/Switzerland 2003	Overloading lines between Switzerland and Italy	Collapse of the entire Italian electric power system	55 million	18 hours	n.a
Sweden, 2005	Storm Gudrun, extreme wind	Extensive damage of overhead lines in Southern Sweden	0.7 million	1 day – 5 weeks, 111 GWh	(US\$526 million)
Central Europe 2006	Busbar fault at a substation in Germany	Disturbances in the whole interconnected grid in Europe	15 million households	Less than 2 hours	n.a
London, 2003	Poor Protection Relays	Disturbance of 720 MW line in South London	410,000 people	37 minutes	n.a
Philippine, 1992-1994	Insufficient generation capacity	Interruption in Countrywide electricity supply	Entire country	12 hours daily	US\$1.89-\$2.52 billion per annum
US/Canada, 2003	Tree flashovers	Disturbance in interconnected grid in North America	50 million people	16 hours – 1 week	US\$8.3-\$11.9 billion

Source: 'The Economic Costs of Unsupplied Electricity: Evidence from Backup Generation among African Firms', Musiliu Oseni & Michael Pollitt

Appendix 4

Methodology for Estimating Energy and Growth Impacts

This Appendix outlines the details of the calculations conducted as part of the analysis in this report.

Calculation 1: The impact of increased electricity supply on GDP

Step #	Explanation	Result	Comment
1	Calculate the increase in generation capacity attributable to Dana Gas and Crescent Petroleum	87% = 1,625/1,871	
1a	Total rated capacity in KRI	3,496 MW	Source: Ministry of Electricity, Dec 2012
1b	Dana Gas/CP-supplied plant capacity	1,625 MW	Source: Crescent Petroleum
1c	Other capacity	1,871 MW = 3,496 – 1,625	
2	Estimate the elasticity of GDP with respect to electricity consumption	0.8 = Average of below	
2a	Hong Kong (1973-2006)	0.9	
2b	Turkey (1965-2005)	0.4	Source: See Table 2 in Appendix 3
2c	Turkey (1968-2008)	0.5	
2d	Pakistan (1973-2006)	1.2	
3	Estimate the proportionate increase in GDP	67% = 87% * 0.8	
4	Estimate the dollar increase in pre-construction GDP	\$12.7bn = 67% * \$19bn	
4a	Estimated GDP of KRI in 2008	\$19.0bn = \$23.6bn * 1/ (1.045^3)	
4b	Estimate average GDP growth rate 2008-2011	4.5%	Source: Kurdistan Board of Investment (2009 est.)
4c	GDP of KRI in 2011	\$23.6bn	Source: Kurdistan Board of Investment (2011 est.)
5	Repeat calculations above using low (2b) and high (2d) estimates for elasticity	\$6.2 – 15.5 bn	
6	Express as a proportion of 2011 GDP	26% – 66% = 6.2 – 15.5 / 23.6	

Calculation 2: The impact of increased electricity reliability on GDP

Step #	Explanation	Result	Comment
1	Estimate the incremental benefit of reducing interruptions from 14-hours to 2-hours/day	\$131kW = 175 – 44	
1a	Estimate the business costs of 14-hour interruption (i.e., 8 hours of supply)	\$175/kW	Estimated from power-cost – curve in Figure 12 in Appendix 6
1b	Estimate the business costs of 2-hour interruption (i.e., 22 hours of supply)	\$44/kW	Estimated from power-cost – curve in Figure 12 in Appendix 6
2	Estimate Joint Operator share of increase in operating hours	54% = 1,625 / 3,019	
2a	Estimate total new capacity 2008-2012	3,019 MW	Taken from Appendix 6
3	Estimate Joint Operator share of incremental benefits in (3)	\$71/day = 54% * \$131	
4	Estimate interruption costs for equivalent demand (=capacity) in United States	\$41.8bn/year = 1,625MW * \$71/ kW/day	
5	Adjust costs for energy intensity in Iraq (reflecting different potential values per output per unit of energy input)	\$9.6bn – \$21.2bn = \$41.8bn * (1.98 – 4.36)	
5a	Calculate low estimate of energy intensity ratio between USA and Iraq	1.98 = (\$5.7bn/ mtoe) / (\$11.3bn/ mtoe)	Source: Total GDP at Market Exchange Rates for both countries (World Bank). Total Energy Consumption for both countries (IEA).
5b	Calculate low estimate of energy intensity ratio between USA and Iraq	4.36 = (\$1.9bn/ mtoe) / (\$8.3bn/ mtoe)	Source: Non-oil manufacturing output, Iraq (Iraqi National Statistics Bureau). Iraq Industrial energy Consumption (IEA). US non-oil manufacturing output (US Bureau of Economic Analysis). US Industrial Energy Consumption (IEA).
6	Express as a proportion of 2011 GDP	41% – 90% = 9.6 – 21.2 / 23.6 (2011 est.)	Source: Kurdistan Board of Investment

Appendix 5

Facts and Figures in the power sector

In this Appendix we have provided a summary of the key facts and figures for the power sector in KRI, which have been used throughout this report. Before reading, the reader should familiarise themselves with the following points:

- **A note on capacity:** Rated capacity is otherwise known as “boilerplate capacity” or “nameplate capacity” and is the maximum potential generation capacity. Actual capacity available will be lower than this due to parasitic loads, seasonal factors,

fuel availability, downtime due to maintenance and malfunction, and the economics of the individual plant at a given time.

- **The “Joint Operators” refers to Dana Gas and Crescent Petroleum.** The Joint Operator Capacity is referred to as either 46% (percentage of total rated capacity) or 74% (percentage of total gas-fired capacity) depending on context.

Key statistics

	2008		2012		Change 2008-12		2020 (Planned)	
	MW	%	MW	%	MW	%	MW	%
Joint Operator	-	0%	1,625	46%	+1,625	+54%	n/a	n/a
Other Operators*	477	100%	1,871	54%	+1,394	+46%	n/a	n/a
Total Rated Capacity	477	100%	3,496	100%	+3,019	+100%	9,460	100%
Hydro	n/a	n/a	210	6%	n/a	n/a	946	10%
Gas	n/a	n/a	2,202	63%	n/a	n/a	7,095	75%
Diesel	n/a	n/a	874	25%	n/a	n/a	-	0%
HFO	n/a	n/a	210	6%	n/a	n/a	1,419	15%
Total	n/a	n/a	3,496	100%	n/a	n/a	9,460	100%
Max. load (annual high)	n/a	n/a	1,900	n/a	n/a	n/a	n/a	n/a
Max demand (annual high)	n/a	n/a	2,900	n/a	n/a	n/a	n/a	n/a

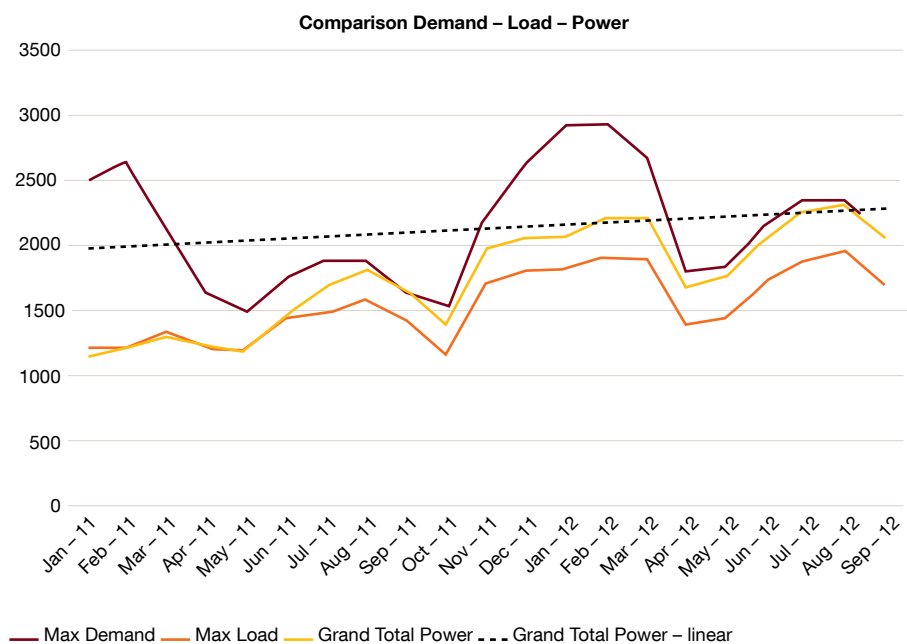
Source: Kurdistan Regional Government, Ministry of Electricity presentation at CWC Oil and Gas conference, Erbil, Dec 2012 & KRG, Ministry of Electricity Presentation to IEEJ, June 2012 (available at <http://eneken.ieej.or.jp/data/4502.pdf>)

Current power plants in KRI

Governorate	Power Plant	Capacity (MW)
Dohuk	Dohuk GPP	500
	Baadra Diesel	150
	East Dohuk Diesel	29
	Deralock Hydro	–
	Aqra Diesel (Sakr)	10
	Total	689
Erbil	Erbil GPP	1,000
	Erbil North Diesel	29
	Khabat Generation (Thermal)	–
	Erbil Diesel (Sakr)	–
	Bakhma Hydro	10
	Total	1,039
Sulaymania	Sulaymania GPP	1,000
	Dokan	400
	Darbedikan	249
	Sulaymania Diesel	29
	Tasluja Diesel	–
	Sulaymania Diesel (Sakr)	15
	Quesnjag (Sakr)	15
	Chwarqurna (Sakr)	20
	Chamchamal (Sakr)	20
	Chwarta (Sakr)	10
	Kifri (Sakr)	10
	Total	1,768
	Grand Total	3,496

Source: Kurdistan Regional Government, Ministry of Electricity presentation at CWC Oil and Gas conference, Erbil, Dec 2012

Monthly maximum demand, load and power, KRI, January 2011 – September 2012



Source: Kurdistan Regional Government, Ministry of Electricity presentation at CWC Oil and Gas conference, Erbil, Dec 2012

Appendix 6

Data Sources for energy and Growth Analysis

In this Appendix we have included some of the specific data identified during the literature review that supports the calculations in this report. It contains 3 parts:

- Table 4 the results from a US-based study looking at the costs of power interruptions.
- Figure 12 extrapolates these results on a per kW and per kWh basis

over a longer supply interruption period so that the results can be used to analyse the historical situation in KRI.

- Table 5 provides some sensitivity on how these costs differ across sectors of the economy. These numbers are not used in the calculations but are contextually useful.

Table 4: Estimated Average Electric Customer Interruption Costs USD by Customer Type and Duration

Interruption Cost	Momentary	30 minutes	1 hour	4 hours	8 hours
Medium and Large C&I					
Cost Per Event	\$11,756	\$15,709	\$20,360	\$59,188	\$93,890
Cost Per Average kW	\$14.4	\$19.3	\$25.0	\$72.6	\$115.2
Cost Per Un-served kWh	\$173.1	\$38.5	\$25.0	\$18.2	\$14.4
Cost Per Annual kWh	\$1.65E-03	\$2.20E-03	\$2.85E-03	\$8.29E-03	\$1.31E-02
Small C&I					
Cost Per Event	\$439	\$610	\$818	\$2,696	\$4,768
Cost Per Average kW	\$200.1	\$278.1	\$373.1	\$1,229.2	\$2,173.8
Cost Per Un-served kWh	\$2,401.0	\$556.3	\$373.1	\$307.3	\$271.7
Cost Per Annual kWh	\$2.28E-02	\$3.18E-02	\$4.26E-02	\$0.1403	\$0.2482
Residential					
Cost Per Event	\$2.7	\$3.3	\$3.9	\$7.8	\$10.7
Cost Per Average kW	\$1.8	\$2.2	\$2.6	\$5.1	\$7.1
Cost Per Un-served kWh	\$21.6	\$4.4	\$2.6	\$1.3	\$0.9
Cost Per Annual kWh	\$2.06E-04	\$2.48E-04	\$2.94E-04	\$5.81E-04	\$8.05E-04

Figure 12: Power loss function extrapolated

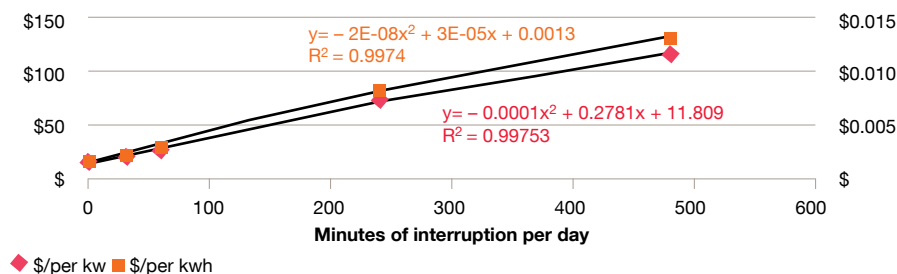


Table 5: Estimated Average Electric Customer Interruption Costs Per Event US 2008\$ by Duration and Business Type (Summer Weekday Afternoon)

Interruption Cost	Momentary	30 minutes	1 hour	4 hours	8 hours
Medium and Large C&I					
Agriculture	\$4,382	\$6,044	\$8,049	\$25,628	\$41,250
Mining	\$9,874	\$12,883	\$16,366	\$44,708	\$70,281
Construction	\$27,048	\$36,097	\$46,733	\$135,383	\$214,644
Manufacturing	\$22,106	\$29,098	\$37,238	\$104,019	\$164,033
Telecommunications & Utilities	\$11,243	\$15,249	\$20,015	\$60,663	\$96,857
Trade & Retail	\$7,625	\$10,113	\$13,025	\$37,112	\$58,694
Fin., Ins. & Real Estate	\$17,451	\$23,573	\$30,834	\$92,375	\$147,219
Services	\$8,283	\$11,254	\$14,793	\$45,057	\$71,997
Public Administration	\$9,360	\$12,670	\$16,601	\$50,022	\$79,793
Small C&I					
Agriculture	\$293	\$434	\$615	\$2,521	\$4,868
Mining	\$935	\$1,285	\$1,707	\$5,424	\$9,465
Construction	\$1,052	\$1,436	\$1,895	\$5,881	\$10,177
Manufacturing	\$609	\$836	\$1,110	\$3,515	\$6,127
Telecommunications & Utilities	\$583	\$810	\$1,085	\$3,560	\$6,286
Trade & Retail	\$420	\$575	\$760	\$2,383	\$4,138
Fin., Ins. & Real Estate	\$597	\$831	\$1,115	\$3,685	\$6,525
Services	\$333	\$465	\$625	\$2,080	\$3,691
Public Administration	\$230	\$332	\$461	\$1,724	\$3,205

Source: 'Estimated Value of Service Reliability for Electric Utility Customers in the United States', Berkeley National Laboratory, Michael J. Sullivan, Matthew Mercurio, Josh Schellenberg (June 2009)

C&I: Commercial and Industrial electricity customers

Appendix 7

Financial Savings from Diesel Substitution

The cumulative KRG cost saving as a result of diesel substitution from the date of commencement of gas supply is estimated at USD 15.9 billion, with recurring and continuing total annual cost savings amounting to USD 3.4 billion per annum (see Table 6 below). This is based on physical volume information provided by Dana Gas and

Crescent Petroleum, as well as their estimate of the nominal price of diesel across the period, which is assumed to be USD 113.47 per Barrel. Based on these assumptions, the cumulative savings to KRG between October 2008 and December 2014 are estimated to be in the KRI of USD 15.9 billion

Table 6: Financial savings from diesel substitution

Period	(a) MMScf Millions (1)	b = a * 1140 Equivalent in MMBTU (2)	c = b/5.762 Equivalent in Barrels (3)	d Nominal Diesel Price (US \$ per Barrel) (4)	e = d*1.3 Inception to date (Dec 14) (new basis) Price incl Transport (US \$ per Barrel) (5)	f = (c * e) Total Diesel cost saving (US \$)
Inception to Dec' 08	6,790.00	7,740,600	1,343,388	126.66	164.66	221,198,763
Jan' 09 to Dec' 09	31,652.81	36,084,203	6,262,444	70.86	92.11	576,844,553
Jan' 10 to Dec' 10	54,398.14	62,013,880	10,762,562	91.32	118.71	1,277,670,005
Jan' 11 to Dec' 11	92,037.82	104,923,118	18,209,496	126.23	164.10	2,988,252,785
Jan' 12 to Dec' 12	113,502.91	129,393,319	22,456,321	129.18	167.94	3,771,298,068
Jan' 13 to Dec' 13	118,033.28	134,557,939	23,352,645	124.72	162.14	3,786,374,041
Jan' 14 to Dec 14	113,151.55	128,992,767	22,386,804	113.47	147.51	3,302,385,298
Inception to date (31 Dec 14)	529,566.51	603,705,825	104,773,659			15,924,023,513
Annual savings (320 MMscf /day) (1)	116,800.00	133,152,000	23,108,643	113.47	147.51	3,408,867,159

Note 1: Current gas plant processing capacity of 116,800 MMscf per annum (320MMscf x 365 days) is based on current plant production levels of 320 Mmscf/day.

Note 2: Gross heating value of Natural gas conversion factor assumed as 1,140 MMBTU / MMScf.

Note 3: The approximate heat content of diesel is converted at 5.762 MMBTU per Barrel (Source: Energy Information Administration).

Note 4: Nominal diesel price (US\$) per barrel of Diesel based on 2014 price of Mediterranean CIF gasoil 1% sulphur (Source: IHS Global oil prices and refining margins outlook, March 2014 / Bloomberg Gasoil 1% med cif index in \$/T (converted at 7.45T/bbl).

Note 5: Transportation cost mark-up of 30% has been assumed based on our market research of companies operating in this region, such as Genel Energy Plc. Genel realises a c.\$7 5/bbl oil price which implies a c.30% transaction cost when compared to the average Brent price for the six months to June 2013 of US\$108/bbl (Source: PwC Analysis).

We note that the KRG's gas power stations are dual-capacity and can generate power from both natural gas or middle distillate fuel. Therefore, we have not added any additional plant conversion costs in our calculations above.

Source: Crescent Petroleum, IHS, Energy Information Administration and PwC Analysis

Based on the United States Energy Information Administration forecasts, it is also likely that the price of diesel fuel will rise over time, increasing the savings in real terms to KRG. The expected real growth rates of the prices of crude oil and diesel fuel to 2020 are 2.3% per annum and 1.7% per annum

respectively. Since the imported Iraqi price of diesel should reflect international supply and demand conditions for oil products, the real savings to KRG are likely to increase by 1.7 – 2.3% per annum over time.

Appendix 8

Capital Costs Breakdown

Table 7: Breakdown of Dana Gas and Crescent Petroleum Gas Project Local KRI expenditure (rounded)³⁴

Breakdown of Dana Gas and Crescent Petroleum Gas Project expenditure up to 31.12.14

Description	Costs (Million USD)
Well testing	6.64
24" Pipeline	200.43
Early Production Facility	12.98
Infield Flow line and surface facilities	16.02
Seismic survey and interpretation	45.99
Oil & Gas interests (Drilling and Workover)	84.20
LPG Plant and Associated Facilities	423.94
Liquid Pipelines and Chemchamal Loading Facilities	20.56
Buildings, Vehicles and other assets	4.13
Inventory	40.24
Operating costs	269.27
Total project spend	1,124.41

Breakdown of Dana Gas and Crescent Petroleum Gas Project local expenditure up to 31.12.14 (included within total costs above)

Year	Costs (Million USD)
Pre-2011	270.00
2011	50.44
2012	53.64
2013	83.93
2014	38.41
Total Local Spend	496.42

³⁴ The numbers in Table 7 reflect total cash spend each year. For the purposes of the economic impact analysis, and when cited elsewhere in this report, these numbers are adjusted for inflation using the US GDP deflator.

Appendix 9

Methodology for Employment Impacts Estimation

Construction stage – employment and economic output impacts

Nature of impacts

The employment and economic output impacts of the Dana Gas and Crescent Petroleum Gas Project can be assessed in terms of three types of impact:

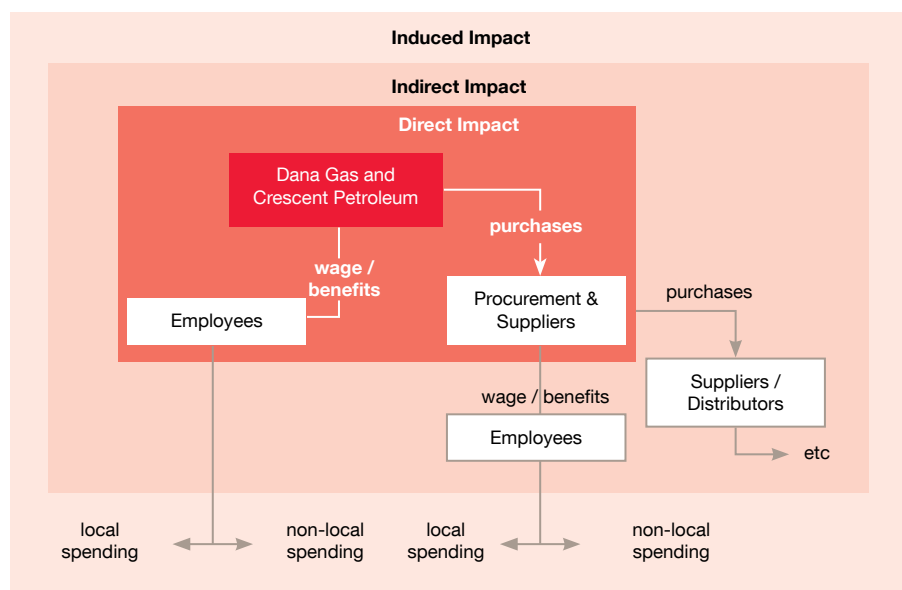
- **Direct impact** – the increase in employment and output as a result of Operator’s business activities (demand for their goods and services). This direct impact includes on site jobs created through the Dana Gas and Crescent Petroleum Gas Project’s construction expenditure, including both direct employees of Dana Gas and Crescent Petroleum and subcontractors directly involved in the construction process (both on site and off site);
- **Indirect impact** – the increase in employment and output resulting from business expenditure on goods and services such as procurement of

materials, equipment and a range of services from building to cleaning, catering and professional services. The effects can be measured in terms of additional employment generated by the suppliers delivering the goods and services to the businesses located on the site; and

- **Induced impact** – the increase in employment and output in the wider economy as a result of expenditure by those employed by direct (businesses located on the site) and indirect (supply chain) employees generated by the Dana Gas and Crescent Petroleum Gas Project.

This chain of economic knock-on impacts is illustrated in the diagram below.

Flow of economic impacts through the economy



Direct impact

The direct construction expenditure leads to increased output generated in the KRI economy. The precise relationship between the capital expenditure and net output generated can only be determined through a detailed assessment of the input/output effects upon other economic sectors in the KRI economy. In this way, the Dana Gas and Crescent Petroleum Gas Project's investment's contribution towards the KRI economy in terms of value added or net output can be measured, and this output translated into employment created through reference to figures on GDP per employee in the construction sector.

The methodology outlined above would require a detailed knowledge of the capital expenditure programme and its effects upon the KRI economy. Construction employment is typically estimated through applying relevant ratios of capital expenditure to jobs (usually expressed in terms of job-years). We are not aware of such ratios existing for Iraq.

Therefore, to estimate the direct employment effects for KRI's construction sector, we analyzed the average production patterns in the construction sector, the gas manufacture and distribution, and business services sectors for the countries of Turkey, Iran, Armenia, Georgia and Kyrgyzstan. From our analysis, it is estimated that the USD 313 million of additional demand for construction work in KRI results in a direct employment effect of 4,411 job-years and a direct Gross Value Added effect of USD 128 million in the construction sector. In addition, an operational spend in the gas manufacture and distribution sector, and business services sector of USD 188 million results in a direct employment effect of 14,063 job-years and a direct Gross Value Added effect of USD 117 million.

We considered data on the average wage per employee in KRI with that paid for construction labour employed in the Dana Gas and Crescent Petroleum Gas Project and found that this is significantly higher. As a result the average GDP per worker figure is higher for the construction workers employed on the Dana Gas and Crescent Petroleum Gas Project compared with the average for KRI / Iraq as a whole.

Indirect and Induced impact

The numbers above relate to the direct impact of the Dana Gas and Crescent Petroleum Gas Project only. As mentioned, the indirect and induced impacts of the Dana Gas and Crescent Petroleum Gas Project has generated significant additional employment and output in KRI and will continue to do so going forward. Typically, these impacts are estimated through use of appropriate multipliers.

The extent of the indirect and induced employment effects within the KRI economy is conditioned by the “leakage” caused by employing people from outside the impacted area. In determining this leakage, the following considerations are important:

- Size of the local area, since the smaller the geographical area the greater the leakage;
- The structure of the local economy and strength of its economic linkages, and hence the ability of the local economy to retain economic activity within its own boundaries;
- The nature of the direct employment created, and hence the disposable incomes of the workers;
- Time period of evaluation, since over time it is expected that local businesses will adapt more fully to the demands made on their services and reduce the extent of leakages out of the local economy;
- The nature of the relationship between revenue and employment within a given enterprise, since

in practice the extent to which secondary businesses can absorb a certain amount of additional demand without need for further recruitment will vary between businesses.

Considering indirect effects (i.e. firms purchases from each other) and induced effects (i.e. wages and net profits) together suggests that the overall multiplier is the inverse of the overall leakage out of the local economy (i.e. what does not leave the local economy must be retained). Thus, a leakage of say 60 percent implies a multiplier of 1.67 and leakage of say 40 percent implies a multiplier of 2.5.

Output and employment multipliers, derived from national or regional “Input-Output Tables” are typically used to quantify the relationships outlined above. Given Iraq’s circumstances, it is not surprising that neither the Iraqi nor the KRI government currently provide a reliable Input-Output Table with which to undertake this analysis in a conventional manner. Thus, PwC have carefully considered which of these impacts can be quantified in a robust and credible manner using alternative methodologies. To calculate the indirect and induced effects we took data from the GTAP database. This data covers a geographic Region which also includes KRI and Iraq in general. The data has been used as a proxy for the economic interrelations of the Kurdish and Iraqi economy. Additionally we used assumptions for the regional supply share to quantify the indirect effects.

Indirect Effects

In order to generate the additional demand output, the construction sector requires intermediate goods and services from the KRI itself as well as from outside the KRI. Based on data from the analyzed regions in the GTAP database, we have estimated that the intermediate goods and services equate to 55.4 %. The main sectors which will face additional demand related to the additional production in KRI's construction sector are Non-Organic Manufacturing Goods (Metal, Plastic, Chemical etc.), Transport, General Services and Trade.

In order to estimate the shares of domestic supply of the intermediate goods we further analyzed the relationship between GDP and domestic input share per sector. Based on this analysis we derived the indirect socio-economic effects along the entire supply chain arising from the indirect demand for intermediate goods and services. As a result it is estimated that nearly 26% of these intermediate capital goods and services will be supplied by Kurdish companies. Slightly more, approximately 27.5% would be supplied by Iraqi companies in general.

A similar process was followed for spend in the operational spend sectors such as Gas Manufacture and Distribution and Business Services.

Therefore, we estimated an indirect GVA of USD 52 million for KRI and USD 54 million for Iraq. Additionally it can be estimated that the project has induced an indirect employment effect of 9,570 job-years for KRI and 9,997 for Iraq as a whole.

Induced effects

Induced effects can be interpreted as effects which occur due to additional spending of the direct and indirect employed people in the economy. Due to the additional consumption of the direct and indirect employed people the induced effects in KRI sum equate to a GVA of USD 28.7 million and employment effects of 11,907 job-years. For Iraq as a whole the induced effects are estimated at a GVA of USD 29.2 million and employment effects of 12,048 job-years.

Overall impact

The following tables summarize the direct, indirect and induced effects arising from the USD 313 capital expenditure and USD 188 million operational expenditure in both KRI and Iraq.

KRI impacts

	Output (MillionUSD)	Employment (Job Years)	GVA (Million USD)	GVA/Job (USD)
Direct	463	18,474	245	13,284
Indirect	98	9,570	52	5,403
Induced	25	11,907	29	2,411
Total	586	39,952	326	8,156

Iraq impacts

	Output (MillionUSD)	Employment (Job Years)	GVA (Million USD)	GVA/Job (USD)
Direct	463	18,474	245	13,284
Indirect	104	9,997	54	5,426
Induced	26	12,048	29	2,423
Total	592	40,519	329	8,116

The output multiplier can be interpreted as the sum of overall output in relation to the sum of direct additional demand. As the result the output multiplier is estimated at **1.27 for KRI and 1.28 for Iraq**.

Since the direct job effect in comparison with the GVA effect is rather low, the employment multiplier which depicts the ratio between direct and aggregated job effects (direct, indirect, and induced) is higher. **For KRI the employment multiplier is calculated at 2.16 and for Iraq it is 2.19.**

The GVA multiplier depicts the ratio between the sum of GVA and the direct GVA. Consequently the GVA multiplier is **1.33 for KRI and 1.34 for Iraq**.

We note that the GVA to Output ratios are higher in the Gas and Business Services sectors (as well as their supply-chain), relative to the Construction Sector (and its supply-chain). Combined with lower GVA/worker in these sectors as well, the employment creation effects are significantly higher on a per-dollar of expenditure basis from the operational spend, versus the capital expenditure.

Appendix 10



















Community Impacts

Summary of Dana Gas and Crescent Petroleum's activities in community engagement programme

The Table below provides a summary of all the different initiatives which have been implemented together with beneficiary numbers, impacts areas and relevantly impacted MDGs over the period 2007 – 2014. Unfortunately, these activities, along with further planned activities, have been curtailed due to the ongoing dispute with KRG.

Activity	Description	Beneficiaries	Relevant impact areas	Relevant MDGs
Drilling Waterwells in drought area in Qader Karam, Shoresh and Chemchemical 	In August 2009, Dana Gas and Crescent Petroleum drilled 3 water wells in Chemchemical as part of the drought program.	10,000 people	Standard of living Health & well-being Security & stability	  
Replacing Chemchemical Water Tanks 	Replacement of a 50 year old water tank with a new tank.	10,000 people	Standard of living Health & well-being Security & stability	  
Providing Shwan Sub-District with Water Treatment system 	Delivery of two water chlorine systems for Shwan district in 2008.	200 people	Standard of living Health & well being	  
Mobile Health Team 	Five mobile health teams are in operation in Qader Karam, Chemchemical, Sangawa, Shwan, Alton Kopre and, Qushtapa. Each team has two doctors who visit families and school students in all the villages within these districts.	5,000 people	Health & well being	   
Construction of X-ray room in Alton Kopree Hospital 	Alton Kopree hospital located along the Kirkuk-Erbil highway, which has a high accident rate. The lack of an X-ray facility at the hospital has meant that patients have to be sent to either Erbil or Kirkuk. An X-ray facility was built by Dana Gas and Crescent Petroleum with the co-operation of Rebaz Foundation.	10,000 people	Health & well being	   

Activity	Description	Beneficiaries	Relevant impact areas	Relevant MDGs
Handover of a Health Centre Caravan to Grdasoor-Quashtapa 	In 2008, caravan was handed over to Grdasoor-Quashtapa area for use as a health center.	500 people	Health & well being	  
Construction of a 4-classroom school in Qarachewar-Qadirkaram 	In 2009, a school was built in Qarachewar village in Qadirkaram district as part of Dana Gas and Crescent Petroleum's community support program.	Students in the villages	Human capital	
Donated Educational materials to Chemchemal & Qader Karam Schools 	Dana Gas and Crescent Petroleum in cooperation with the Rebaz foundation donated Educational materials to the students.	600 students	Human capital	
Donated 19 water coolers to Altun Kupri Schools 	In 2008, Dana Gas and Crescent Petroleum handed over 19 water coolers to the schools in the town of Altun Kupri.	1,000 students	Standard of living Human capital	 
Granted 7 Scholarships for Master Degree in the American University in Suleymanya (AUIS) 	Dana Gas, Crescent Petroleum & Rebaz Foundation will pay for all the education expenses.	7 MBA students	Standard of living Human capital	 

Activity	Description	Beneficiaries	Relevant impact areas	Relevant MDGs
Donating a 250 KV generator to Qadirkaram town 	Dana Gas and Crescent Petroleum donated a 250KV generator to provide power for the small town of Qadirkaram and provide a monthly supply of fuel for the Genset.	Qader Karam & Sangaw districts	Standard of living Security & stability	 
Construction of four soccer fields in Qader Karam, Shoresh, Chemchemical and Rezan 	The purpose behind this project was to improve the social levels in these districts and provide young people in the communities, with a chance to engage in different educational, cultural and sports activities.	Youth in the areas	Health & well being Community cohesion Human capital	 
Supporting Qadirkaram Community with kerosene 	Dana Gas and Crescent Petroleum donated 28,500 liters of kerosene to Qadirkaram community.	100 families	Standard of living Community cohesion Security & stability	
Supporting Community in Qandel district 	Dana Gas and Crescent Petroleum organised and collected \$10,000 to help poor families, widowers & disabled people in Qandel district	95 families	Standard of living Community cohesion Health & well being	
Provision of Generator Set in district of Sangaw 	Dana Gas and Crescent Petroleum provided a 400kva Generator Set to the district of Sangaw for the benefit of the district and ensuring availability of power when regular supply is disconnected	Sangaw district	Standard of living Community cohesion Security & stability Health & well being	
Supporting maternity hospital in Chemchemical 	Dana Gas and Crescent Petroleum provided the maternity hospital in Chemchemical with prefab cabins to be used for receiving patients, ultrasound & lab facilities and as general administration support for the hospital	Chemchemical district	Standard of living Community cohesion	  
Donation of AC units 	Dana Gas and Crescent Petroleum donated AC Units to the Health Center and the Directorate of Water in Qadir Karam	Qader Karam district	Standard of living Health & well being	

Activity	Description	Beneficiaries	Relevant impact areas	Relevant MDGs
Hiring Vehicles and providing transportation to schools 	Dana Gas and Crescent Petroleum have hired vehicles to transport students and teachers from 5 remote villages to schools in Qadir karam	Students in the villages	Standard of living Health & well being	
Supporting Qadir Karam and Chemchemical societies 	Dana Gas and Crescent Petroleum have provided prefab cabins to an NGO and Nursery in Chemchemical, heating & cooling supplies to Qadir Karam shrine & mosque and hired machinery to help reinforce a bridge and finish the construction of a pond in villages in Qadir Karam	Chemchemical & Qadir Karam districts	Community cohesion Security & stability Health & well being	 
Literature support to a writer 	Dana Gas and Crescent Petroleum have helped in printing a book for a young writer from Chemchemical on a literary topic reflecting the need to support works of art and literature	Book writer	Community cohesion Standard of living	 
Supporting orphans along with Barzani Charity Foundation 	Dana Gas and Crescent Petroleum have worked with the Barzani Charity Foundation to secure monthly payments to 1000 orphans in the KRI Region for one year	1000 orphans	Community cohesion Security & stability Standard of living	  
Financial support to a hospital in KRI 	Dana Gas and Crescent Petroleum provided financial contribution to help the Par Hospital in the KRI Region upgrade their facilities and improve healthcare in the KRI	KRI Region	Community cohesion Health & well being	  
Provision of free electricity (760 KW) to 5 villages in Qadir Karam town	Since inception, DGCP project has been providing free electricity (upto 16,000 kWh per day) to houses, government building and shops in 5 villages of Qadir Karam district. At the price paid to power plants by Ministry (\$0.2 per kWh), this translates to power subsidy of \$96k per month. Inception to date, DGCP have contributed c. \$4.2m towards this	Houses, Government building & shops in these villages (276 in total)	Standard of living, Health & well-being, Security & stability	  

Source: the description of activities and beneficiary numbers have been provided by Crescent Petroleum

Appendix 11

Wage Data Sources

One of the main ways in which the Dana Gas and Crescent Petroleum Gas Project is helping the KRI is by generating good quality jobs with a decent remuneration that provide families in the KRI with stable and predictable income. This does not only help families to escape poverty and improve their livelihoods, but also to improve their access to health care, education and other social services, as well as having resources to endure shocks in their livelihoods, personal disasters, environmental issues and other hardship caused by war, violence and crime.

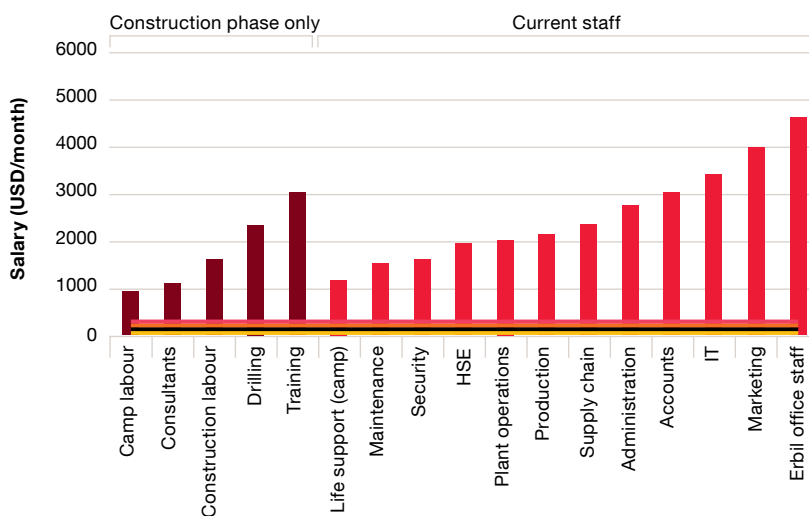
We have compared the wages paid to local employees by the Dana Gas and Crescent Petroleum Gas Project in both the construction and operation stages against:

- Average wages in Iraq;
- Average wages in the oil and gas industry in Iraq;
- Minimum wage in Iraq; and
- Poverty benchmark levels in Iraq.

The figure below shows that the monthly wages for local people employed during the construction and operational phases of the Dana Gas and Crescent Petroleum Gas Project are higher than mean monthly wages and minimum wages. Unskilled labourers such as those that worked in camp and construction earned at least eight times the minimum wage for unskilled labour in Iraq (USD 126 per month). All existing workers also earn wages that are well above the minimum and mean wages in the country. All wages range from a minimum of 4 times the mean wage in the case of life support (camp) workers up to 17 times the mean wage in the case of Erbil office staff who earn on average USD 4,550 per month. Wages paid by the Dana Gas and Crescent Petroleum Gas Project allow all employees to live well above the national average standard of living. Assuming that the average standard of living represents a basic nutritional food basket in KRI, the lowest paid employees in 2014 would be able to pay for the basic needs of around 17 people.

PwC-estimated average monthly wages for local operations staff

Average monthly wages of local operations staff (USD)



Source: PwC analysis

- Salary, construction only (2011)
- Salary, current staff (2013)
- National Mean Income (\$271)
- Minimum wage, skilled (\$252)
- Minimum wage, unskilled (\$126)
- National Poverty Line (\$66)

- Wage levels provided by Dana Gas and Crescent Petroleum
- National poverty line sourced from <http://musingsoniraq.blogspot.com/2011/01/state-of-iraqs-provinces.html>
- National mean wage sourced from <http://www.niqash.org/content.php?contentTypeID=28&id=2660&lang=0> and brought to 2010 prices
- Minimum wages sourced from <http://www.minimum-wage.org/international/en/Iraq>

In addition, local direct and indirect employees during the construction phase were paid roughly in line with the industry average in Iraq. During the construction phase as well as the current operational phase all monthly wages for locals have been well above the mean wage in Iraq.

Appendix 12

GHG Reduction Estimation Methodology

Calculation methodology for avoided GHG emissions and the avoided Social Cost of Carbon

In summary, the mass of GHG emissions avoided as a result of gas-for-diesel substitution at domestic power facilities in Erbil and Chemchemal was determined based on the volume of natural gas substitute delivered to the two power stations during the assessment period. The mass of GHGs emitted as a result of natural gas combustion was compared against the mass of GHGs that would have been emitted had the two power

plants burned a fixed volume of diesel, with the same total energy content as the natural gas substitute. The difference between these calculations provides the estimated GHG emissions avoided as a result of switching fuels. Multiplying this mass of avoided GHG emissions by the Social Cost of Carbon provides an estimate of the avoided damage cost. Details on the methodology are provided below:

Step 1 – Select the GHG emissions factors

Applied Emission Factors

The conversion factors for the combustion of fuel types vary slightly depending on the fuel classification, net heating values and combustion device. In the absence of GHG emissions data specific to the power stations in KRI, we have applied proxy GHG emission factors (EFs) that provide default emissions for the stationary combustion of different fuels. As such, these factors may not necessarily reflect the exact same specifications (such as efficiency and location) as the power stations in KRI. It is recommended that Dana Gas and Crescent Petroleum identify emission factors that are specific to the power plant to calculate more tailored

GHG emission figures, although the methodology adopted represents a robust approach, given the prevailing data available.

The EFs applied were sourced from the IPCC 2006 Guidelines for National Greenhouse Gas Inventories. These EFs are based on default factors for fuel energy and the heat content of the natural gas fuel and are also used in the Greenhouse Gas Protocol's August 2012 Emission Factor Calculation Tool. Individual EFs were obtained for CO₂, CH₄ and N₂O and a set of composite CO₂e emission factors were determined using the Global Warming Potentials provided in the IPCC's Fourth Assessment Report.

GHG emission factors applied in environmental impact analysis

Fuel Type	Unit	CO ₂	CH ₄	N ₂ O	CO ₂ e
Diesel	kg/litre	2.67649	0.00036	0.00002	2.69198
	tonnes/bbl	0.42556	0.00006	0.00000	0.42802
Natural gas	kg/m ³	1.88496	0.00017	0.00000	1.89016
	tonnes/MMscf	53.37612	0.00476	0.00010	53.52341

Source(s): http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_2_Ch2_Stationary_Combustion.pdf
<http://www.ghgprotocol.org/calculation-tools/all-tools>

Step 2 – Calculate avoided GHG emissions

The most common approach used to calculate GHG emissions is to apply documented emission factors to known activity data from the organisation:

$$\text{GHG emissions} = \text{Activity Data Emission Factor (i.e. fuel consumption)} \times \text{Emission Factor (i.e. specific to fuel/engine type)}$$

We have therefore applied our fuel emission factors to (i) the volume of natural gas (in MMscf) that has so far been supplied to the two power plants in Erbil and Chemchemical in order to generate electricity and (ii) the volume of diesel (in Barrels) that would have been required to generate an equivalent amount of electricity, had the Dana Gas and Crescent Petroleum Gas Project not gone ahead. We then determine the net impact on GHG emissions by subtracting the avoided diesel-driven GHG emissions from the natural gas-driven GHG emissions, as follows:

$$\text{Net GHG impact} = \text{Activity Data Emission Factor (i.e. fuel consumption)} - \text{Avoided emissions from diesel}$$

The volumes of natural gas supplied and diesel saved between October 2008 and December 2014 were provided by Dana Gas and Crescent Petroleum. In total, **530 billion scf** of natural gas was delivered between October 2008 and December 2014, resulting in the avoidance of **105 million bbls** of diesel fuel across the same period.

By applying the emission factors identified in the section above, we estimate that gas-for-diesel substitution at the electric power facilities in Erbil and Chemchemical has resulted in net avoided emissions of **16.47 million tCO₂e** between October 2008 and December 2014. In 2014, gas-for-diesel substitution resulted in an annual GHG emission saving of **3.52 million tCO₂e**.

Net GHG impact associated with gas-for-diesel substitution at Erbil and Chemchemical

Description	Barrels					Inception to date (Dec 14)
	Pre – 2011	2011	2012	2013	2014	
Natural gas supplied						
Gas volume (MMscf)	92,841	92,038	113,503	118,033	113,152	529,567
Equivalent energy (MMBtu)	105,838,694	104,923,118	129,393,319	134,557,939	128,992,767	603,705,867
Avoided diesel use						
Equivalent energy (MMBtu)	105,838,694	104,923,118	129,393,319	134,557,939	128,992,767	603,705,867
Equivalent volume (Litres)	18,368,395	18,209,496	22,456,321	23,352,645	22,386,804	16,659,012,991
Emissions factors						
Nat. gas (tCO ₂ e/MMscf)	53.52341	53.52341	53.52341	53.52341	53.52341	53.52341
Diesel (tCO ₂ e/litre)	0.42556	0.00006	0	0.42802	0.00269	0.00269
	0.42802	0.42802	0.42802	0.42802		
GHG emissions (tCO₂e)						
Emissions from nat. gas	4,969,167	4,926,188	6,075,068	6,317,529	6,056,257	28,344,208
Avoided diesel emissions	7,862,130	7,794,117	9,611,863	9,995,513	9,575,060	44,812,745
Net GHG impact (tCO₂e)	-2,892,963	-2,867,929	-3,536,795	-3,677,984	-3,518,803	-16,468,537
Rate adopted for savings (US\$ / tCO ₂ e)						
						\$87
Savings						
						(\$1,432,762,751)

Step 3 – Determine avoided societal cost of carbon

The Social Cost of Carbon

Estimates of the SCC attempt to value the damage (as a result of current and future climate change) attributable to each tonne of carbon dioxide equivalent (CO₂e) released. The SCC applied in this calculation is derived from a subset of the SCC estimates reported by the economist Richard Tol in his 2009 paper “The Economic Effects of Climate Change”. The 232 estimates of SCC included in Tol’s paper are based on a wide range of models and assumptions and range in USD from below-zero to four-figure estimates. This range occurs as a result of a number of factors that can have a significant impact on SCC estimates including; how future damages from emissions are discounted; the level of adjustment for price inflation; valuing damages; accounting for catastrophic risks; and income values for different countries.

The estimate for the SCC used here has been derived by applying criteria to the above factors in order to gain an average estimate of the SCC. The SCC is expressed as USD 87 per tCO₂e in 2010. This estimate is highly sensitive to the assumptions outlined above and it should be recognised that there is significant uncertainty around the true SCC.

The estimated GHG emissions avoided from the replacement of diesel fuel with natural gas between October 2008 and December 2014 are 16.47 million tonnes CO₂-equivalent, with avoided emissions in 2014 amounting to 3.52 million tCO₂e. The total avoided social cost of carbon between October 2008 and December 2014 is therefore estimated to be **USD 1.43 billion**, with the avoided social cost of carbon in 2014 standing at **USD 306 million**.

It should be noted that whilst the above calculation quantifies the amount of carbon and related damage that is avoided from replacing diesel fuel, it does not account for the remaining environmental damage and socio-economic impacts related to the GHG emissions currently emitted from the two power stations. However, any presentation of the wider environmental impacts of the Dana Gas and Crescent Petroleum Gas Project would ideally be balanced alongside the socio-economic benefits provided from the capital infrastructure project and the provision of a secure, low cost electricity supply.

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Crescent Petroleum also provided PwC with a range of data on employment and wages of its own employees, its expenditure in Iraq, its fuel supply, and its community activities and number of beneficiaries.

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