



Iraq Prime Minister Advisory Commission

# Integrated National Energy Strategy (INES)

## Final Report

*Baghdad, September 25, 2012*

This document is confidential and is intended solely for  
the use and information of the client to whom it is addressed.

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## TABLE OF CONTENTS

<b>Acknowledgements</b> .....	<b>4</b>
<b>Abbreviations</b> .....	<b>5</b>
<b>Units of Measures</b> .....	<b>6</b>
<b>Executive Summary</b> .....	<b>7</b>
<b>1. Introduction</b> .....	<b>26</b>
<b>2. Baseline of the Energy Sector in Iraq</b> .....	<b>28</b>
2.1. Overview .....	28
2.2. Upstream Oil Subsector .....	29
2.3. Downstream Oil Subsector .....	34
2.4. Natural Gas Subsector .....	41
2.5. Power Subsector .....	44
2.6. Linked Industries Subsector .....	50
2.7. The Oil & Gas Legal and Institutional Landscape .....	53
2.8. The Power Legal and Institutional Landscape .....	58
2.9. The Linked Industries Legal and Institutional Landscape .....	61
<b>3. Baseline of Socio-Economic and Environmental Situation</b> .....	<b>63</b>
3.1. Overview .....	63
3.2. Socio-Economic Situation and Contribution of the Energy Sector .....	63
3.3. Environmental Situation and Impact of the Energy Sector .....	68
<b>4. Strategy Framework</b> .....	<b>75</b>
4.1. Overview .....	75
4.2. Vision Statement .....	75
4.3. Strategy Evaluation.....	76
4.4. INES Building Blocks .....	77
<b>5. Strategy Formulation</b> .....	<b>88</b>
5.1. Overview .....	88
5.2. Strategic Choices .....	88
5.3. The INES Plan.....	116
5.4. INES Results .....	128
5.5. Sensitivities and Risk.....	134

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<b>6. Institutional Reform</b> .....	<b>138</b>
6.1. Overview .....	138
6.2. Short-Term Institutional Reform .....	138
6.3. Medium to Long Term Institutional Reform .....	151
6.4. Institutional Reforms Outside the Energy Sector.....	159
<b>7. Path Forward</b> .....	<b>163</b>
7.1. INES Roadmap .....	163
7.2. INES Governance .....	171

## **Appendix**

Appendix A - Infrastructure baseline

Appendix B - Regional and International Market Trends

Appendix C - Legal and Institutional Baseline and Benchmarks

Appendix D - Socio-Economic and Environment Baseline

Appendix E - Strategy Framework

Appendix F-- Strategy Formulation and Detailing

Appendix G - Data Sources, Assumptions, and Additional Analyses

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## Acknowledgements

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## Abbreviations

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ABOT	Al Basra Oil Terminal
BOT	Build Own/Operate and Transfer
CAPEX	Capital Expenditure
CCGT	Combined Cycle Gas Turbine
CSSF	Common Seawater Supply Facility
DG	Directorate General
E&P	Exploration and Production
EPC	Engineering Procurement and Construction
ERP	Enhanced Redevelopment Plans
FDP	Field Development Plans
FEED	Front End Engineering and Design
GHG	Greenhouse Gases
GoI	Federal Government of Iraq
GSA	Gas Sales Agreement
GT	Gas Turbine
HSE	Health, Safety and Environment
ICC	Integrated Control Center
IEA	International Energy Agency
IFRK	Iraq Federal Region of Kurdistan
IGEC	Iraq General Electricity Company
INES	Integrated National Energy Strategy
INGC	Iraq National Gas Company
INOC	Iraq National Oil Company
IPA	Industrial Park Authority
IPP	Independent Power Producer
IREA	Iraq Renewable Energy Authority
ISIC	Iraq Strategic Industries Company
JV	Joint Venture
KAAOT	Khor Al Amaya Oil Terminal
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
MoE	Ministry of Electricity
MoEnv	Ministry of Environment
MoIM	Ministry of Industry and Minerals
MoO	Ministry of Oil
MoU	Memorandum of Understanding
NIC	National Investment Commission
OIP	Oil In Place
OPEX	Operation Expenditure
PMAC	Prime Ministry Advisory Commission
PPT	Plateau Production Target
PSC	Project Steering Committee
REEC	Renewable Energy and Environment Center
RGE	Regional Government Entity
RR	Regional Regulator
SOE	State-Owned Enterprise
ST	Steam Turbine
T&D	Transmission & Distribution
TSC	Technical Service Contract

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## Units of Measures

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bbbl	barrel
Bn	Billion
bscfd	billion standard cubic foot per day
c-Km	circuit - Kilometer
GW	Giga Watt
ID	Iraqi Dinar
kbpd	thousand barrel per day
kcm/d	thousand cubic meter per day
KTPA	Thousand Ton Per Annum
kWh	kilo Watt hour
mmboe/d	million barrel of oil equivalent per day
mmbpd	million barrel per day
mmbtu	million british thermal unit
mmscfd	million standard cubic foot per day
Mn	Million
MTPA	Million Ton Per Annum
Tcf	Trillion cubic foot
Tn	Trillion
TWh	Terra Watt hour

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## Executive Summary

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This report recommends an Integrated National Energy Strategy (INES) for Iraq. It defines a vision for Iraq's energy future, assesses the energy resources available to Iraq, and considers options for deploying those resources. On that basis it proposes a long-term plan of investment, infrastructure development, and institutional reform.

The report covers a time span extending to the year 2030. It includes all the major components of Iraq's energy sector: upstream and downstream oil, natural gas, power, and linked industries. It takes an integrated perspective toward these subsectors, analyzing their interactions with each other and assessing strategic alternatives in terms of their impact on the sector as a whole rather than on any single subsector. Additionally, the report considers not only the energy sector's internal economic dynamics but also its broader socio-economic and environmental context.

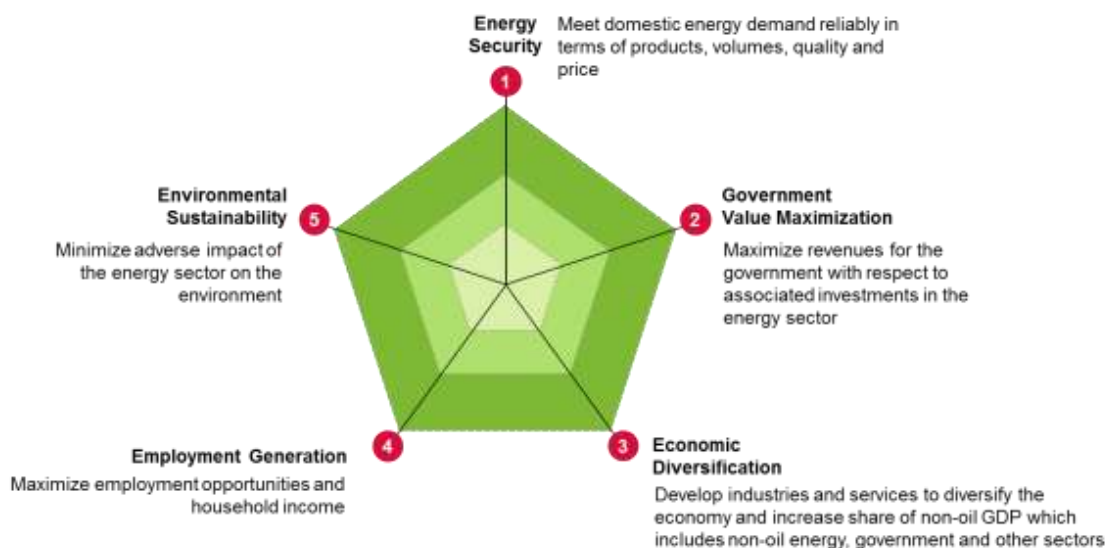
Iraq's overall economy is closely linked to the performance of its energy sector. Both have suffered from forty years of intermittent warfare and international sanctions. Iraq today has oil and gas reserves that rank among the world's largest, yet the infrastructure needed to take advantage of these resources is in disrepair, industries that depend on these resources are virtually non-existent, and Iraq's electric power system is chronically unable to meet demand.

The aim of the INES is to define a plan that will reverse this deterioration and develop Iraq's energy resources to their full potential. This aim is reflected in the INES vision statement.

*"Develop the Energy sector in a coherent, sustainable and environment-friendly manner to meet domestic energy needs, foster the growth of a diversified national economy, improve the standard of living of Iraqi citizens, create employment, and position Iraq as a major player in regional and global energy markets"*

From this vision statement, five dimensions of evaluation have been defined which shape the strategic choices of INES.

### Exhibit ES - 1: INES Strategy Evaluation Dimensions



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The program of investments and reforms set forth in INES provides major gains on all these dimensions and lays a foundation for future national prosperity. Accomplishing this program, however, will require purposeful and coordinated government action and institutional commitment.

In particular:

- INES requires immediate infrastructure development across all energy subsectors: oil (upstream and downstream), gas, power, and industry. Development must be rapid, but also balanced. These subsectors are interdependent. Each depends for its own advancement on advances in the others. They need to evolve in parallel.
- The delivery of INES benefits cannot begin until the basic infrastructure for all of these subsectors is in place. The next three years of infrastructure development are critical to the success of INES. Once effective linkages have been established among the various energy subsectors, enormous benefits will begin flowing to the people of Iraq. On the other hand, breakdowns in those linkages will create supply bottlenecks that waste time, resources, and opportunity.
- In order to accomplish the ambitious short-term INES infrastructure program, Iraq's energy-sector Ministries will need to focus intensely on specific critical tasks. These tasks are enumerated in the INES.
- Rapid, sustained, and balanced growth in the medium- and long-term phases of INES will require fundamental institutional reforms. Energy-sector Ministries will need to reorganize. They also will need to establish regulations, programs, and institutions that encourage private-sector participation in the energy sector. International investment needs to be encouraged in order to introduce world-class standards of technology, performance, and transparency. Local private investment needs to be encouraged in order to build domestic skills and entrepreneurship and to diversify economic development.
- Along with managing large and immediate growth in infrastructure, Iraq's Ministries also will need to foster rapid growth in institutional capabilities. In particular, they will need to employ a variety of tools to stem and to reverse the flight of talent from Iraq, and to build professional capabilities in such areas as accounting, engineering, planning, contracting, law, and general management.
- Implementation of INES will require a strong INES governance mechanism that sets benchmarks, monitors progress, addresses obstacles, adapts plans to new circumstances, and ensures continual coordination among Ministries. Such a response system of governance and coordination will mitigate the downside risk of not achieving the full benefits of INES by minimizing slippages and under-performance.

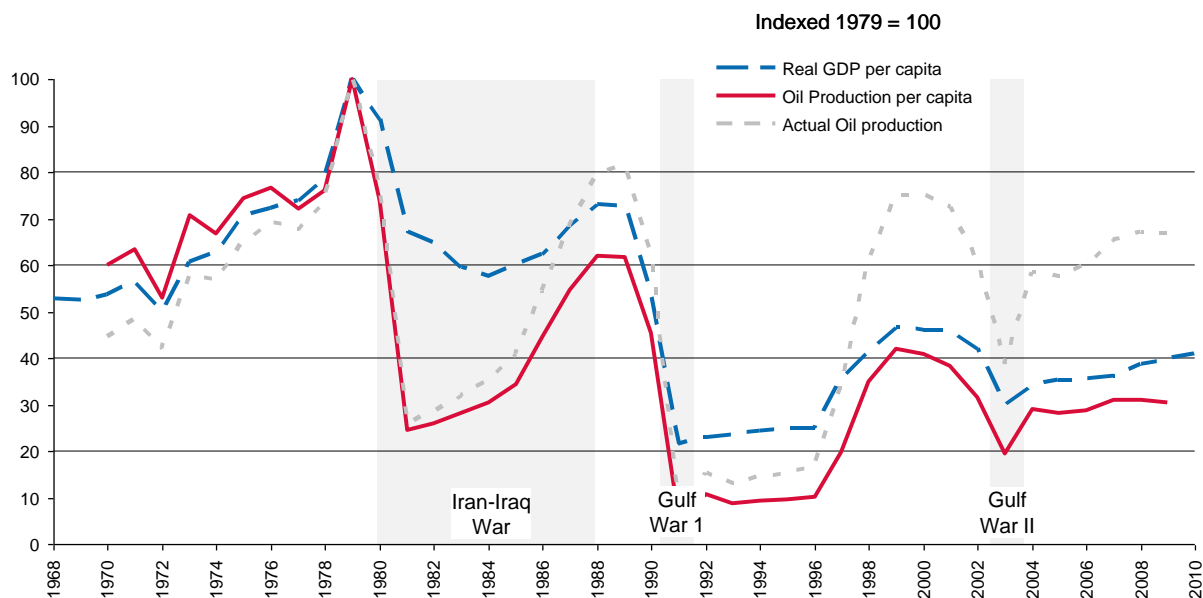
Iraq is endowed with great resource wealth. Its challenge is to unlock that wealth through a coordinated plan of development, managed through capable institutions. INES sets forth a strategy for meeting that challenge.



## The Upstream Oil Subsector

Iraq's economy is closely linked to oil production. Forty five percent of Iraq's GDP and ninety percent of the federal government's revenue in 2010 came from oil exports. Iraq's prosperity depends on a sustained revival of oil production and prudent use of the wealth it creates.

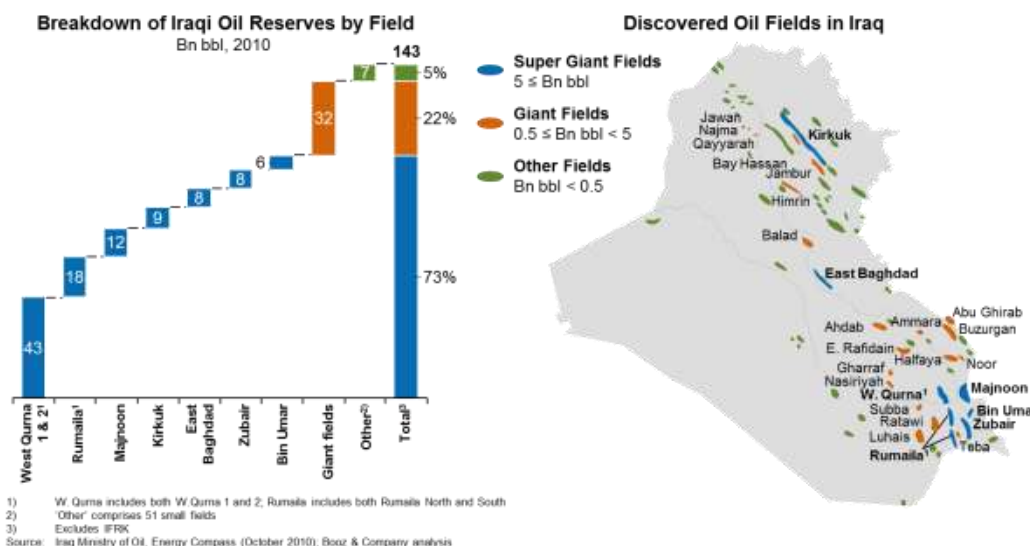
### Exhibit ES - 2: Linkage between Iraqi Oil Production and Prosperity



Source: UN, CSO; Booz & Company analysis

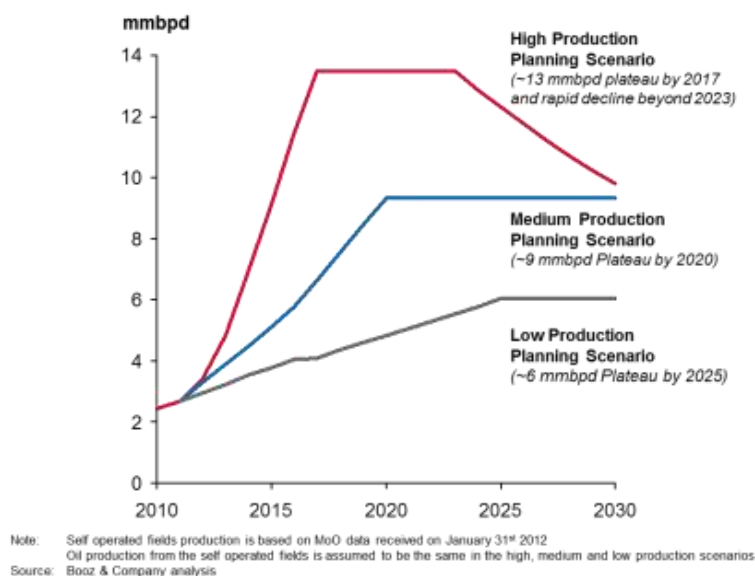
Iraq estimates that it has 143 billion barrels of conventional oil reserves, the third largest national reserve of conventional oil in the world after Saudi Arabia and Iran. Three-quarters of these reserves are concentrated in seven super-giant fields: West Qurna, Rumalia, Majnoon, Kirkuk, East Baghdad, Zubair, and Bin Umar. All of these fields except Kirkuk and East Baghdad are located in the country's southern region. Iraq's oil resources have not yet been fully explored, and they may turn out to be much higher than current estimates, possibly in excess of 200 billion barrels.

### Exhibit ES - 3: Iraq's Oil Reserves



In the past three years Iraq has taken major steps to increase future production. Most importantly, the federal government has awarded technical service contracts (TSC's) to several major international oil companies in order to develop or increase production from twelve large oil fields. Projections of future production from these fields are necessarily uncertain, and a range of production profiles therefore has been considered for planning purposes.

**Exhibit ES - 4: Alternative Oil Production Profiles**



Iraq's primary upstream strategic objective now is to ensure that the development of these fields proceeds expeditiously, aiming for production by the end of 2014 at a rate between the medium and high production profiles. The minimum target production level should be 4.5 mmbpd in 2014. To accomplish this objective, the Ministry of Oil (MoO) will need to pursue three initiatives:

- Monitor and facilitate the execution of upstream development, particularly in the five critical fields (West Qurna 1 & 2, Rumaila, Zubair, and Majnoon) constituting 75% of incremental production.
- Fast-track the Common Seawater Supply Facility (CSSF) project. Possibly expand that project or define alternative schemes to cover additional fields. Ensure that produced water from wells is appropriately treated and made available for reinjection.
- Ensure that field evacuation infrastructure from wellheads to the trunk pipelines is built on time and conforms to Iraq's crude segregation strategy

Iraq's secondary upstream objective is to develop within the next three years a basis for setting long-term production targets. It is recommended that the MoO develop for this purpose a Petroleum Reserve Management System to organize and analyze the information gathered from current oil-field activities, in particular the Final Field Reports and Enhanced Recovery Reports that will be submitted by TSC operators in 2013. Using this system the Ministry will be able to set production levels that optimize the interplay of reservoir conditions, field-management best practices, long-term production potential, project economics, and world market dynamics. Until the time, likely in 2015, when those revised

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production levels are defined, INES plans are based on the assumption that production will occur at the level of the Medium production profile.

Thereafter Iraq's primary upstream objective will be to manage production and develop reserves in accordance with its long-term production targets.

### *The Downstream Oil Subsector*

The downstream oil sector comprises three broad activities: commercializing crude oil as an export product, refining crude oil into oil products suitable for domestic use and export, and distributing refined oil products to domestic customers.

**Crude oil commercialization.** Iraq's export capacity until recently has been limited to 2 mmbpd through port facilities in Basra, and 0.7 mmbpd through a pipeline across Turkey to the Mediterranean. The interior North-South Strategic Pipeline connecting the northern and southern evacuation systems is currently inoperable due to war damage. Consequently Iraq today has no flexibility to divert production from one export point to another.

In order to export the projected increases in volumes of oil produced, Iraq will need to expand its evacuation infrastructure. In order to avoid compromising its existing recognized brands of light crude oil ("Kirkuk" and "Basra Light"), Iraq also will need to segregate the heavier grades of crude oil that will be tapped as production increases.

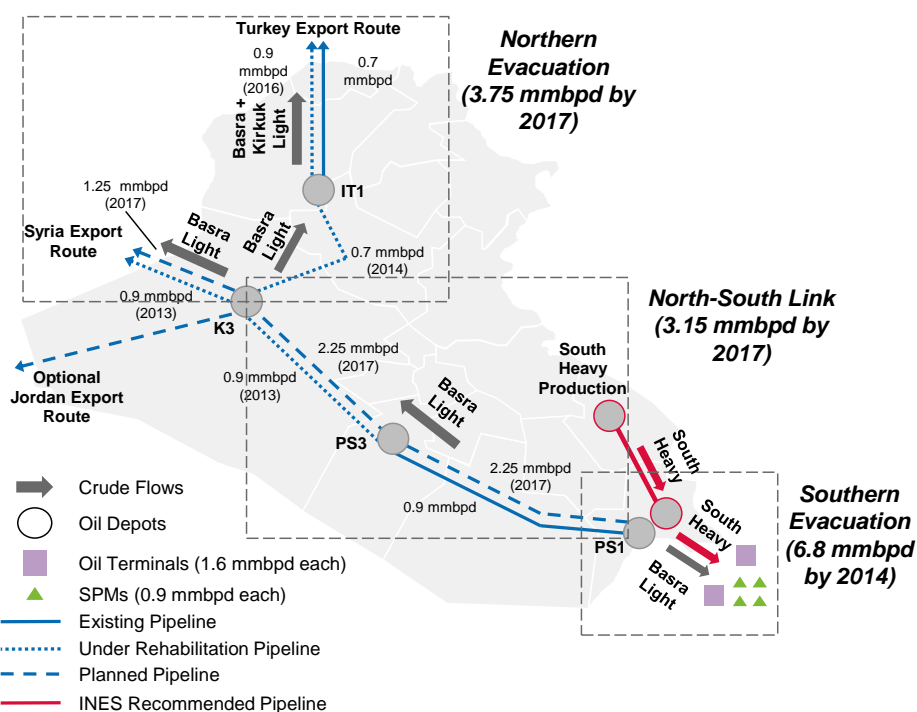
Under the INES plan several initiatives are recommended in the next several years:

- *The northern evacuation system* will expand to 3.75 mmbpd by 2017. Options to route crude to the Mediterranean via pipelines through Turkey and Syria, and to the Red Sea via Jordan will be considered. The Turkey pipeline itself will be rehabilitated and expanded to a capacity of 1.6 mmbpd. An existing but inoperative pipeline through Syria will be rehabilitated to carry 0.9 mmbpd, and a new parallel pipeline through Syria will be constructed to carry 1.25 mmbpd. A pipeline via Jordan to Aqaba in the Red Sea should also be considered in parallel to provide additional route diversification especially if the Syria pipeline does not materialize. Within the northern evacuation system an existing line between oil depots K3 and IT1 will be rehabilitated to a capacity of 0.7 mmbpd to provide flexibility in directing volumes to the Mediterranean either through Syria or Turkey.
- *The southern evacuation system* will be expanded to an overall capacity of 6.8 mmbpd by 2014. This expansion will comprise the addition of four Single Point Mooring buoys (SPM's) off shore, each with a capacity of 0.9 mmbpd, and an increase in capacity at the Khor Al Amaya Oil Terminal (KAAOT) from its current capacity of 0.4 mmbpd to possibly 1.6. The Al Basra Oil Terminal (ABOT) will remain at its current capacity of 1.6. In addition to this expansion in terminal capacity, an additional pipeline system from the southern fields to the terminals will be built. 2.0 mmbpd of the evacuation pipeline and terminal capacity will be dedicated to a separate new grade of heavy crude oil. Execution of these plans is currently underway. Recently two of the four planned SPM's and their pipeline linkages were commissioned, and a third is currently being installed.
- *The North-South link* will play a critical role in moving Basra Light to northern evacuation points, and in providing overall system flexibility. The portion of the existing North-South Strategic Pipeline between PS3 and K3, which is currently damaged, will be

rehabilitated, so that the entire link between PS1 and K3 will be capable of carrying 0.9 mmbpd by 2015. Additionally a new parallel line will be built from PS1 to K3 to carry 2.25 mmbpd by 2017. The entire capacity of the North-South link by then will be 3.15 mmbpd.

The rehabilitation of the North-South pipeline link and the expansion of export capacity at both ends will give Iraq new possibilities for choosing export routes and markets. Asian market is expected to have largest growth in demand and offer Iraq with the highest netback when routing its crude from its southern terminals through the Arabian Gulf. Recognizing this, INES however proposes that Iraq avoid over-reliance on any single regional market or any single route. INES therefore recommends an evacuation system that provides Iraq the capacity to place a larger proportion of its crude to Asian markets, while offering the flexibility to route up to half its production through its northern boundaries to the Mediterranean and the Red Sea as a hedge against Strait of Hormuz. In addition to flexibility, the route through Iraq's northern boundaries to the Mediterranean also provides the most economic transport to serve western markets. This would therefore require the transport of large volumes of Basra Light from the South to the North.

**Exhibit ES - 5: Crude Oil Evacuation Infrastructure**



**Oil refining.** Approximately 20 percent of Iraq's current crude production is refined into products for domestic consumption. Iraq today has major refineries in three locations - Beiji, Daura, and Basra - each supported by a cluster of satellite topping units. The aggregate design capacity of these refineries is 900 kbpd, but due to extensive disrepair the aggregate available capacity is only 660 kbpd.

Even at this reduced level of available capacity, Iraq's total refinery output is more than the country's aggregate domestic demand of 412 kbpd, but the components of demand and production are not aligned. Iraqi refineries produce far more fuel oil than Iraq can currently

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transport or consume, and the excess is simply blended back into crude oil. On the other hand, these refineries produce less gasoline, gasoil, and LPG than is needed domestically. This undersupply of gasoline, gasoil, and LPG creates a substantial import requirement, with a net annual cost to Iraq in 2009 of approximately \$250 million. Moreover, the gasoline that Iraq's refineries do produce is of poor quality, characterized by high sulfur content, lead additives, and low octane ratings.

As domestic demand for refined products grows, Iraq will need to increase both the capacity of its refineries and the complexity of their configuration. Under the INES plan, over the next three years the existing refineries at Daura and Basra will be upgraded, and selected small topping units will be rehabilitated. Between 2015 and 2019 some existing refining capacity will be retired and new refineries in Qayyarah, Karbala, Amara, Kirkuk and Nassiriyah will be built. This program will increase domestic refinery capacity from 800 kbpd to more than 1,400 kbpd, and will permit Iraq to cover domestic demand in all oil products, at appropriate quality standards, by 2019. Additional capacity will be required in later years as domestic demand continues to grow.

In the future, Iraq should consider adding an export-oriented refinery to add value to its crude oil and to diversify its energy-related export offerings. Any such refinery should handle at least 300 kbpd in order to benefit from scale economies, and it should have a complex configuration capable of processing heavy crude and yielding higher middle distillates in line with international demand. The advisability of adding this capacity will depend on future global market dynamics and refinery margins.

**Distribution.** The existing system for domestic distribution of Iraq's refined oil products present challenges in transportation, storage, metering, and retail service.

Over the next three years the MoO should develop a comprehensive plan for reforming this sector. The pipeline network for white products needs to be expanded to reach demand centers and depots across the country. The fuel oil pipeline network and road tanker fleet need to be expanded to convey currently stranded volumes of fuel oil to power plants, cement plants and brick plants. Gasoline and gasoil storage needs to be expanded to align with international standards and located so as to provide balanced geographic coverage. The installation of meters at injection and withdrawal points across the distribution system need to be completed to provide accurate information on volume flows, and control stations need to be established to monitor and manage these flows.

The quality and availability of gasoline retail stations could be dramatically improved by building more stations in high-demand areas, increasing retail margins to incentivize investments in service quality, and establishing and enforcing a code of operating and safety standards. Gasoline retail should be opened to entry by international retailers, and existing OPDC stations should be divested to the private sector.

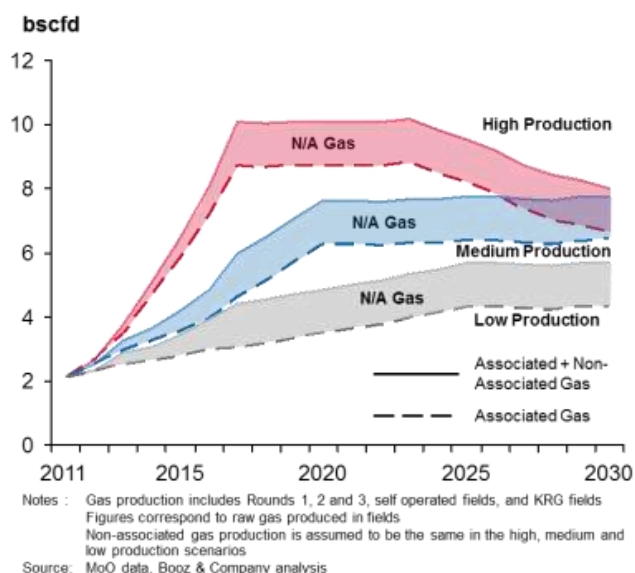
### *The Natural Gas Subsector*

Iraq estimates that it holds approximately 112 trillion standard cubic feet (Tscf) of natural gas reserves, an endowment that would make it the twelfth largest holder of conventional gas reserves in the world. Broad areas of Iraq especially in the western desert remain unexplored for natural gas, and many existing non-associated gas fields have yet to be fully explored at deep levels. With this additional potential, Iraq's total gas reserves could be as

high as 280 Tscf, placing Iraq among the world's top five holders of conventional gas reserves.

Iraq produced 1.7 bscfd of gas in 2009, a figure that is low in light of the size of its reserves. In the coming years that production rate will increase substantially. Because production levels for associated gas will track production levels of oil, the three production profiles described above for future oil production yield three corresponding profiles for future associated gas production. Production of non-associated gas is expected to develop at a rate that will not be affected by the different oil production scenarios.

### Exhibit ES - 6: Alternative Gas Production Profiles



Increased gas production will present a challenge. Even today at far lower levels of production, more than 40 percent of the gas produced is flared in-field, a practice that not only wastes a valuable and needed resource but also creates significant air pollution and carbon release. This flaring occurs because most Iraqi oil fields lack the infrastructure needed to gather and process gas, and because the pipeline system needed to transport gas from processing plants to consumption points is inadequate.

The amount of gas that currently is flared would be sufficient, if properly handled, to meet most of Iraq's currently unmet gas needs. Because of these infrastructure deficiencies, however, Iraq has both an excess of gas at the fields and a deficit of gas at consumption points.

This shortage of delivered gas imposes significant economic costs. It forces power plants to use more expensive and less efficient fuel substitutes like crude oil and fuel oil. It precludes altogether the introduction of efficient combined-cycle power plants. It also precludes development of industries such as fertilizers, petrochemicals, steel, and aluminum that depend on gas feedstock and gas fuel.

Consequently, Iraq's primary objective in the natural gas subsector is to develop the infrastructure needed to handle and distribute gas production. Plans are in place to accomplish this objective. Under the terms of Iraq's Technical Service Contracts with international oil companies, a large number of oil field operators are responsible for developing and operating gas gathering and processing facilities for the gas they produce. The MoO is responsible for gathering and processing at its self-operated fields. In addition,



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the MoO will need to develop a pipeline system to convey processed gas to consumption points. This infrastructure development is scheduled to occur between now and the end of 2014, at which point adequate physical linkages will connect gas production and gas consumption, and flaring can be minimized.

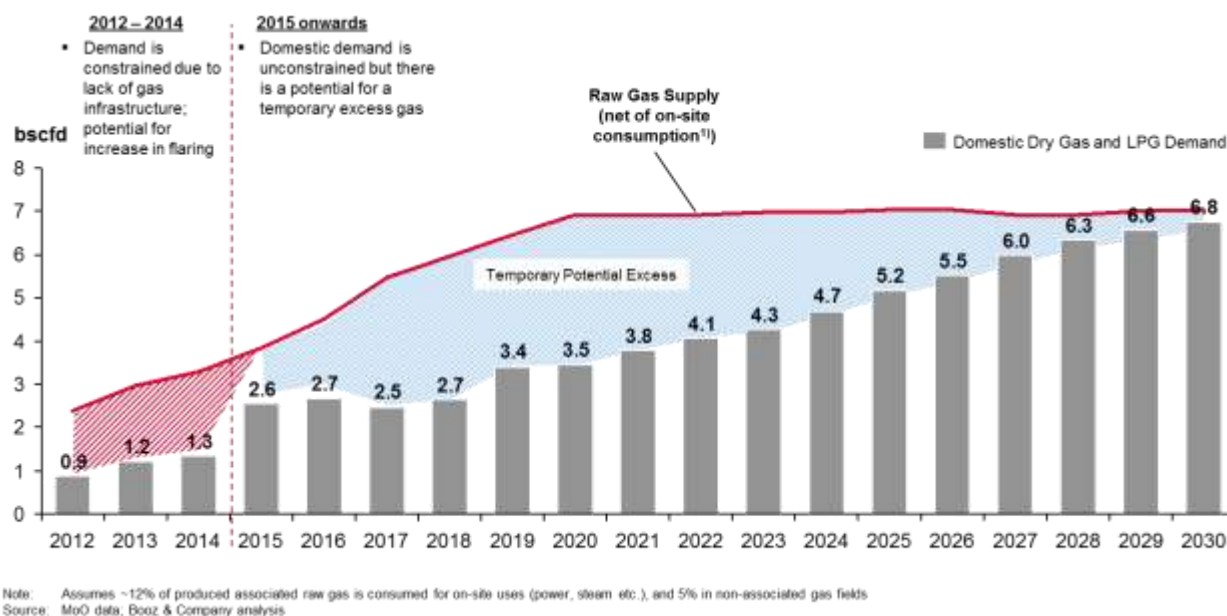
Between now and the end of 2014, MoO needs to pursue three initiatives:

- Monitor and expedite the development of field-level gathering, compression, and processing facilities.
- Install the infrastructure needed to connect processing facilities with demand locations. In addition to dry gas, Iraq's processing plants will also produce Liquid Petroleum Gas (LPG) and light naphtha. The existing infrastructure connecting gas processing plants and refineries to LPG end-users will need to be expanded, and bottling capacity close to domestic demand centers will need to increase. Both LPG and light naphtha will be produced in quantities greater than needed to serve domestic demand. In order to export this surplus, appropriate storage facilities and terminal facilities will need to be developed in the South.
- Commission a technical plan for a Master Gas System. As power plants and industrial facilities come on line, the variety of stakeholders and handover points will grow. Requirements regarding gas composition, volumes, delivery location, and delivery schedules will require a complex network of pipelines, storage facilities, compression points, and centralized control. A detailed technical study is needed to design an optimum infrastructure plan, including technical standards and regulations for construction and use of the system.

By 2015, virtually all of Iraq's gas production should be captured and processed and available for transport to domestic end users. By that point, gas flaring due to inadequate infrastructure would be minimized, and all of Iraq's domestic gas requirements will be satisfied.

However, beginning in 2015 a different stranded gas challenge may arise. At that point more gas will likely be produced and processed than Iraq can consume domestically. That surplus will need to be exported. If it cannot be exported, it will have to be flared, at volumes exceeding even those experienced today.

## Exhibit ES - 7: Potential Export of Surplus Gas



Beyond 2015, once all domestic uses for natural gas have been met for power generation and for the development of gas based linked industries, any potential surplus gas can be exported. Potential export markets are available, but each such market will require the construction of a dedicated pipeline or LNG infrastructure, and each of the pipeline options will require long-term supply commitments. In order to make those long-term commitments, Iraq will need to ensure that its surplus production remains steady. Since production from currently producing fields will eventually level off, and since domestic demand will continue to rise, that surplus can be sustained only if new non-associated gas fields are developed.

The long-term objective for the Natural Gas subsector is therefore to manage the balance of gas supply and off-take. This objective involves two initiatives:

- Establish gas export contracts and pipeline connections with regional customers that are sufficient to absorb excess gas production in the medium term, and that are sustainable in the long term through development of new gas reserves.
- Through exploration and development of non-associated gas reserves, assure a long-term supply of gas that is independent of oil production and that can be produced flexibly to meet demand requirements.

### *The Power Subsector*

Iraq suffers from a severe shortage of electricity. This shortage imposes major costs on the economy in the form of lost production time, damage to capital assets from power interruption, and an inability to carry on normal commercial processes on a reliable schedule. In a country that experiences cold weather in the winter and extremely hot weather in the summer, the shortage of power also imposes significant hardship on individuals. The absence of reliable power supply from the grid has led to the widespread installation of private diesel generators, whose constant operation imposes high generation costs, creates noise, pollutes the air, and emits large quantities of carbon into the atmosphere. It is estimated that the total cost to the Iraqi economy attributable to power shortages exceeds \$40 billion annually.

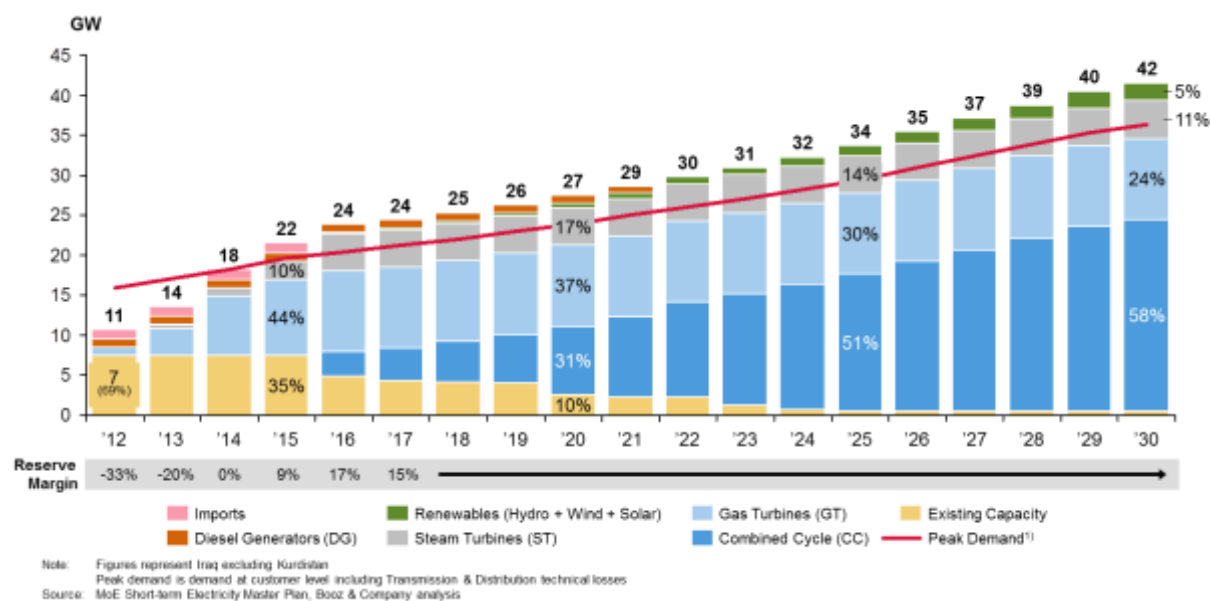


While this shortage is due to a variety of system deficiencies, the necessary first step toward addressing it is to increase generation capacity. Under the INES plan, 40 new plants will be built between now and 2016, adding 22 GW of capacity to the 7 GW of effective capacity currently available. These new plants will consist of steam and gas turbines, capable of running on natural gas in the long run but also capable of running on fuel oil when needed. This flexibility in fuel requirements will be important during the next few years, when gas infrastructure will be under development and gas supplies may continue to be restricted.

By 2016 there will be sufficient available capacity in the system (after adjusting for local operating conditions and expected technical losses) to meet peak demand with a reserve margin of 15 percent. Thereafter the fleet will expand to keep pace with demand growth, and newer plants will displace inefficient existing plants. The only fossil fuel capacity to be added after 2016 will be Combined Cycle Gas Turbines (CCGT's), which are the most fuel-efficient and least environmentally damaging of fossil fuel technologies.

Renewable generation will be used in the short term to supply remote off-grid demand locations. In the medium- to long-term, solar and wind power capacity will be developed for connection with the grid, and the potential for hydro-power development will be examined. By 2030 it is expected that renewable capacity will exceed 2 GW, approximately 4-5 percent of total system capacity.

**Exhibit ES - 8: Planned Expansion of Iraq's Generation Capacity**



As a consequence of these changes to the generation fleet, Iraq's fuel consumption for power will shift strongly toward natural gas. Imports will end by 2016. Crude, heavy crude, and LFO all will be phased out as power fuels and redeployed to export, refineries, and industry. Natural gas, which fuels one quarter of power production today, will fuel four-fifths by 2030.

In parallel with these improvements in generation capacity, Iraq will expand, strengthen, and de-bottleneck the T&D network. Technical losses will be reduced to acceptable levels and a smart grid program will be initiated to monitor grid performance and enhance peak load management.

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Once a publicly acceptable level of supply reliability is established after 2016, Iraq will begin to increase tariffs, aiming toward a gradual alignment of price with cost. As tariffs begin to reflect the economics of power production, demand-side management measures can be introduced such as green building codes, load control programs, district cooling in high density areas, gas kitchens, and solar water heaters.

As Iraq acquires self-sufficiency in power, it will be able to develop a strategy for international power exchange, either as a net exporter or as part of a cooperative regional grid for reserve sharing and load balancing. Iraq has already entered into power exchange agreements with neighboring countries such as Iran and Turkey. Iraq's location provides a strategic position for potential wheeling of power from the Middle East to Europe. In a possible future environment where the Middle East's solar potential is developed to a point where it can provide substantial carbon-free power for export, Iraq could be an important grid cross-road to regional and Western power markets.

### *The Linked Industries Subsector*

Six industries in Iraq fall into the category of linked industries: petrochemicals, fertilizers, steel, aluminum, cement, and bricks. Each of these industries consumes large quantities of energy in the form of power or heating fuel for its production processes, and two of these industries (petrochemicals and fertilizers) require large quantities of natural gas components as feedstock for their products. Each of these industries provides a foundation for multiple secondary industries and thereby provides a vital link in converting Iraq's energy resources into national economic strength.

Today these six industries are underdeveloped and in various states of disrepair and disuse. Chronic shortages of power and feedstock severely limit their operation. Most of Iraq's domestic demand for the products of these industries is met through imports. Yet each of these industries, if built to sufficient capacity, and if provided sufficient energy resources, has the potential to develop into a significant and profitable producer, meeting all of Iraq's needs and in some cases establishing also a material export presence.

- **Bricks.** At the end of 2012, Iraq will have 29 MTPA of capacity for brick manufacture. Domestic demand exists currently for 43 MTPA, and is expected to grow with Iraq's reconstruction, rising to 65 MTPA in 2030. Because of high transportation costs, domestically manufactured bricks should be in a position to displace imports. To serve this rising domestic demand entirely from domestic production, INES plans an expansion in brick capacity to 72 MTPA by 2030. Under this plan, domestic demand for bricks will be fully met from domestic production by 2015 and will continue to be met from domestic production thereafter. However, fertile soil currently used as raw material for brick manufacturing should be gradually phased out with the concurrent introduction of alternative materials and new technology.
- **Cement.** Iraq in 2010 had 7 MTPA of utilized cement capacity. This capacity supplies half of Iraq's domestic consumption of 13.5 MTPA; the remaining demand is supplied through imports at an annual cost of \$780 million. Relatively low transport costs and abundant availability of fuel and limestone gives Iraqi cement production an inherent price advantage against imports. INES plans to bring total cement capacity to 65 MTPA by 2030. Under this plan, domestic demand for cement will be fully met from domestic production by 2014 and will continue to be met from domestic production thereafter.

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- **Petrochemicals.** Iraq today has limited petrochemical production. Domestic demand of 188 KTPA is met almost entirely through imports at a cost of approximately \$275 million. Yet petrochemicals represent a substantial commercial opportunity for Iraq. Iraq's gas resources are abundant, and they are rich in ethane and other compounds used as feedstock in petrochemical conversion processes. Iraq therefore has a natural advantage in this industry. Similar advantages have led other countries in the Middle East to enter the world petrochemicals market aggressively, growing from a global market share of 8 percent in 2000 to a global market share of 18 percent in 2010. However, many of these countries are encountering constraints in their gas supply, particularly in ethane, and are moving toward use of more expensive, heavier feedstock like naphtha. Over the coming years, while these countries are adjusting to ethane shortages, Iraq's ethane abundance will give it a highly advantageous position on the global supply curve. Under INES plans, substantial investment will be made in petrochemicals, bringing total capacity to 15.6 MTPA by 2030.
  - **Fertilizers.** Iraq in 2010 had three fertilizer plants, with a combined utilized capacity of 300 KTPA. This capacity supplies half of Iraq's domestic demand for fertilizer; the remainder is imported at an annual cost of \$100 million. Like petrochemicals, the fertilizer industry offers a large commercial opportunity for Iraq. Fertilizer production uses methane as its primary feedstock, and Iraq's abundance of natural gas provides a potential cost advantage in world markets. Global demand for fertilizer is expected to grow at an annual rate of 5 percent over the next twenty years as population increases and as pressures for agricultural productivity rise. Even higher rates of demand growth are expected in South Asia, which already today is the world's largest net importing region. South Asia's proximity and accessibility via the Arabian Gulf make the region a promising market for Iraqi fertilizer production. Under INES plans, fertilizer capacity will rise to 6.3 MTPA by 2030.
  - **Steel.** Iraq today has no steel capacity and must meet its 2 MTPA of domestic demand entirely through imports at an annual cost of \$1.2 billion. Iraq could profitably displace these imports with its own domestic industry. The locational cost advantage of domestic steel manufacture in domestic markets, combined with relatively low energy cost, will make domestic steel production competitive with imports with respect to long steel products. Iraq's steel advantage in export markets, on the other hand, will be minimal, and the market for Iraqi steel is therefore likely to be limited to domestic customers. Even so, the opportunities for expansion of steel manufacture are significant. Under INES plans, steel capacity in Iraq will reach 10.2 MTPA by 2030.
  - **Aluminum.** Iraq currently has no aluminum capacity, but the high energy intensity of aluminum manufacture gives Iraq a natural cost advantage that would likely place it in the most cost-efficient quartile of world aluminum producers. World demand for aluminum is expected to grow over the next decade at an annual rate of 6 to 7 percent as Asian countries continue to industrialize and as global rates of automobile ownership continue to rise. Iraq's potential cost advantage would position it as a strong competitor in this market. Under INES plans, Iraq's aluminum capacity will reach 1.0 MTPA by 2030.

Brick and cement manufacture should be developed in diverse locations within Iraq in order to draw on local raw materials and to serve local construction needs. Petrochemicals, fertilizers, steel, and aluminum, on the other hand, require proximity to import and export routes, reliable supplies of gas and power, and modern infrastructure. For these reasons INES recommends the establishment of an industrial park near Basra capable of

accommodating the establishment and expansion of not only these primary industries but also the downstream and support industries that will develop around them. In addition, in order to ensure coordinated development of these industries, to develop infrastructure synergies, and to encourage participation of private capital within a predictable and consistent policy framework, INES recommends the establishment of the Iraq Strategic Industries Company responsible for managing the Iraqi government's investments in these industries and for sponsoring joint ventures with international investors.

### *INES Investment Requirements and Results*

The development program recommended by INES will require capital and operating expenditures of approximately \$620 billion (\$530 billion as capital expenditures and \$90 billion as operating expenses), in 2011 dollars between 2012 and 2030, including all contracted payments to TSC operators. Of this total figure, it is assumed that about 15 percent will be available from private investments, primarily in refineries and linked industries.

Approximately 60 percent of projected INES expenditures by the Government of Iraq will go toward the production and evacuation of crude oil, and much of that amount will consist of reimbursements to the MoO's TSC operators. 15 percent of expenditures will go toward the production and handling of natural gas, and another 15 percent toward the renovation and expansion of the national power system.

#### **Exhibit ES - 9: Projected Ministry of Oil Expenditures on INES - USD Billion (2011\$)**

	2012-15	2016-20	2021-25	2026-30	Total
Oil TSCs Petroleum Costs	49.0	79.4	53.4	56.2	<b>238.0</b>
Oil TSCs Remuneration Fees	2.9	10.0	11.2	10.0	<b>34.1</b>
MoO Self-Operated Fields	3.7	1.4	1.0	1.0	<b>7.1</b>
Common Seawater Supply Facility	4.3	5.1	0	0	<b>9.4</b>
Refineries	4.5	6.6	1.5	1.5	<b>14.1</b>
Oil Products Domestic Distribution	0.5	0.4	0	0	<b>0.9</b>
Oil Evacuation Infrastructure	20.0	14.0	0.5	0	<b>34.5</b>
<b>Total MoO Oil Investments</b>	<b>84.9</b>	<b>116.9</b>	<b>67.6</b>	<b>68.7</b>	<b>338.1</b>
Gas TSC Development Costs (Round 3)	3.0	3.1	0	0	<b>6.1</b>
Gas TSC Remuneration Fees (Round 3)	0.1	1.8	2.0	2.0	<b>5.9</b>
Additional Gas Field Development	0	5.2	15.1	16.6	<b>36.9</b>
Basra Gas Company	12.0	0.3	0	0	<b>12.3</b>
Non-BGC Gas Processing Facilities	7.9	1.7	3.2	1.5	<b>14.3</b>
Domestic Gas Pipelines	2.8	0.3	0.5	0.2	<b>3.8</b>
Export Gas Pipelines	0	2.7	0	0	<b>2.7</b>
<b>Total MoO Gas Investments</b>	<b>25.8</b>	<b>15.1</b>	<b>20.8</b>	<b>20.3</b>	<b>82.0</b>
<b>Total MoO Investments</b>	<b>110.7</b>	<b>132.0</b>	<b>88.4</b>	<b>89.0</b>	<b>420.1</b>

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**Exhibit ES - 10: Projected Ministry of Electricity INES Expenditures - USD Billion (2011\$)**

	2012-15	2016-20	2021-25	2026-30	Total
Generation	22.5	9.8	10.3	5.3	<b>47.9</b>
IPPs	0	0.9	1.0	1.2	<b>3.1</b>
Transmission	8.4	3.5	4.5	7.0	<b>23.4</b>
Distribution	4.3	1.5	1.5	2.5	<b>9.8</b>
<b>Total MoE Investments</b>	<b>35.2</b>	<b>15.3</b>	<b>17.3</b>	<b>16.4</b>	<b>84.2</b>

**Exhibit ES - 11: Projected Ministry of Industry and Minerals INES Expenditures - USD Billion (2011\$)**

	2012-15	2016-20	2021-25	2026-30	Total
Steel	0.5	1.7	1.2	0.6	<b>4.0</b>
Urea	0.3	0.7	1.3	0.3	<b>2.6</b>
Petrochemicals	1.7	6.4	6.6	0.8	<b>15.5</b>
Aluminum	0	0.6	1.2	0.6	<b>2.4</b>
Basra Industrial Park Infrastructure	0.4	1.0	0.7	1.2	<b>3.3</b>
<b>Total MoIM Investments</b>	<b>2.9</b>	<b>10.4</b>	<b>11.0</b>	<b>3.5</b>	<b>27.8</b>

Over the period covered by INES, the revenue to the government generated by these expenditures is expected to amount to approximately \$6 trillion. Of this amount, almost 85 percent is attributable to oil exports. The cash flow from these cost and revenue projections is highly positive from the outset. At the base-case benchmark oil price assumption of \$110 per bbl for Brent (in constant 2011 dollars), the net present value of cash flow over the span of INES is \$5 trillion. The NPV rises or falls by roughly \$1 trillion as the assumed average oil price over the INES time period rises or falls by \$20.

This investment program also provides positive results with respect to the other four INES dimensions of strategy evaluation. All domestic demand for energy and energy-intensive products will be met through domestic production by 2022. Employment in the general economy, spurred by governmental reinvestment of energy sector revenue, is expected to rise by 10 million jobs by 2030, bringing Iraq to a condition of full employment. By 2020, economic activity in the non-oil-and-gas sectors of the economy will be growing at a pace that surpasses growth in the oil and gas sector. Thereafter, the economy's relative dependence on oil will steadily diminish.

By displacing inefficient power plants, by improving the quality of transportation fuels, by eliminating gas flaring, and by establishing a comprehensive water-resource infrastructure for use in oil production, the INES investments will address directly some of the most glaring environmental challenges currently facing Iraq. The economic growth engendered by these investments will need to be accompanied by a comprehensive national commitment to environmental protection.



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While specific economic projections are of course sensitive to oil price and production assumptions, the basic INES recommendations for infrastructure investment, timing, and capacity development appear to be valid under a broad range of economic assumptions. In this sense, INES is a low-risk strategy.

However, successful execution of INES is subject to numerous risks. INES calls for infrastructure build-up at a pace well beyond anything that Iraq has managed before now. Iraq must overcome logistics bottlenecks, resource constraints, and institutional limitations to coordinate and manage multiple major initiatives. Iraq also must design and plan a long-term structure for sector governance capable of achieving the long-term INES vision. These challenges highlight the importance of institutional alignment with the INES plan.

### *Institutional Reform*

The energy sector's institutional challenges fall into two time-frames, short-term and middle-to long-term.

**Short term.** In the short term the paramount challenges concern implementation. The INES plan is front-loaded, in the sense that numerous significant infrastructure and design decisions need to be made and implemented within the next three years, all in coordination with one another. The sector's rate of investment spending will double during this period. Large numbers of contracts will need to be awarded and managed, and a greatly expanded capital plant will need to be built and operated.

Three ministries will have primary responsibility for these tasks: the Ministry of Oil, the Ministry of Electricity, and the Ministry of Industry and Minerals. INES proposes that each of these Ministries establish a task force empowered to coordinate and expedite the INES agenda within its Ministry. Because of the need for simultaneous development of oil and gas infrastructure, it is proposed that the Ministry of Oil establish two such task forces, one for oil and one for gas.

It is proposed also that each Ministry also establish an institutional reforms committee in addition to its task forces. This committee would be assigned to oversee the improvement of long-term institutional capabilities and the design of a long-term institutional structure.

The task forces and the institutional reforms committees should be chaired by a Minister or Deputy Minister. Each task force and committee should comprise 6 to 7 senior officials of its Ministry, supported by external advisors as needed. Each should have the authority to make decisions on behalf of its Ministry, and each should be held accountable for accomplishing a specific set of tasks pursuant to the INES schedule.

The MoO's Oil Task Force will be responsible for ensuring that oil production ramps up on schedule. It will monitor and expedite field works, facilitate logistics, and oversee development of the water injection infrastructure and oil evacuation infrastructure. The Gas Task Force will monitor the development of needed gas gathering, processing, and transport infrastructure, and ensure alignment with user requirements. It will commission the design of a Master Gas System that optimizes pipeline architecture, provides efficient systems of flow control, and defines appropriate technical standards and regulations for the gas system.

The MoO's Institutional Reforms Committee will be responsible for developing and overseeing a long-term agenda for building institutional capabilities and reforming institutional structures. In the short term it will establish a Petroleum Reserve Management

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System to help organize and analyze oil field data and support the development of long-term production targets. It also will review and revise current programs to incentivize private investment in refineries, and will recommend policies for the domestic pricing of oil products, to be implemented within the next year in order to permit industrial planning.

The MoE's Power Task Force will be responsible for ensuring that the Ministry's short-term plan for expanding and commissioning new generation capacity is accomplished on time. It will confirm that the necessary EPC contracts and fuel allocations are in place, that plant construction proceeds on schedule, that transmission is upgraded to handle new production, and that plans are in place for operating the new plants once they are commissioned. The MoE's Institutional Reforms Committee will develop a long-term agenda for capabilities improvement and institutional restructuring. It also will initiate a program for the phased introduction of Independent Power Projects (IPPs) into the Ministry's generation portfolio. Finally, the MoE will establish a Loss Reduction Committee charged with developing a program for reducing technical and commercial losses and defining a potential role for private-sector operators of distribution systems.

The MoIM's Linked Industries Task Force will have two short-term responsibilities. The first is to establish a government-owned Iraq Strategic Industries Company to coordinate and sponsor joint ventures in petrochemicals, fertilizers, steel, and aluminum. The second is to establish an Industrial Park Authority with the authority and resources to develop a major industrial park near Basra to provide shared infrastructure and facilities support to strategic export industries. The Ministry's Institutional Reforms Committee will be responsible for developing long-term plans for capabilities improvement, Ministry restructuring, and promotion of local content in industry.

**Medium to Long term.** In the medium to long term, Iraq's energy sector needs to adopt institutional reforms that will equip it to oversee lasting growth and value creation. Because hydrocarbon resources and their energy derivatives will dominate Iraq's economy for the foreseeable future, Iraq's future prosperity will depend to a large degree on the professionalism, transparency, efficiency, and integrity of its energy sector management. A framework of energy governance is needed that insulates the sector from short-term political pressure and allows sector managers to focus on the economic performance of their businesses.

The Industry Reforms Committees within each Ministry will be responsible for four issues that are central to establishing this kind of institutional environment. During the short term, these committees will develop plans addressing these issues; in the medium term the Ministries will implement those plans.

- *Capability development.* Each Ministry needs to expand and strengthen its base of professional skills. Skills are particularly needed in the areas of contracting, project management, operations and maintenance, planning, regulation, and environmental management. Each Ministry needs an aggressive program to recruit, hire, and train skilled personnel. It also should work with national universities to develop programs of classroom and on-the-job technical and managerial training. In addition, each Ministry should work with its international contractors to incorporate training opportunities for Iraqis into their construction and management services.
- *Institutional design.* Governance of the energy sector should be characterized by (1) clear separation and accountability for the policy, regulatory, and operational aspects of

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governance; (2) unambiguous distribution of responsibility between federal and regional authority; (3) corporatized structures for the entities responsible for operations, and (4) unbundling of operational responsibilities to the extent needed for transparency, economic coherence, and competitive readiness. INES provides institutional design recommendations in these areas for each Ministry, for consideration by that Ministry's Institutional Reform Committee.

- *Private sector involvement.* Participation by international investors provides not only a source of capital to the energy sector but also a source of investment discipline. International investors in Iraq would introduce international standards of financial accountability and transparency, serve as a reality check on the economic viability of investments, and provide a path for the introduction of world-class technology and expertise. Each Ministry should explore opportunities for expanding private-sector participation opportunities and attracting private sector investment. It also should establish programs to encourage and develop local private-sector content in its sphere of operation in order to expand and diversify Iraq's private economy.
- *Pricing.* Many of Iraq's energy products, most notably power, are priced at levels that have little relationship to their cost of production or their opportunity cost. Over the long run this misalignment leads to resource inefficiency, creates barriers to competition, and makes it difficult to establish a workable market environment. Over the course of INES, indirect subsidization of energy pricing through non-economic pricing should be gradually phased out.

### *INES Governance*

INES establishes a highly ambitious set of objectives, many of which are scheduled for achievement in the initial, short-term phase. The expansion of oil production, the installation of gas infrastructure, and the elimination of power shortages cannot be delayed without great cost to the economy, the environment, and to the well-being of the Iraqi people.

Once these short-term objectives are accomplished, a strong foundation will be laid for long-term development. The energy sector at that point will have momentum for accomplishing the significant objectives that lie beyond 2015.

The short term is the point of critical risk. Objectives are front-loaded into this period, but institutions have little running room to build the capabilities needed.

In addition to the special Ministerial task forces recommended, INES requires an oversight framework at the highest levels of government to ensure that the right economic and managerial resources are applied to these immediate needs, and that appropriate coordination occurs among Ministries.

INES should be owned by the Executive Branch of the Government through the Prime Minister's office that will approve strategic decisions and allocate budgets. The Legislative Branch represented by the Council of Representatives and its dedicated committees will monitor the implementation of INES and support the Government in its responsibilities.

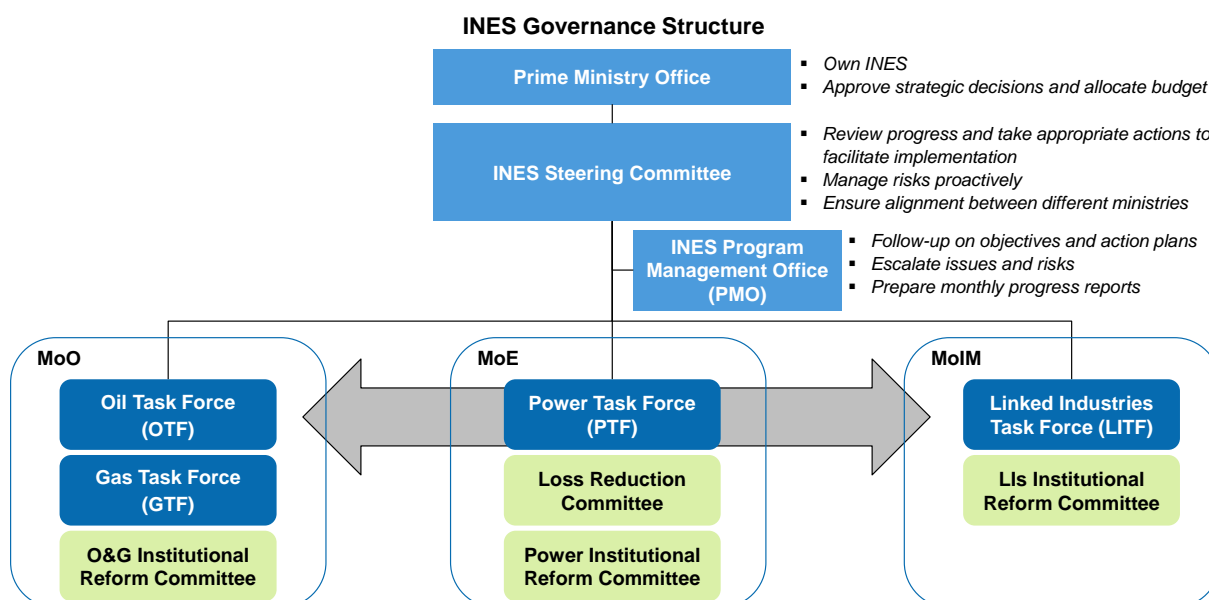
INES recommends that Iraq establish an INES Steering Committee responsible for the Implementation of INES. The Steering Committee will be chaired by the Deputy Prime Minister for Energy Affairs or the Chairman of the PMAC. It will comprise senior



representatives such as deputy ministers from the Ministries of Oil, Electricity, Industry and Minerals, Environment, Planning, and Finance. The responsibility of the Steering Committee will be to keep INES implementation on track and to provide a forum where high-level decisions can be reached quickly.

Supporting the Steering Committee will be a Program Management Office (PMO) that will monitor progress, provide regular reports, and identify issues for resolution. It also will provide a day-to-day point of coordination among the Ministerial task forces and committees to ensure that plans are aligned and synchronized, and that necessary collaborations between Ministries are occurring.

**Exhibit ES - 12: INES Governance Structure**



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## 1. Introduction

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This report presents the recommendations of the Prime Minister's Advisory Commission for an Integrated National Energy Strategy (INES) for Iraq. It describes the current challenges facing Iraq's energy sector and the opportunities presented by Iraq's energy resources. It defines a vision and a set of national policy objectives for Iraq's energy future. It then lays out a long-term plan of policy commitments, infrastructure development, and institutional reform designed to achieve that vision.

The scope of INES includes all the major components of Iraq's energy sector: upstream and downstream oil, natural gas, power, and linked industries. The recommendations presented reflect the economic interdependency of these components and their collective impact on Iraq's socio-economic and environmental welfare. It covers a time span extending from the present to 2030.

The INES has been developed over the past 18 months by Booz & Company under the guidance of a steering committee of Iraqi government officials established by the PMAC, representing the Ministries of Oil, Electricity, Planning, Finance, Mining and Industry, and Environment. This steering committee has held more than 40 workshops to review data and recommendations, and has played the lead role in setting the direction of the report, identifying areas for analysis, reviewing and modifying data and assumptions, and making policy choices.

The information used in developing the INES was gathered through extensive interaction with Iraqi government ministries. This interaction involved an iterative process of collecting, reconciling, and updating historical and current data. These data sources have been supplemented by more than 150 interviews with government officials in the Iraq federal government, with officials in Iraqi State-Owned Enterprises, with executives of international oil companies and oil service companies involved in Iraq, and with numerous technical consultants engaged in Iraq's development plans. Although nearly all the official data made available pertains to activities managed by the federal Government of Iraq, interviews conducted with several senior officials of the Iraq Federal Region of Kurdistan provided insight into that region's policies and plans as well.

The study has been conducted in five phases.

- **Phase 1** consisted of planning: developing a detailed project plan, detailing data requirements, identifying interview subjects, scheduling interviews, and agreeing on mechanisms for information collection, verification, and management.
- **Phase 2** consisted of base-lining: developing a comprehensive understanding of the current conditions of each subsector within the energy sector, identifying the principal challenges and strategic choices facing each subsector, and framing those challenges in the context of Iraq's socio-economic and environmental circumstances.
- **Phase 3** consisted of formulating the strategy: defining a vision and strategic evaluation framework, identifying broad strategic choices, and selecting an overall strategic design.
- **Phase 4** consisted of detailing the strategy: developing integrated infrastructure priorities, specifying the scope, timing, and sequence of investments, allocating

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resources to uses, and identifying the institutional reforms needed to effect these plans.

- **Phase 5** consisted of finalizing the report: preparing final documentation, reviewing conclusions with the PMAC and with Iraq Ministries, and clarifying recommendations.

Iraq is endowed with one of the world's richest supplies of oil and gas. Properly developed, this endowment can be the foundation of a diverse, productive, and continually growing economy. In order to realize this potential, Iraq needs strategic clarity in two areas. The first area is economic, involving resource allocation and capital investments. The second is institutional, involving accountabilities, capabilities, governance, and industry structure.

Because multiple institutions must work together to accomplish the purposes of an integrated energy strategy, a clear economic roadmap is needed that sets a shared agenda. Because that agenda can be accomplished only through effective management of a large number of complex, interconnected tasks, strong institutional roles and capabilities also are needed. The INES recognizes this dual need for economic and institutional direction, and provides recommendations in both areas.

Following the present introductory chapter, **Chapter 2** provides a description of Iraq's energy sector baseline. It summarizes Iraq's current energy position and existing development plans, and describes the challenges faced by the sector.

**Chapter 3** considers the socio-economic context in which the energy sector operates, and the particular stresses that the energy sector imposes on the environment

**Chapter 4** describes the framework used to define the strategy: beginning with a vision statement, proceeding to strategic objectives, and analyzing the strategic building blocks of supply, demand, and resource allocation priorities.

**Chapter 5** describes and explains the INES economic plan. It evaluates that plan against the defined INES policy objectives, and assesses its risks and sensitivities.

**Chapter 6** turns to the institutional dimension of INES, describing at a strategic level the legal and institutional initiatives needed to implement effectively the plan described in Chapter 5.

**Chapter 7** lays out a timeline of steps required by INES, defines the key metrics by which progress should be assessed, and recommends a structure for providing on-going INES oversight, execution, and coordination.

The INES is designed to provide a common strategic agenda for the various entities involved in directing and managing Iraq's energy sector. Major planning efforts are still required to develop the technical, budgetary, and organizational details of this strategy. Decisions regarding site locations, infrastructure configuration, environmental remediation, and many other issues need to be made on the basis of detailed technical analysis. INES provides a framework for these further studies and decisions, and specifies many of the subjects they need to address, but it is not a substitute for them.

The current narrative document summarizes INES findings, analyses, and recommendations. The appendices to this document provide further supporting detail. The narrative and appendices together constitute the final INES report.

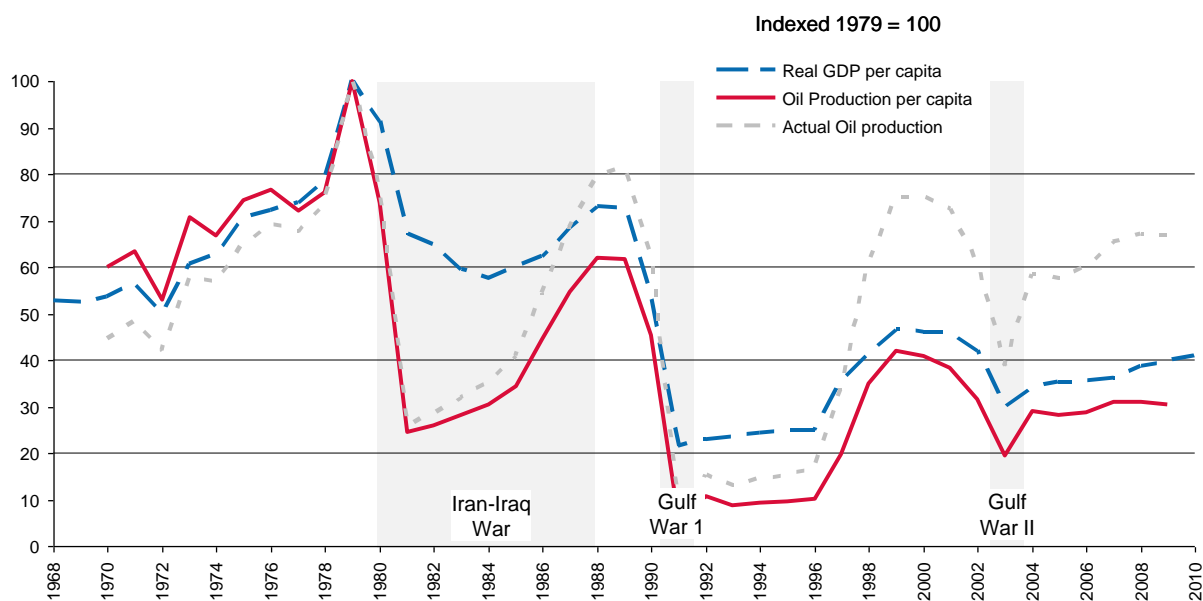
## 2. Baseline of the Energy Sector in Iraq

### 2.1. Overview

Iraq's overall economy is closely linked to the performance of its energy sector. Thirty years of intermittent warfare and international sanctions have substantially degraded both. Iraq today has oil and gas reserves that rank among the world's largest, yet the infrastructure needed to take advantage of these resources is in disrepair, industries that depend on these resources are virtually non-existent, and Iraq's electric power system is chronically unable to meet demand.

The link between Iraq's erratic oil production and its economic performance is shown in Exhibit 2-1. Today 45 percent of Iraq's GDP and 90 percent of the federal government's revenue come from oil exports. Iraq's prosperity depends on a sustained revival of oil production and prudent use of the wealth it creates. In the long run, as prosperity takes hold, diversification of economic activity will attenuate this dependency, but for the foreseeable future Iraq's energy industry is vital to Iraq's social and economic development.

**Exhibit 2 - 1: Linkage between Iraqi Oil Production and Prosperity**



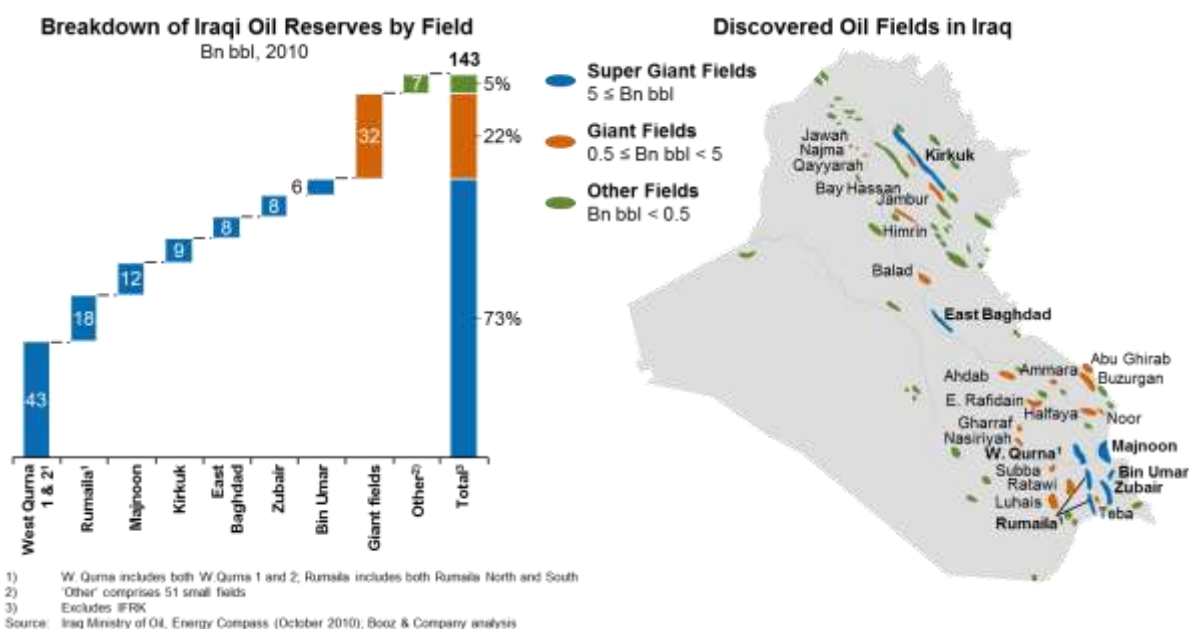
Source: UN, CSO; Booz & Company analysis

This chapter of the INES report describes briefly the challenges presented by the various components of Iraq's energy sector and what measures are currently under way to address those challenges. Based on this assessment, it identifies the one or two primary strategic choices that each energy subsector presents. Although these challenges and strategic choices are categorized under separate subsector headings, they are interconnected. To address any one of them effectively requires addressing all of them. Subsequent chapters of the report recommend how that can be done.

## 2.2. Upstream Oil Subsector

Iraq estimates that it has 143 billion barrels of conventional oil reserves,<sup>1</sup> the third largest national reserve of conventional oil in the world after Saudi Arabia and Iran. Three-quarters of these reserves are concentrated in seven super-giant fields: West Qurna, Rumalia, Majnoon, Kirkuk, East Baghdad, Zubair, and Bin Umar. All of these fields except Kirkuk and East Baghdad are located in the country's southern region. Iraq's oil resources have not yet been fully explored, and they may turn out to be much greater than current estimates, possibly in excess of 200 billion barrels.<sup>2</sup>

Exhibit 2 - 2: Iraq's Oil Reserves

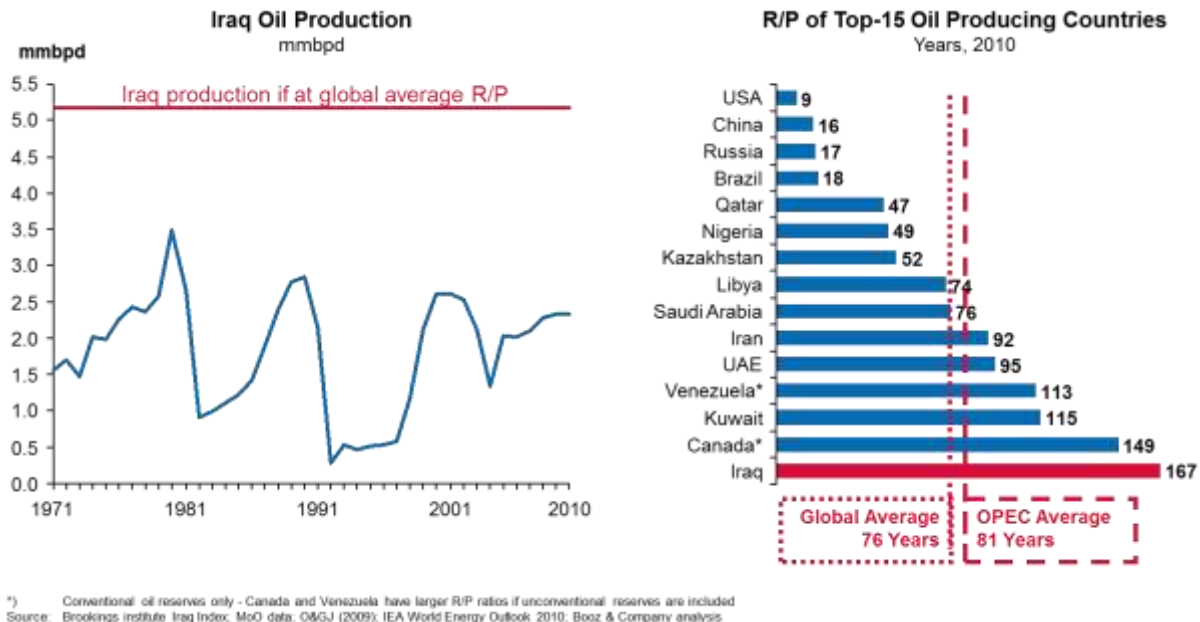


Iraq's oil production does not reflect the vastness of its oil reserves. In 2010 Iraq's ratio of reserve levels to annual production (R/P) was 170 years, more than twice the global average of 75 years. At the global average R/P ratio, Iraq would produce more than 5 million barrels per day (mmbpd) of crude oil. Iraq has never reached that level, and its peak production of 3.5 mmbpd reached in 1979 has not been matched since then. Production in 2010 stood at 2.3 mmbpd, and in 2011 grew to 2.7 mmbpd. 80 percent of current production comes from only four fields: Rumaila, Kirkuk, West Qurna, and Zubair. Rumala and Kirkuk are the most mature of these fields with R/P ratios of around 45 and 80 years respectively; all other fields have R/P ratios greater than 100 years with significant potential for production growth.

<sup>1</sup> This estimate was announced in 2010. Iraq's reserves declarations are not strictly aligned with the Society of Petroleum Engineers' (SPE) framework for classifying oil resources.

<sup>2</sup> Estimates by the United States Geological Survey (USGS). Three quarters of Iraq's discovered resources are located in Cretaceous geological strata and the rest in Tertiary strata. Deeper and older Jurassic and Paleozoic horizons, which are producing in neighboring Kuwait, have not yet been tested in Iraq. Moreover, nearly one-third of Iraq's land area, mostly in the Western Desert, has not yet been explored for oil.

## Exhibit 2 - 3: Historic Iraqi Underproduction



In the past three years Iraq has taken major steps to increase future production. The federal government has awarded technical service contracts (TSC's) to several major international oil companies in order to develop or increase production from twelve large oil fields. Four contracts were awarded in June, 2009, in a bidding process known as Round 1. Seven additional contracts were awarded in December, 2009, in a bidding process known as Round 2. Round 1 contracts were designed to enhance the development of oil fields already under production, while Round 2 contracts were designed to develop new fields.<sup>3</sup> Prior to these bidding rounds Iraq already had entered into a TSC contract to develop the Ahdab field.

The federal government has used a TSC mechanism in order to comply with Constitutional restrictions against transferring ownership of Iraq's petroleum resources to third parties. The Iraq Federal Region of Kurdistan (IFRK), meanwhile, has taken a different approach to oil field development. Rather than using TSC's it has instead entered into production sharing agreements.<sup>4</sup>

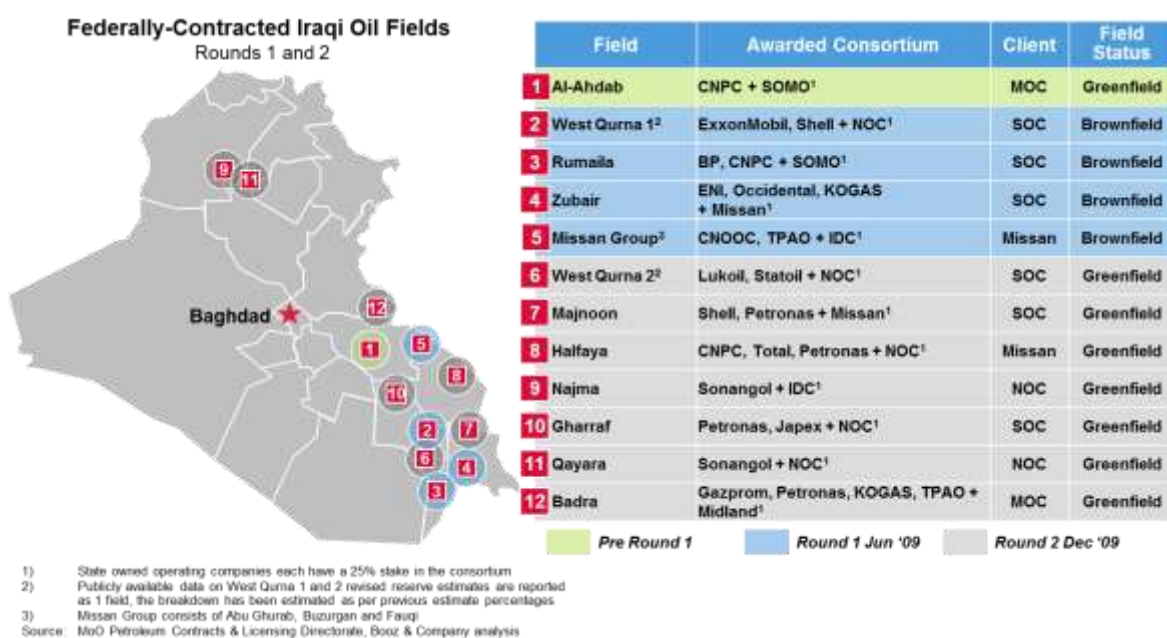
<sup>3</sup> Two of the Round 2 fields, Majnoon and Qayyarah, already were producing small amounts of oil, but nonetheless were treated as new fields for TSC purposes.

<sup>4</sup> Production Sharing Agreements (PSA's) and Technical Service Contracts (TSC's) are alternative methods for enlisting the services of international oil companies (IOC's) in developing a country's oil resources. Under a PSA the IOC receives a share of the oil it produces sufficient to cover its costs, and then an additional predetermined share beyond that. It thereby holds a defined ownership interest in the oil. The IOC funds exploration and development at its own risk, but has an incentive to take reasonable risks since it has a share in the production. The IFRK has used this mechanism for its development program, issuing 25 separate agreements, mostly for exploration blocks.

Under a TSC, by contrast, the government retains all ownership rights in the oil. It contracts with the IOC to perform development services and compensates the IOC through payments covering the IOC's capital and operating cost, plus a negotiated service fee typically depending on volume produced. Since any transfer of ownership over Iraqi oil resources raises Constitutional issues of sovereign control over resources, and requires Parliamentary approval, a TSC provides a way of entering into development contracts without case-by-case Parliamentary action. Consequently it has been the method preferred by Iraq's federal government.



## Exhibit 2 - 4: Field Development Technical Service Contracts



In both bidding rounds, contracts were awarded partly on the basis of proposed remuneration fees per barrel of oil produced, and partly on the basis of production volume commitments. Each consortium was asked to commit to a plateau production target that it could achieve by 2017 and sustain thereafter for a specified plateau period.<sup>5</sup> In its tenders, Iraq stated that it expected an aggregate minimum plateau production commitment of approximately 6 mmbpd. Aggressive bidding in both rounds by oil companies eager to establish a foothold in Iraq resulted in a far higher level of commitment, amounting to 12.5 mmbpd.<sup>6</sup>

These production commitments have been undertaken by several of the world's largest and most experienced oil companies, and it must be assumed that they are achievable. However, several of the oil fields under contract are in the early stages of development, and some uncertainty in ultimate production levels and in the timing of production ramp-up is inevitable. Moreover, Iraq does not yet have the detailed oil-field information it needs to confirm reserve volumes or to decide what rate of extraction is optimal for long-term reservoir management.

Substantial infrastructure development is needed as well. Many of the oil reservoirs under development require water injection, but the water supply and treatment infrastructure needed for that purpose are not yet available. In addition, export pipelines and terminals must be refurbished and expanded to handle increased production volumes.<sup>7</sup> Production ramp-up on the scale contemplated increases greatly the complexity of supply chains. All of

<sup>5</sup> Round 1 plateau periods are 7 years. Round 2 plateau periods range from 7 to 13 years.

<sup>6</sup> This figure applies to fields under TSC development, and excludes forecasted oil production from IFRK fields and from the Iraq Ministry of Oil's self-operated fields.

<sup>7</sup> Substantial progress is being made in these areas, particularly with respect to export infrastructure. Two new single-point mooring stations are now operational and a third is currently being installed. Contracts have been signed for expansion of other offshore facilities.

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these needs impose a substantial institutional burden, challenging the Government of Iraq to streamline processes, facilitate logistics, and provide timely and efficient contract review and approval.

Independent projections by industry analysts vary widely in light of these uncertainties, but all fall well below the levels committed to under the TSC's. For these reasons a range of production scenarios is needed for planning purposes.

In order to develop these scenarios, an assessment has been made of each TSC oil field based on available data regarding reservoir quality and field complexity. Benchmark data have been combined with these assessments in order to develop field-by-field expected recovery factors and depletion rates, expressed as a low-high range of plausible outcomes. These outcomes then have been applied to two different field reserve estimates - - the 115 billion barrels of reserves that can be classified as proven under SPE standards, and the 143 billion barrels that include also contingent reserves. These calculations have yielded a plausible range of plateau production levels.

The time needed for reaching these plateau levels has been estimated in light of the number of wells required and the corresponding need for mobilizing rigs, securing permits and approvals, and managing supply logistics. International oil project databases have been consulted to identify the range of project delays experienced in the past by projects comparable in scope to those covered by Iraq's TSC's.

Combining the likely range of plateau production levels and the likely range of ramp-up rates yields a range of potential production profiles. Three have been chosen that are sufficiently divergent to serve as a basis for scenario planning and sensitivity testing. The production ramp-up rate and plateau level stipulated in the TSC contracts are taken to represent the High production profile. The slowest ramp-up rate and the lowest projected production plateau provide the Low production profile. These high and low profiles provide the boundaries within which aggregate production is likely to fall. Approximately half-way between them is the Medium production profile. This profile assumes a ramp-up rate at the mid-point of the expected range, and a plateau level that combines high recovery and depletion rates with the low reserve estimate.<sup>8</sup>

These INES production profiles comprise production from the twelve TSC oil fields, the Iraqi self-operated fields, and the IFRK fields. Production from self-operated fields is expected to provide approximately 0.8 mmbpd by 2015, and production from IFRK fields is expected to provide another 0.5 mmbpd.<sup>9</sup> These expectations are the same across all three production profiles. The differences between INES production profiles are attributable to different scenarios for TSC production.

In the High production profile, which aligns with the 12.5 mmbpd contractual commitments of the twelve TSC oil fields, a total plateau production of 13.5 mmbpd is reached by 2017 and

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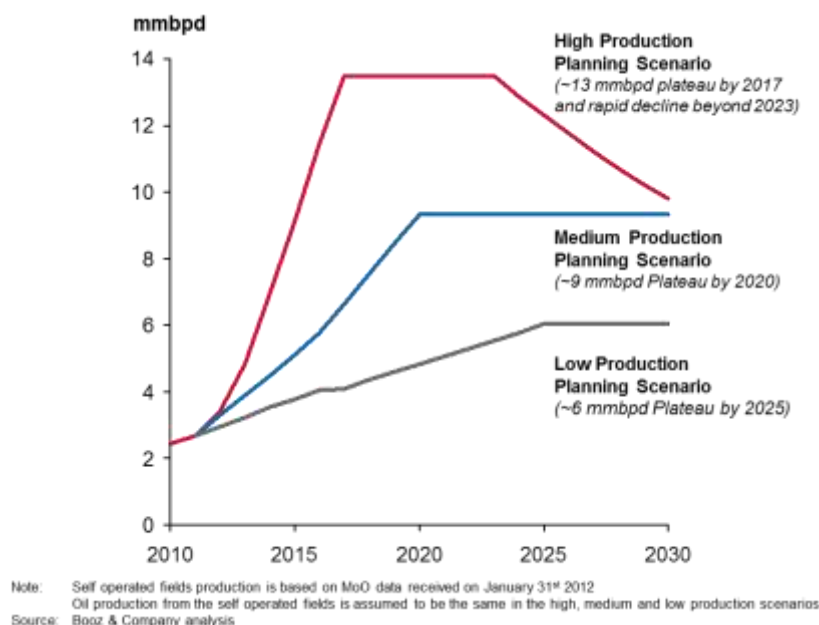
<sup>8</sup> Further details of this analysis and a comparison with the Preliminary Development Plans submitted by oil field operators are provided in Appendix A.

<sup>9</sup> The INES projection regarding the IFRK production is an estimate based on interviews with Kurdistan officials, news reports and the Consultant's views. Official data regarding the IFRK production plans has not been made available. As new data is released, this estimate likely will need to be modified. Any such modification should be reflected in the overall Iraqi production profiles described here.



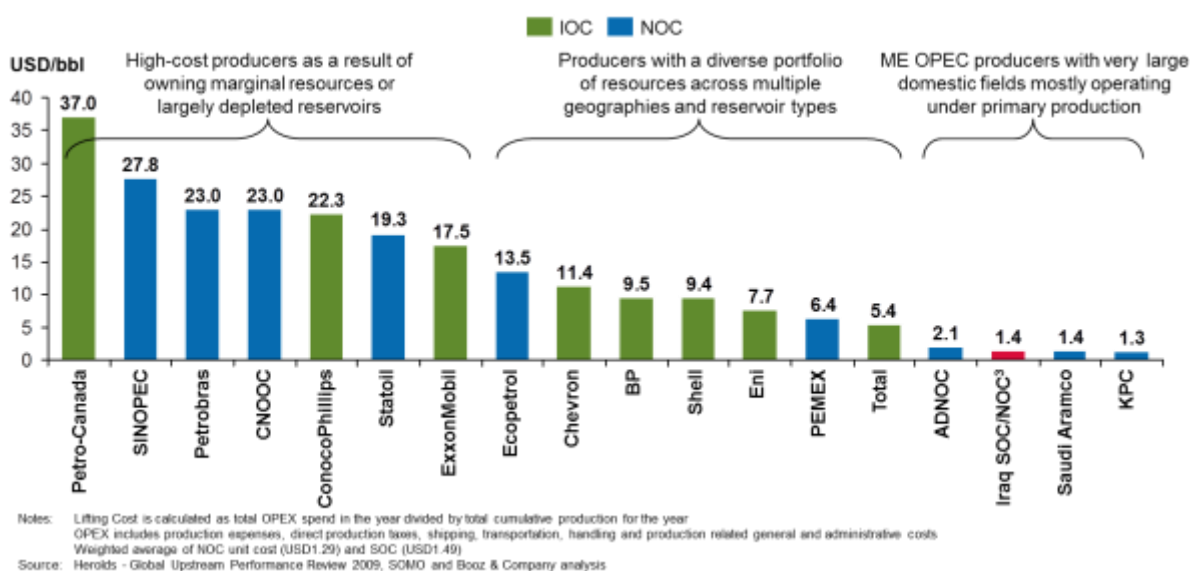
is maintained until 2023, after which production declines rapidly. In the Medium production profile, a total plateau production of 9 mmbpd is reached by 2020 and is maintained through 2030 (the end of the INES planning period). In the Low production profile, a total plateau production of 6 mmbpd is reached by 2025 and is maintained through 2030.

**Exhibit 2 - 5: Oil Production Profile Planning Scenarios**



Iraq's cost of oil production is among the lowest in the world. In 2009 it was approximately \$1.40 per barrel, equivalent to production costs in Saudi Arabia and Kuwait. With future increases in production and capital investment, this cost per barrel will rise, but it is expected nonetheless to remain far below the marginal cost of production that sets world oil prices.

**Exhibit 2 - 6: Lifting Costs of Major NOCs and IOCs (2009)**



Framing Iraq’s current upstream oil situation in terms of strengths, weaknesses, opportunities, and threats yields the following picture:

### Exhibit 2 - 7: Upstream Oil SWOT

<p><b>Strengths</b></p> <ul style="list-style-type: none"> <li>▪ The world’s third-largest conventional oil reserves</li> <li>▪ One of the world’s last sources of large volumes of untapped conventional oil</li> <li>▪ Significant cost advantage over other potential sources of new oil</li> <li>▪ Contracted production commitments from the world’s leading oil companies and a mobilizing array of equipment and service companies</li> </ul>	<p><b>Weaknesses</b></p> <ul style="list-style-type: none"> <li>▪ Limited seismic and well data, creating uncertainty regarding attainable production levels</li> <li>▪ Underdeveloped infrastructure for water injection</li> <li>▪ Underdeveloped infrastructure for oil evacuation</li> <li>▪ Underdeveloped logistics support for supplies of equipment and personnel</li> <li>▪ Little administrative experience in managing and coordinating a rapid expansion of production from multiple fields</li> </ul>
<p><b>Opportunities</b></p> <ul style="list-style-type: none"> <li>▪ Substantial world market for crude oil due to growing gap between worldwide demand for oil and supplies from existing fields</li> <li>▪ Significant room for expansion of Iraqi production, given Iraq’s high reserves-to-production ratio</li> <li>▪ Significant possibility of growth in oil reserves from future exploration and from expansion of deeper drilling horizons</li> </ul>	<p><b>Threats</b></p> <ul style="list-style-type: none"> <li>▪ Diminished total potential from major oil fields due to early overproduction</li> <li>▪ Drop in world oil price due to short-term oversupply</li> <li>▪ Strains on supply chains for services and equipment due to rapid ramp-up</li> <li>▪ Bottlenecks in contract oversight and support</li> </ul>

These circumstances present one strategic choice:

- **Crude oil production:** What ramp-up pace and plateau production level to target in order to optimize production sustainability, revenue, and sound reservoir management.

### 2.3. Downstream Oil Subsector

The downstream oil sector comprises three broad activities: commercializing crude oil as an export product, refining crude oil into oil products suitable for domestic use and export, and distributing refined oil products to domestic customers.

**Crude oil commercialization.** Iraq exports two grades of crude oil – “Basra Light” and “Kirkuk,”- with API specifications of 34<sup>0</sup> and 36<sup>0</sup> and sulfur contents of 2.9% and 2.3% respectively.<sup>10</sup> These grades are recognized light-crude brands in world markets.

<sup>10</sup> API ratings were established by the American Petroleum Institute to describe on an arbitrary but uniform scale the density of oil, expressed in terms of degrees API. The lower the specific gravity of

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Basra Light is produced primarily in the southern fields of Rumaila, West Qurna, Zubair and Missan. In 2010 Basra Light production was 1.8 mmbpd, of which 1.5 mmbpd were exported. This export crude is evacuated to terminals in Basra. From there it is shipped through the Arabian Gulf and then routed either to the east to Asian markets, or to the west, through the Suez Canal or around the Cape of Good Hope, to European and North American markets.

Kirkuk is produced primarily from the northern fields of Kirkuk, Jambour, and Bai Hassan. In 2010, the total production of Kirkuk was 575 kbpd, of which 412 kbpd was evacuated through a pipeline from Kirkuk to Ceyhan on the Mediterranean. From there Kirkuk is shipped to European and North American markets.

Until recently, the export capacity at Basra has been limited to 2 mmbpd, and pipeline capacity into Turkey has been limited to 0.7 mmbpd. This evacuation capacity has been sufficient for Iraq's export production levels through 2011, but will need to be expanded to accommodate increased production. Iraq's Ministry of Oil (MoO) proposes to rehabilitate the Khor al Amaya and Al Basra oil terminals in the South to a total possible capacity of 3.2 mmbpd, and to install four single-point mooring buoys (SPM's), each providing an additional capacity of 0.9 mmbpd. Two of these SPM's and their pipelines linkages have recently been commissioned. In the North the MoO proposes to bring the capacity of the Turkey pipeline up to 1.6 mmbpd through a program of rehabilitation and expansion managed collaboratively with Turkey.

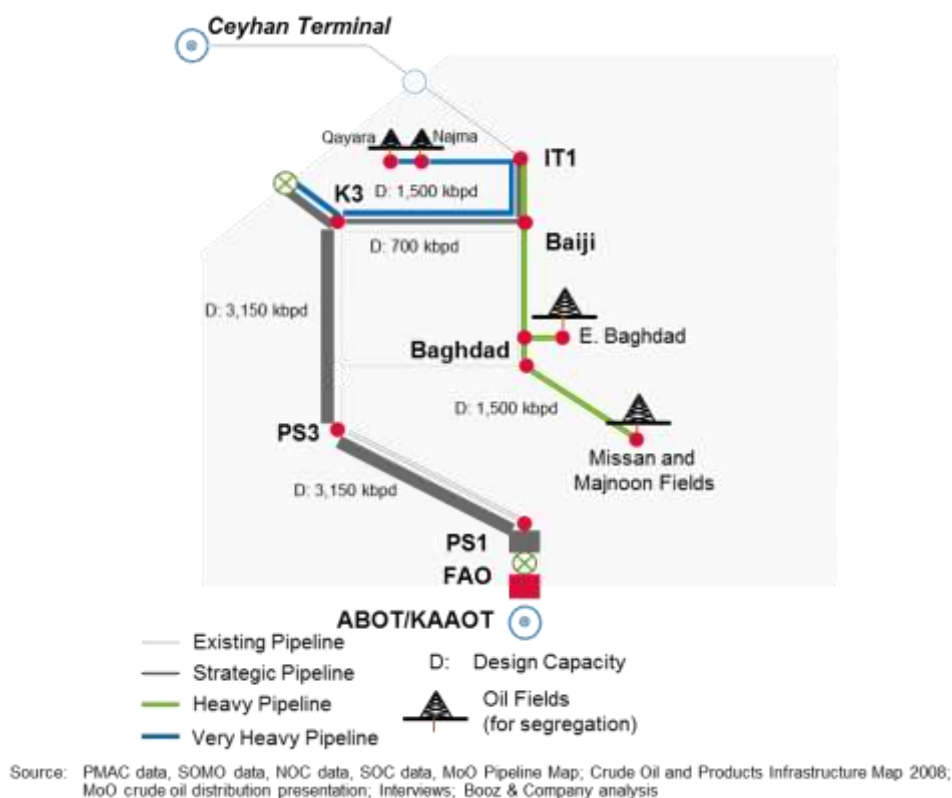
The interior North-South Strategic Pipeline connecting Iraq's two export points, the Mediterranean and the Arabian Gulf, is currently inoperable due to war damage. Consequently Iraq today has no flexibility to divert production from one export point to another. The MoO plans to re-establish this north-south link. An export route through Syria is also contemplated, involving the rehabilitation and expansion of an existing but damaged regular crude pipeline (2.2 mmbpd of capacity) and the development of a new heavy crude pipeline (1.5 mmbpd of capacity).

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oil (or the greater its tendency to float on water), the higher is the API rating, and (other things being equal) the higher the price it commands in world markets.

Sulfur is corrosive, and typically needs to be removed from oil during the refining process. For this reason, low-sulfur crude (sweet crude) sells for a higher price than higher-sulfur crude (sour crude). API rating and sulfur content together largely determine the price differential of a particular crude brand compared with benchmark brands like Brent or West Texas. An API rating of 34-36<sup>0</sup> is moderately light, and a sulfur content of 2.3 - 2.9 percent is moderately sour.

## Exhibit 2 - 8: Planned Expansion of Iraq's Oil Evacuation System

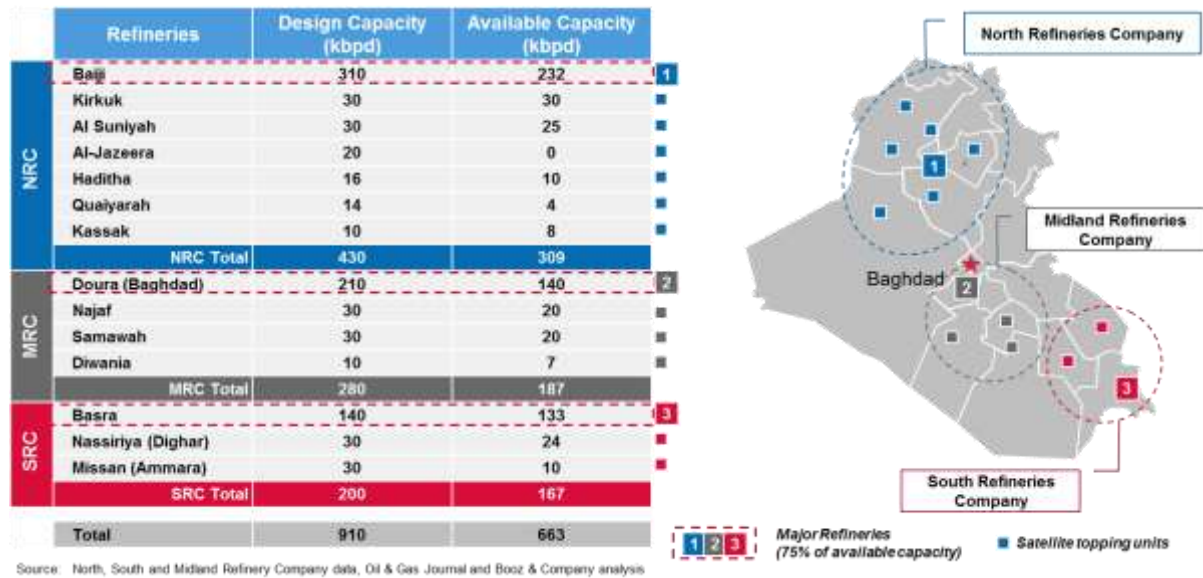


Production increases will require Iraq to formulate a grade segregation strategy. The new reservoirs that are to be tapped under existing production plans contain significantly heavier oil than the reservoirs currently in production. As production increases, therefore, so will the average density of Iraqi oil. Iraq can either accept a deterioration in API rating and rebrand its current offerings, or it can segregate the new heavy production into one or more separate grades while preserving the specifications of the existing brands.

Iraq also will need to apportion its crude production among potential global markets. The rehabilitation of the North-South pipeline link and the expansion of export capacity at both ends will give Iraq new possibilities for choosing export routes and markets. The highest "netbacks" (sales revenue minus cost of transport) are available from export to Asia. Continued export to Europe and North America, on the other hand, preserves market diversity and reduces Iraq's exposure to the geopolitical circumstances and economic fluctuations of one particular global region. Iraq's choice of markets and routes will reflect the relative importance it assigns to these different benefits.

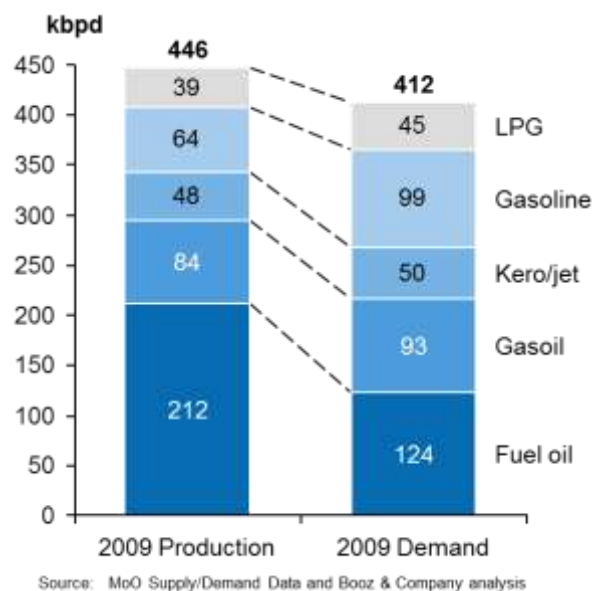
**Oil refining.** Approximately 20 percent of Iraq's current crude production is refined into products for domestic consumption. Iraq today has major refineries in three locations - Beiji, Daura, and Basra - each supported by a cluster of satellite topping units.

**Exhibit 2 - 9: Current Refinery System (2010)**



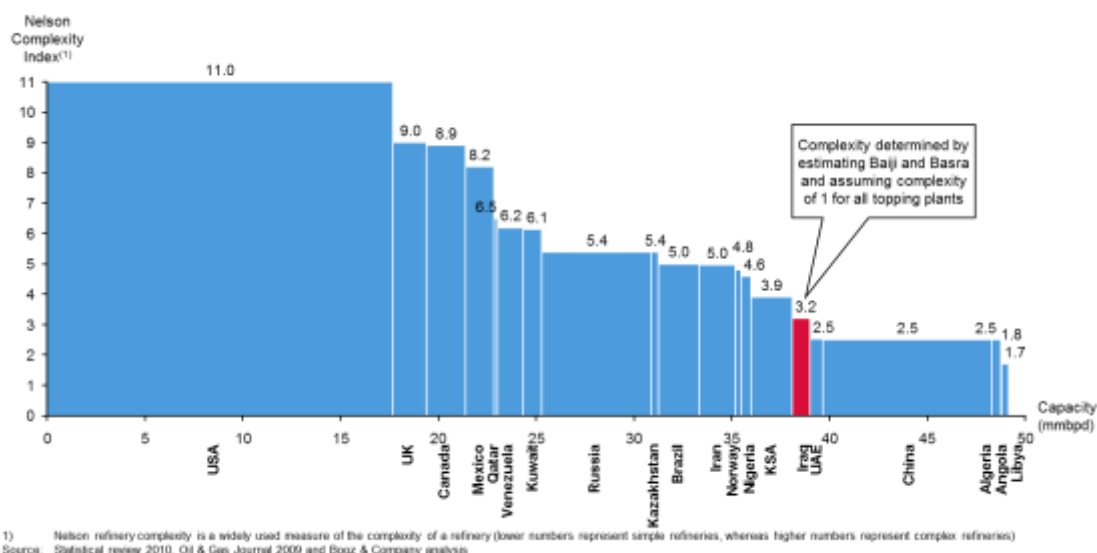
The aggregate design capacity of these refineries is 900 kbpd, but due to extensive disrepair the aggregate available capacity is only 660 kbpd. Even at this reduced level of available capacity, Iraq's total refinery output is more than the country's aggregate domestic demand of 412 kbpd, but the components of demand and production are not aligned. Iraq produces far more fuel oil than is needed domestically and less gasoline, gasoil, and LPG than is needed. This undersupply of gasoline, gasoil, and LPG creates a substantial import requirement, with a net annual cost to Iraq in 2009 of approximately \$250 million. Moreover, the gasoline that Iraq's refineries do produce is of poor quality, characterized by high sulfur content, lead additives, and low octane ratings. Fuel oil on the other hand is produced in excess of demand, and because of fuel oil distribution bottlenecks much of the fuel oil that could be used is stranded. Consequently much of the fuel oil produced by Iraqi refineries is simply blended back into crude oil.

**Exhibit 2 - 10: Misalignment of Domestic Supply and Demand for Refined Products**



These two problems of production misalignment and poor product quality are attributable to the design of Iraq’s existing refineries. These refineries are simple in configuration. They lack deep conversion units such as catalytic crackers and cokers, and have limited ability to remove sulfur from oil products or to produce high-octane gasoline.<sup>11</sup> The MoO is currently addressing some of these issues by upgrading existing refineries with the addition of isomerization and other upgrading units capable of producing higher octane gasoline.

**Exhibit 2 - 11: Refining Capacity vs. Complexity**  
Top 20 Oil Producing Countries (2009)



Through further upgrade and expansion of some existing facilities, elimination of others, and construction of new facilities, the MoO plans to increase Iraq’s available refining capacity to approximately 1.45 mmbpd by 2019 and improve refinery configuration. Efforts to attract private-sector investment in this program have not been successful to date, most likely due to insufficient investment incentives.

**Distribution.** The existing system for domestic distribution of Iraq’s refined oil products poses challenges in four areas.

- **Transportation.** The capacity of pipelines for transporting “white products” (kerosene, gasoil, and gasoline) is well below production of these products. Consequently, until recently approximately two-thirds of transport from refineries to

<sup>11</sup> Refineries become more “complex” as they acquire additional processing capabilities that can separate useable oil products from increasingly heavy residues. The lowest complexity refineries go no further than to separate oil products according to their different boiling points through atmospheric distillation. A higher complexity refinery incorporates additional downstream processes such as vacuum distillation, fluid catalytic cracking, hydrocracking, and coking that increase the yield of light distillates and improve their quality. The level of complexity is typically expressed by means of the Nelson complexity index, which reflects the complexity and cost of a particular refining process and the amount of throughput associated with that particular process at a given refinery. The higher a refinery’s complexity index is, the greater the investment it represents, and the higher the value of its yield. A configuration that can perform only simple atmospheric distillation has a Nelson complexity index of 1.0.

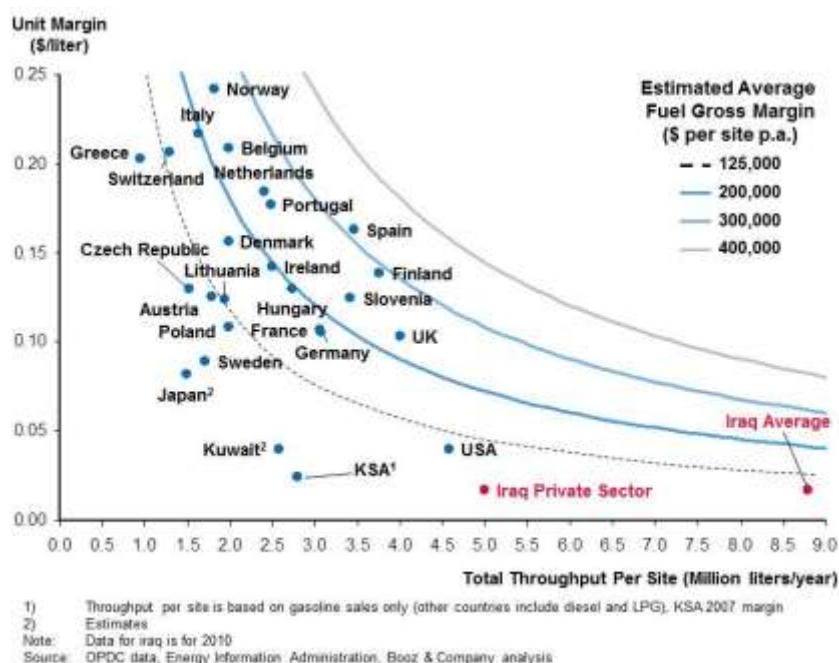


depots has occurred by truck rather than pipelines. Efforts are currently under way to address this problem, including the recent commissioning of a new Beiji–Hamam Al Alil pipeline. With respect to fuel oil, no significant pipeline network exists to connect production to consumption points. As a consequence, power plants that could use much of the excess fuel oil currently produced are forced instead to use crude oil or gasoil, each of which could be applied to more valuable uses.

- **Storage.** Storage capacity, especially for gasoline, is substantially less than the 60 days prescribed by IEA guidelines.
- **Metering.** Current metering systems are unable to track the flow of oil products effectively. Around 70 percent of the points in the distribution system where injections and withdrawals are made have no meters. An additional 10 percent of these points have meters that are not properly calibrated. Losses in the system are consequently impossible to track systematically, and transaction accounting is difficult. The MoO is currently working to improve control over custody transfer by adding more meters.
- **Retail service.** Iraq’s system for retailing fuel relies on two categories of fuel stations. The first consists of many privately owned stations selling small volumes of gasoline. The second consists of a few publicly owned stations managed by the Oil Products Distribution Company (OPDC), a state-owned enterprise under the jurisdiction of the MoO. Each of these OPDC stations sells relatively large volumes.

Margins for both types of stations are very low, at 1.3 US cents per liter for gasoil and 1.7 US cents for gasoline. Private-sector locations are generally less favorable than OPDC locations, and with small volumes they lack the cash flow needed to invest profitably in facilities or service. OPDC stations have on average five times the throughput of private stations, but that volume is often accompanied by long queues. The slow service, frequent run-outs, and dilapidated facilities of most retail stations lead to very low perceptions of retail service quality.

**Exhibit 2 - 12: Gasoline Retail Gross Margin vs. Throughput**  
Average of 2004 - 2008



The strengths, weaknesses, opportunities, and threats of the downstream oil sector may be characterized as follows:

### Exhibit 2 - 13: Downstream Oil SWOT

<p><b>Strengths</b></p> <ul style="list-style-type: none"> <li>▪ Planned expansion of crude oil supply</li> <li>▪ Northern and southern export routes providing access to Europe, North America, and Asia</li> <li>▪ Strong long-term world market demand for crude</li> <li>▪ Well branded crude grades</li> <li>▪ Three large refineries well distributed geographically</li> <li>▪ Ample availability of low-cost refinery feedstock</li> <li>▪ An existing domestic distribution network of pipelines and facilities</li> </ul>	<p><b>Weaknesses</b></p> <ul style="list-style-type: none"> <li>▪ Poor condition of crude pipeline network, with no link between north and south</li> <li>▪ Insufficient evacuation capacity to handle increased crude production levels</li> <li>▪ Poor condition and low availability of refining plants, leading to misalignment of oil product yield with demand and low quality of domestic gasoline and gasoil</li> <li>▪ Limited capacity and reach of the existing pipeline network</li> <li>▪ Suboptimal storage capacity</li> <li>▪ Poor quality of retail gasoline service</li> </ul>
<p><b>Opportunities</b></p> <ul style="list-style-type: none"> <li>▪ Future flexibility to redeploy exports from one geographic market to another</li> <li>▪ Improvement of product yield and quality through refinery construction and rehabilitation</li> <li>▪ Improvement in distribution efficiencies through pipeline construction, storage, and metering</li> <li>▪ Improvement in gasoline retail service through restructuring of economic incentives and introduction of regulatory standards</li> </ul>	<p><b>Threats</b></p> <ul style="list-style-type: none"> <li>▪ Delays in expansion of crude export facilities</li> <li>▪ Deterioration in grade of crude oil produced</li> <li>▪ Continuation of sub-standard refinery and distribution facilities and practices due to lack of attention or funding</li> </ul>

These circumstances present three strategic choices:

- **Crude oil segregation:** Whether to segregate heavier crude oil production to preserve the API degree of existing Basra and Kirkuk grades.
- **Crude oil commercialization:** What global markets to serve and what export routes to develop.
- **Refineries:** What capacity and configuration of refineries to develop, and what balance to strike among imports and exports of refined products.



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## **2.4. Natural Gas Subsector**

Iraq estimates that it holds approximately 112 Tscf of natural gas reserves,<sup>12</sup> an endowment that would make it the twelfth largest holder of conventional gas reserves in the world.

Seventy percent of Iraq's known reserves consist of "associated gas" - gas that is dissolved with crude oil underground and that needs to be separated from the oil as it is pumped to the surface. Iraq's associated gas reserves are concentrated in the South largely in the supergiant oil fields of Rumaila, West Qurna, Bin Umar, Majnoon, and Zubair.

Of the remaining known reserves, twenty percent consist of "non-associated gas" - gas from fields that have no substantial oil content - and ten percent consist of "dome-gas" - the gas cap on top of oil reservoirs. Most of this non-associated and dome gas is located in fields in the North of Iraq.

Beyond these identified reserves, Iraq has significant additional non-associated gas potential. Broad areas of Iraq especially in the western desert remain unexplored for natural gas, and many existing non-associated gas fields have yet to be fully explored at deep levels. With this additional potential, Iraq's total gas reserves could be as high as 280 Tscf, placing Iraq among the world's top five holders of conventional gas reserves.

Iraq produced 1.7 bscfd of gas in 2009, a figure that is low in light of the size of its reserves. A global average R/P ratio of 47 years would provide 6.5 bscfd.

Moreover, upwards of 40 percent of the gas currently produced is flared at the fields, a practice that not only wastes a valuable and needed resource but also creates significant air pollution and carbon release. This flaring occurs because most Iraqi oil fields lack the infrastructure needed to manage the transition of associated gas from wellhead to consumption. At each step in this transition Iraq's capabilities are severely compromised. Many of the southern oil fields lack gathering facilities. Gas processing facilities<sup>13</sup> throughout the country suffer from a chronic lack of adequate maintenance, and nearly half are inoperative due to damaged equipment. Much of Iraq's gas pipeline system is damaged, and gas flow into Iraq populous central region is particularly constrained.

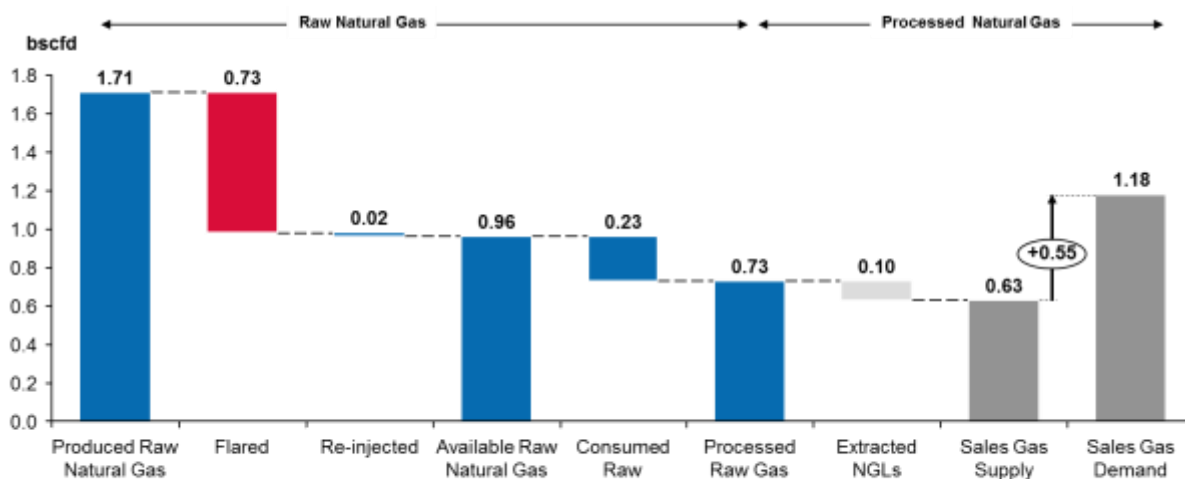
Because of these infrastructure deficiencies, Iraq has both an excess of gas at the fields and a deficit of gas at consumption points. In fact the amount of gas that currently is flared would be sufficient, if gathered and processed, to meet most of Iraq's currently unmet gas needs.

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<sup>12</sup> Natural gas reserves estimates provided by Iraq's South Oil Company and North Oil Company

<sup>13</sup> Processing facilities separates raw gas into commercially distinct components: methane (C<sub>1</sub>), ethane (C<sub>2</sub>), propane (C<sub>3</sub>), butane (C<sub>4</sub>), and light naphtha (C<sub>5</sub> to approximately C<sub>9</sub>).

## Exhibit 2 - 14: Utilization of Gas Produced in Iraq<sup>14</sup> (2009)



Source: SOG and NOC Data; Booz & Company analysis

Until the necessary system of gas infrastructure is installed, much of the gas released by oil production will remain stranded. The geological formation of Iraq's oil reservoirs precludes significant reinjection of gas into oil fields, and no underground locations have been identified that could store gas in significant quantity. As Iraq's oil production increases, more associated gas will be produced with nowhere to go, and the need for an infrastructure solution will become increasingly urgent.

The most obvious economic consequence of these poor infrastructure conditions is the loss attributable to flaring. In 2009 the value of gas disposed of by flaring was around \$3 billion.<sup>15</sup> There are other consequences as well. Iraq's processing facilities do not optimize the value of the gas they receive. Ethane, in which Iraqi gas is rich and which has high value for industry, is not exploited to its full potential and is consumed for less valuable uses in power production and heating. Similarly, liquid petroleum gas (LPG) remains for the most part mingled with less valuable sales gas.

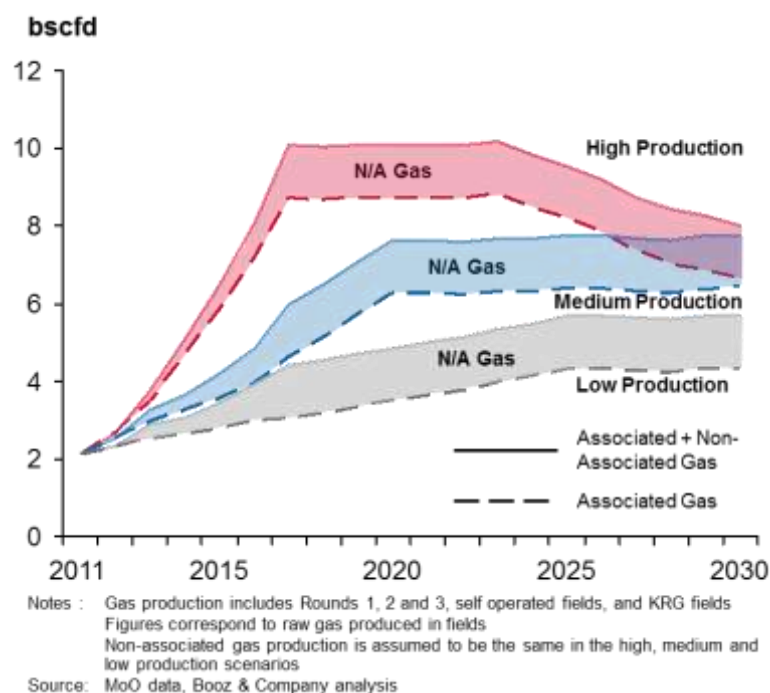
By far the greatest cost of Iraq's inadequate gas infrastructure, however, is the constraint it places on the rest of the economy. Today's shortage of delivered gas forces power plants to use more expensive and less efficient fuel substitutes like crude oil and fuel oil. It precludes altogether the introduction of efficient combined-cycle power plants. In industry, this shortage severely limits Iraq's potential to develop capacity in such industries as fertilizers, petrochemicals, steel, and aluminum that depend on gas feedstock and gas fuel.

<sup>14</sup> The gas quantities described are as follows: "Produced raw natural gas" is the volume of gas produced at the wellhead. "Flared" is the gas that is burned off at the wellhead because it cannot be handled otherwise. "Re-injected" is the gas that is injected into the oil fields to increase pressure and facilitate oil extraction. "Consumed raw" is the gas that is used at or near the oil fields before processing, typically to generate power required by field operations. "Processed raw gas" is the gas made available to processing plants, where it is treated and separated into "natural gas liquids (NGL's)," and "Sales Gas," otherwise known as "dry gas." Sales gas primarily comprises methane (C<sub>1</sub>), although in Iraq it also includes ethane (C<sub>2</sub>) and Liquid Petroleum Gas. Sales gas is consumed for fuel and heat by power plants, industry, commercial, and residential customers.

<sup>15</sup> At international prices of gas products for 2009

Because production levels for associated gas will track production levels of oil, the three profiles described above for future oil production yield three corresponding profiles for future gas production. Production of non-associated gas from existing northern gas fields and from Round 3 fields (Akkas, Mansuriya, and Siba) are expected to develop at a rate that will not be affected by the different oil production scenarios.

**Exhibit 2 - 15: Gas Production Profile Planning Scenarios**



To utilize these growing volumes of gas, the MoO requires TSC operators to capture and process the raw gas produced. For selected Round 1 fields (West Qurna 1, Rumaila, and Zubair) processing will be handled by the Basra Gas Company (BGC), a joint venture of Shell, Mitsubishi, and the South Gas Company.<sup>16</sup> For Ahdab, Missan, and Round 2 and Round 3 fields, gathering and processing will be handled by the operators of each field. Coordination will be required among these operators to establish an efficient system for gathering and processing from multiple fields.

The MoO has the responsibility for marketing and transporting gas products domestically once they leave the processing plants. It has developed plans for establishing a pipeline system connecting gas sources to gas demand nodes. Pipelines carrying LPG from North Gas and South Gas plants to gas bottling centers already exist, but they will need to be expanded to accommodate increased production. Pipelines to transport methane and ethane still need to be developed.

As these plans are implemented the supply of sales gas will increase dramatically. Depending on production levels, that supply may exceed domestic demand. The danger then arises that Iraq will find itself once again with stranded gas, due not to inadequate infrastructure as in the past but rather to sated domestic demand. In that event, it will be

<sup>16</sup> When produced, natural gas from these Round 1 fields becomes the property of the Southern Gas Company (SGC), a subsidiary of the Ministry of Oil. The BGC will buy the gas from SGC, process it, and sell the processed gas streams back to the SGC. The BGC has an option, however, to build and operate a 600 mmscfd LNG terminal, through which it will be able to sell gas directly to export markets.

appropriate to export gas through dedicated pipelines or through shipping in the form of liquefied natural gas (LNG). Significant demand for gas exists in neighboring countries, and markets for Iraqi export will almost certainly be available.

The strengths, weaknesses, opportunities, and threats of the natural gas sector may be characterized as follows:

**Exhibit 2 - 16: Natural Gas SWOT**

<p><b>Strengths</b></p> <ul style="list-style-type: none"> <li>▪ Vast domestic reserves of natural gas</li> <li>▪ Raw gas rich in valuable ethane and LPG</li> <li>▪ Plans for rapid expansion of gas production</li> <li>▪ Signed agreement with BGC for gas processing</li> </ul>	<p><b>Weaknesses</b></p> <ul style="list-style-type: none"> <li>▪ Inadequate gathering, compression, and processing infrastructure</li> <li>▪ Inability to deliver existing production to users</li> <li>▪ High levels of gas flaring</li> <li>▪ Limited separation of raw gas into its high-value components</li> <li>▪ Unsupportive natural gas pricing policy</li> </ul>
<p><b>Opportunities</b></p> <ul style="list-style-type: none"> <li>▪ A high reserve-production ratio, allowing for sustained growth in gas supply</li> <li>▪ High likelihood of major reserves in addition to those already identified</li> <li>▪ Strong, underserved domestic demand in economic sectors that can create high value for the country</li> <li>▪ Strong export potential</li> </ul>	<p><b>Threats</b></p> <ul style="list-style-type: none"> <li>▪ Failure to develop necessary infrastructure in time to accommodate rapidly increasing gas production</li> <li>▪ Failure to make timely export arrangements to dispose of gas supply in excess of domestic demand</li> <li>▪ Consequent increase in flaring and waste of a vital economic resource</li> </ul>

These circumstances present one choice:

- **Balancing gas production and demand:** How best to serve domestic needs and export opportunities, given volumes of production that are largely set by Iraq's oil production levels

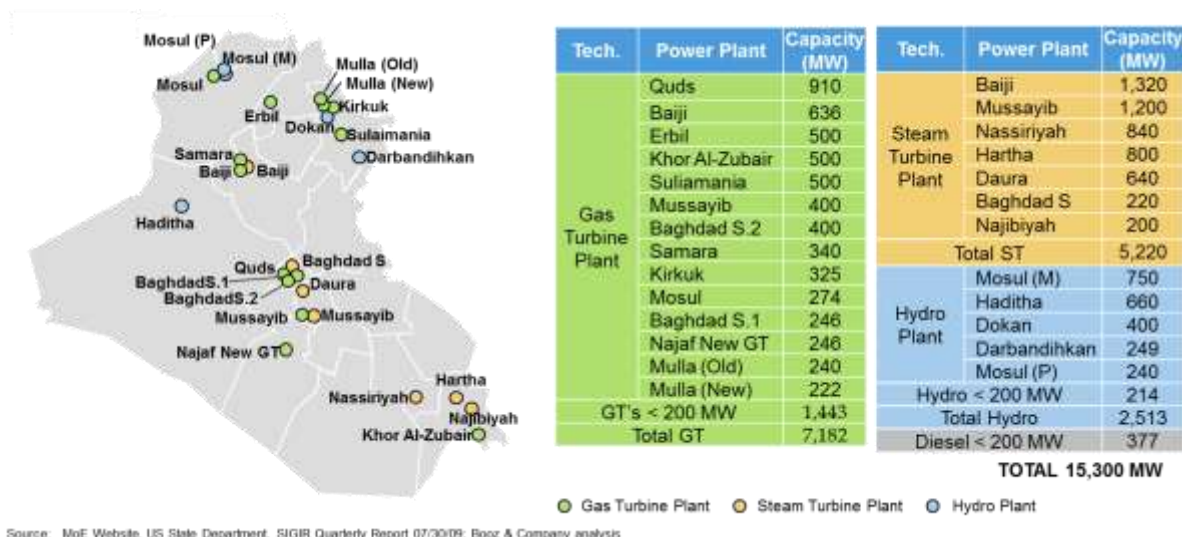
## **2.5. Power Subsector**

Iraq suffers from a severe shortage of electricity. In 2009 electricity supply was available on average only eight hours per day. This shortage imposes major costs on the economy in the form of lost production time, damage to capital assets from power interruption, and an inability to carry on normal commercial processes on a reliable schedule. In a country that experiences cold weather in the winter and extremely hot weather in the summer, the shortage of power also imposes significant hardship on individuals. The absence of reliable power supply from the grid has led to the widespread installation of private diesel generators, whose constant operation imposes high generation costs, creates noise, pollutes

the air, and emits large quantities of carbon into the atmosphere.<sup>17</sup> It is estimated that the total cost to the Iraqi economy attributable to this power shortage exceeds \$40 billion annually.

This shortage is attributable to numerous deficiencies throughout the electricity value chain. Iraq's current nameplate generation capacity is approximately 15 GW,<sup>18</sup> comprising gas turbines (47%), steam turbines (34%), hydropower plants (16%), and diesel generators (2%). This capacity is broadly distributed across the country.

**Exhibit 2 - 17: Power Plant Technology and Nameplate Capacity (2010)**

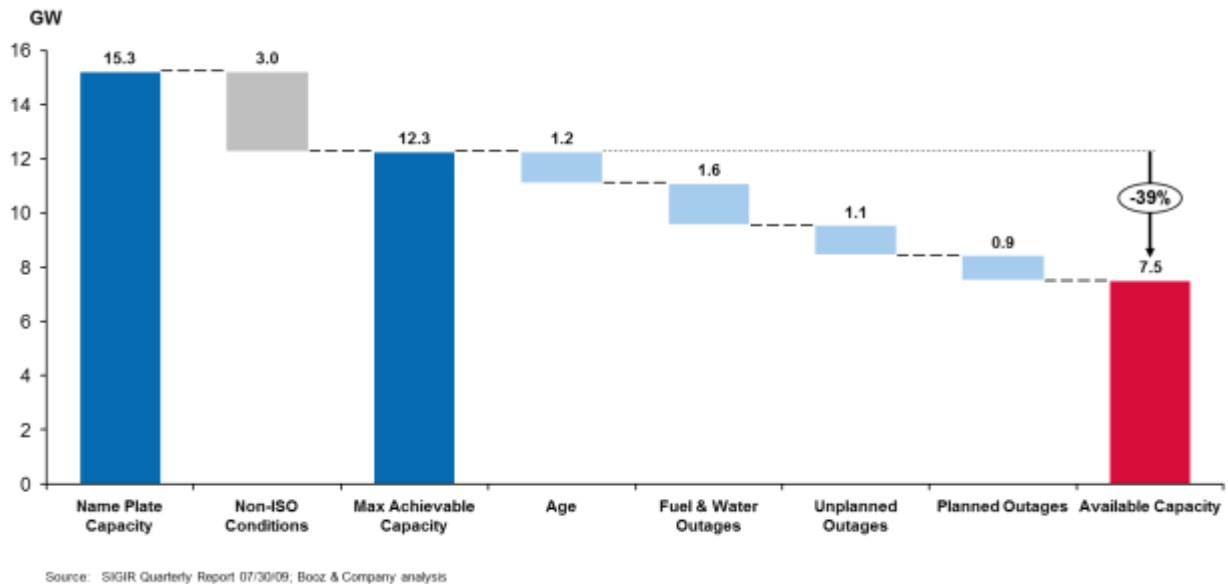


This nameplate capacity, however, is only partially productive. Due to non-standard operating conditions, fleet age, fuel shortages, and equipment outages, the actual capacity available for generation is only 7.5 GW. Even that capacity operates inefficiently due to underutilization and inadequate supplies of delivered natural gas. More than 50 percent of the fuel used to operate gas turbines, for instance, consists of gas oil, crude oil, and heavy fuel oil. These substitute fuels are not only more expensive than natural gas but also degrade the performance and useful life of generation equipment.

<sup>17</sup> Estimates of the number of private diesel generator units operating in Iraq today range from 55,000 to 80,000. These units generate an estimated 21 TWh of electricity per year, equivalent to 30% of total electricity output.

<sup>18</sup> Excluding private diesel generators

Exhibit 2 - 18: De-rating of Iraqi Power Plants (Q2-Q4 2009)



Iraq’s transmission network<sup>19</sup> connects 95 percent of the country’s population to the grid, but the task of maintaining that grid in the face of security threats has diverted attention from overall system improvement. High-voltage bottlenecks exist around power-plant clusters in the North, Center, and South of the country. High loads in the central region, particularly in Baghdad, exceed the transmission capacity available to serve them. Existing lines need to be reinforced, and additional lines need to be built in order to ease bottlenecks and to improve system connectivity and flexibility.

The distribution network<sup>20</sup> suffers from similar problems of overload and poor reliability due to haphazard growth, a shortage of spare parts, and a lack of standardized and systematic maintenance practices. These problems are compounded by the absence of effective metering and billing systems, which lead to rampant theft and gross under-collection of tariffs. Approximately 42 percent of dispatched energy disappears through technical losses, theft, or a failure to bill. Another 26 percent is delivered and billed, but the bills are not collected. Only one-third of the power dispatched by generators is ultimately paid for by customers. Per-kWh tariffs are set at levels that, even if fully billed and collected, would cover only 10 percent of fuel and operating cost.

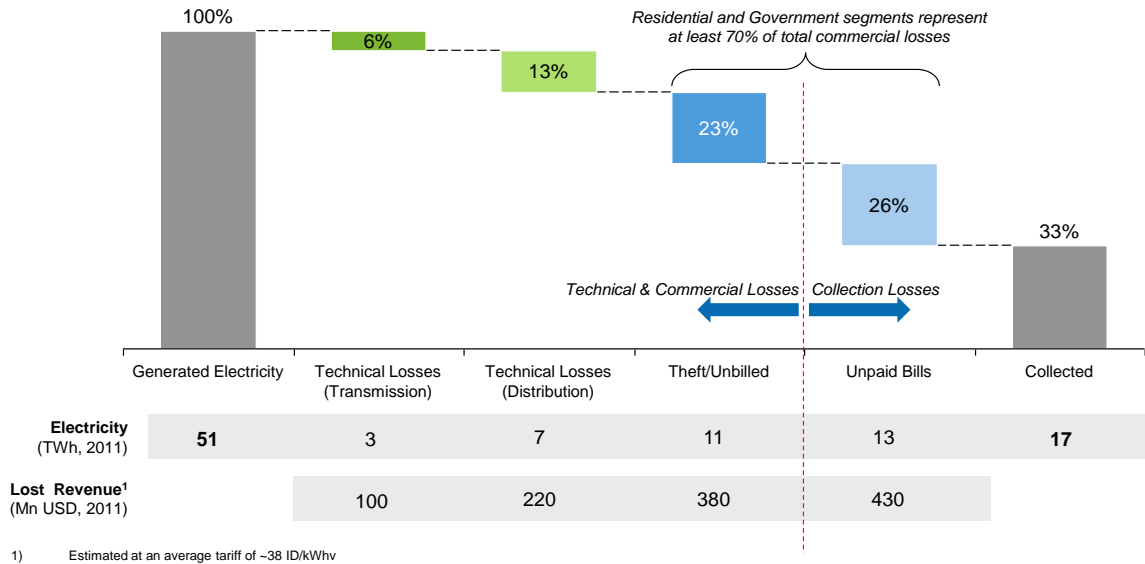
The power network is caught in a vicious cycle of under-delivery and poor reliability, leading to emergency fixes that impair long-term system integrity, and prompting desperate measures by users that further degrade the system.

<sup>19</sup> Iraq’s transmission network in 2010 comprised 4,600 km of 400 kV lines and 13,700 km of 130 kV lines.

<sup>20</sup> Iraq’s distribution network in 2010 comprised 10,000 km of 33 kV lines and 46,600 km of 11 kV lines.

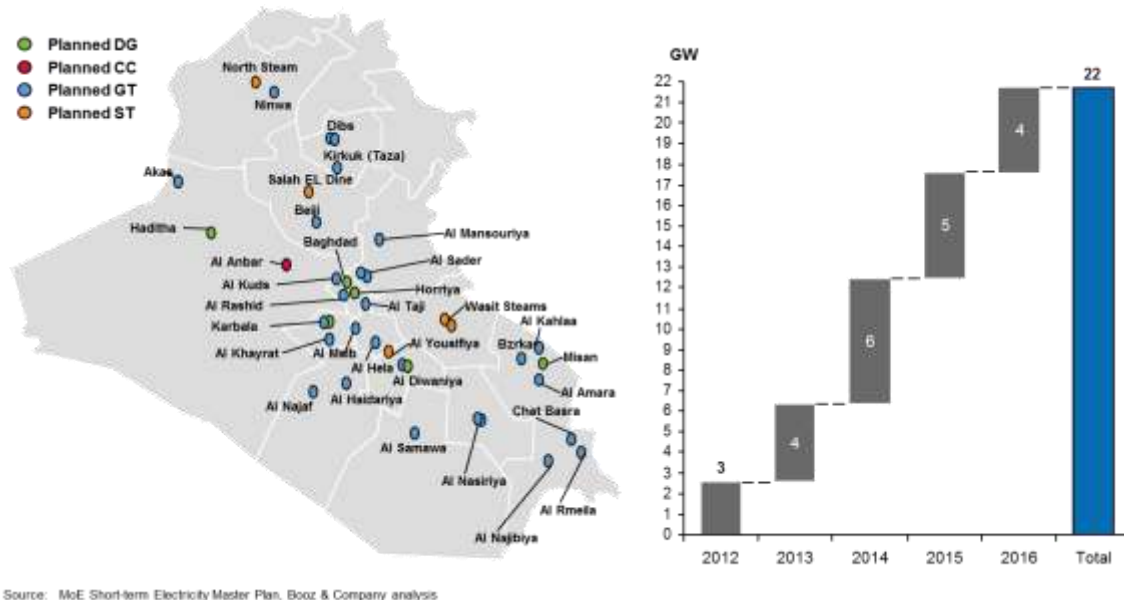


## Exhibit 2 - 19: Estimated Power System Losses



Unraveling this tangle of pathologies begins with generation. The MoE has committed to build sufficient generating capacity to close the gap between electricity supply and demand by the end of 2015, and to add sufficient additional capacity by the end of 2016 to provide a 15 percent reserve margin.<sup>21</sup> By then Iraq's unsuppressed peak demand is expected to reach 16 GW. In order to meet this power need, given current system inefficiencies, the MoE plans to construct 22 GW of new generation, to be added to the existing 7 GW of current effective capacity.

## Exhibit 2 - 20: Planned Power Plant Additions (2011-2015/16)

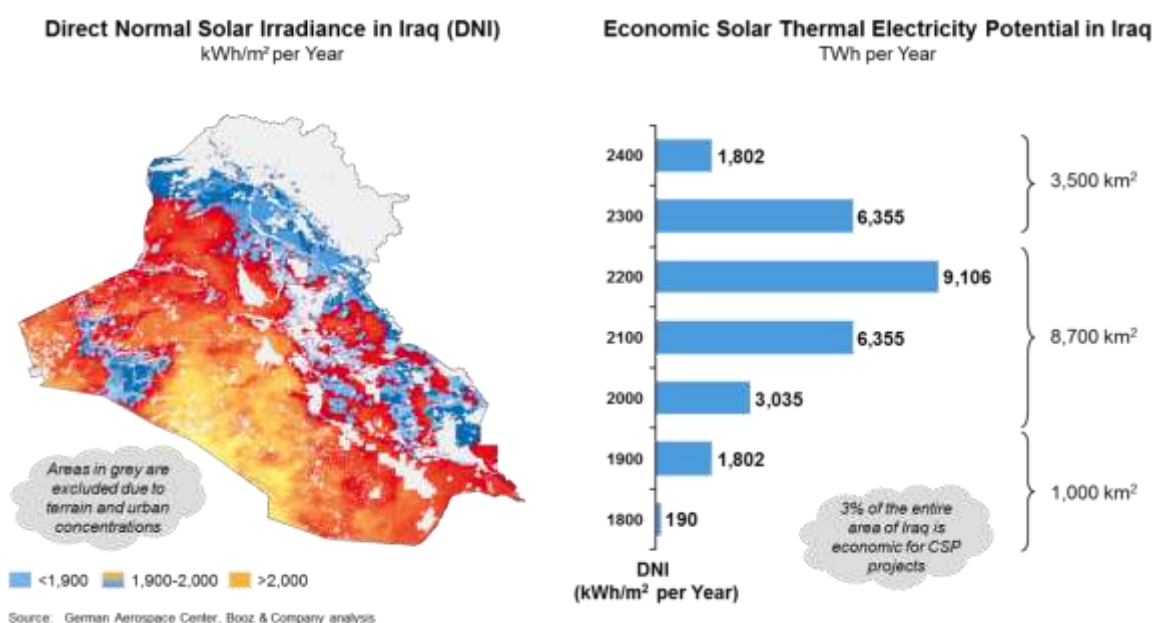


<sup>21</sup> "Reserve margin" is the percentage by which available capacity exceeds expected peak demand. Arithmetically, it equals the ratio of available capacity to peak demand, minus one. The size of the margin indicates the ability of power supply to meet demand in the face of random supply problems like forced outages or unscheduled maintenance. A 15 percent reserve margin is generally considered adequate to ensure close to 100 percent supply reliability.

This new capacity will comprise 40 new plants and will depend for fuel primarily on natural gas. However, only one of the new plants to be built during this period will be a combined-cycle plant and therefore exclusively dependent on natural gas. The remaining plants, even the gas turbines, will be capable of running on fuel oil when needed. This flexibility in fuel requirements will be important during the next few years, when gas infrastructure will be under development and gas supplies may continue to be restricted. Between 2011 and 2014 the overall composition of fuel used for power generation will shift only moderately, with gas rising from 22 percent to 33 percent of total production capacity. After 2015, when natural gas becomes more widely available, the composition of generation fuel will shift more strongly toward gas.

Iraq has the physical potential to provide abundant power from renewable resources. Approximately 13,000 km<sup>2</sup> of land in the southwestern region of Iraq receives sufficient direct solar irradiance to generate 2,000 or more kWh per year per square meter using concentrated solar power technology. In this 3 percent of its total land area Iraq has the physical potential to produce 29,000 TWh per year.

### Exhibit 2 - 21: Iraq's Solar Power Potential



Notwithstanding this physical potential, the cost of solar power production today is far too high for large-scale production to be economically feasible, especially in light of Iraq's abundant natural gas resources. On a smaller scale and for selected applications, however, solar power can be economic. The MoE plans to install 50 MW of hybrid solar and wind plants in 12 remote off-grid and 2 on-grid locations, where their cost is competitive with the cost of diesel generators.<sup>22</sup>

<sup>22</sup> The levelized cost of hybrid solar-wind generators at these remote locations is estimated to be approximately \$0.25 per kWh, consisting primarily of amortized capital cost. The levelized cost of diesel generators for the same locations is estimated also to approximate \$0.25 per kWh, consisting of amortized capital costs, diesel fuel cost, and long-distance diesel fuel transport. In view of this cost equivalence, the environmental advantage of solar-wind generation provides a solid rationale for its application in these circumstances.

Given Iraq’s physical potential for solar power generation, and the prospect of long-term declining capital costs in solar technology, the MoE also plans to pursue a pilot program of on-grid solar and wind projects. Its purpose is to develop the skills and applied understanding needed to take advantage of future solar technology developments.

The potential for hydropower is uncertain due to long-term declines in water supply from Iraq’s two main rivers and due to highly variable annual rainfall. Water resources in the north of the country offer some potential for hydropower; the Kurdistan Electricity Master Plan identifies opportunities for as much as 5 GW of hydropower development. However, the long lead time needed for hydropower projects and the need to establish interconnections in order to transmit power from sources within the IFRK to the rest of Iraq suggest that this potential is long-term rather than immediate.

In parallel with its overall program of generation expansion, the MoE plans to strengthen the existing transmission grid and connect it to the new generating plants. It plans also to rehabilitate and reinforce the existing distribution system and to expand it as needed to serve new load. Once a reasonable level of supply reliability is established, the Ministry will be in position to address critical commercial issues: continuing the shift to more efficient generation technology, reducing theft, improving collection, bringing tariffs closer in line with actual costs, and promoting energy efficiency.

The strengths, weaknesses, opportunities, and threats of the power sector may be characterized as follows:

**Exhibit 2 - 22: Power SWOT**

<p><b>Strengths</b></p> <ul style="list-style-type: none"> <li>▪ An existing system of transmission and distribution covering most of the country</li> </ul>	<p><b>Weaknesses</b></p> <ul style="list-style-type: none"> <li>▪ Chronic power shortages and poor reliability</li> <li>▪ Inadequate and uncertain fuel resources</li> <li>▪ Substandard operation of generating plants</li> <li>▪ Pervasive bottlenecks in the T&amp;D system</li> <li>▪ High levels of technical and commercial losses</li> </ul>
<p><b>Opportunities</b></p> <ul style="list-style-type: none"> <li>▪ Potential for dramatic improvement in power supply through current plans for generation expansion</li> <li>▪ Potential for significant improvements in generating efficiency from increased use of natural gas</li> <li>▪ Abundant opportunities for improvement in commercial practices</li> </ul>	<p><b>Threats</b></p> <ul style="list-style-type: none"> <li>▪ Failure to align generation expansion plans with MoO gas delivery system</li> <li>▪ Delays in constructing and commissioning new generation facilities</li> <li>▪ Persistence of theft, tariff insufficiency, and ineffective collections, leading to continued system inefficiency</li> </ul>

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The electricity subsector faces numerous challenges, but for purposes of the INES, which is concerned primarily with the interdependencies of energy subsectors, these circumstances present one strategic choice.

- **Generation Technology mix:** What configuration of Iraq's generation fleet will provide the power Iraq needs in the most efficient, environmentally sustainable way.

## **2.6. *Linked Industries Subsector***

Several industries in Iraq are dependent on a large and sustained energy supply. Each of these energy-intensive industries can serve as a foundation for the development of many other related downstream industries and service businesses. In this way they provide a vital potential link in converting Iraq's energy resources into national economic strength. Their needs and potential accordingly constitute an important element of INES.

Six industries fall into this category: petrochemicals, fertilizers, steel, aluminum, cement, and bricks. Each of these industries consumes large quantities of energy in the form of power or heating fuel for its production processes, and two of these industries (petrochemicals and fertilizers) require large quantities of natural gas components as feedstock for their products. Each of them provides a foundation for multiple secondary industries.

Today these six industries are underdeveloped and in various states of disrepair and disuse. Chronic shortages of power and feedstock severely limit their operation. Iraq's needs for the products of these industries are met largely through imports. Yet each of these industries, if built to sufficient capacity, and if provided a sufficient supply of energy resources, has the potential to develop into a significant and profitable producer, meeting all of Iraq's needs and in some cases establishing also a material export presence.

- **Petrochemicals.** Iraq in 2010 had only one petrochemicals plant, established in 1977. Its design production capacity of 150 thousand tons per year (KTPA) is well below the 1 MTPA capacity needed for scale efficiency. It also is negligible in comparison to the typical scale seen in energy-rich peer countries. (KSA has a petrochemical capacity of more than 10 MTPA.) Due to facility disrepair, this plant's available capacity is only 35 KTPA, and due to shortages of energy and feedstock supply its utilized capacity in 2010 was only 15 KTPA. In short, Iraq today has virtually no petrochemical production. Domestic demand of 188 KTPA is met almost entirely through imports at a cost of approximately \$275 million.

The Ministry of Industry and Minerals (MoIM) plans to rehabilitate Iraq's existing capacity and restore it to an effective capacity of 150 KTPA. The opportunity presented by petrochemicals, however, is likely far greater than that. Iraq's gas resources are abundant, and they are rich in ethane and other compounds used as feedstock in petrochemical conversion processes. Iraq therefore has a natural advantage in this industry.

Similar advantages have led other countries in the Middle East to enter the world petrochemicals market aggressively, growing from a global market share of 8 percent in 2000 to a global market share of 18 percent in 2010. However, many of these countries are encountering constraints in their gas supply, particularly in ethane, and are moving toward use of more expensive, heavier feedstock like naphtha. Over the coming years, while these countries are adjusting to ethane shortages, Iraq's ethane abundance will give

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it a highly advantageous position on the global supply curve. With expected growth in global demand of more than 4 percent per year, petrochemicals present a significant export opportunity.

- **Fertilizers.** Iraq in 2010 had two fertilizer plants, established in 1975 and 1987, with a combined design capacity of 1.6 MTPA. Due to age and disrepair, the available capacity is only 700 KTPA, and because of shortages of power and natural gas the utilized capacity in 2010 was approximately 210 KTPA. This capacity supplies half of Iraq's domestic demand for fertilizer; the remainder is imported at an annual cost of more than \$100 million. The MoIM currently plans to rehabilitate existing capacity, which would make Iraq self-sufficient in fertilizer at present consumption levels.

The future availability of greatly increased quantities of natural gas provides the opportunity for a more expansive position. Fertilizer production uses methane as its primary feedstock, and as with petrochemicals, Iraq's abundance of natural gas provides a potential cost advantage in world markets. Global demand for fertilizer is expected to grow at an annual rate of 5 percent over the next twenty years as population increases and as demands on agricultural productivity rise. Rates of demand growth in South Asia, which already today is the world's largest net importing region, are expected to be even higher. South Asia's proximity and accessibility via the Arabian Gulf make the region a promising market for Iraqi fertilizer production.

- **Cement.** Iraq in 2010 had 20 cement plants, built between 1949 and 2009, with a combined design capacity of 23 MTPA. Some of these plants are in disrepair, leaving an available capacity of 18 MTPA, including capacity recently added in the IFRK. Power shortages and operational losses reduced the utilized capacity in 2010 to approximately 7 MTPA. This capacity supplies half of Iraq's domestic cement consumption of 13.5 MTPA; the remaining demand is supplied through imports at an annual cost of \$780 million. The MoIM plans to rehabilitate existing capacity.

Although Iraqi cement production enjoys no inherent advantage over production elsewhere, a large portion of total cement cost is attributable to transportation. Iraqi cement manufacture therefore has a price advantage in domestic markets relative to imports simply because of its proximity to customers. For the same reason, there is little opportunity for export of cement production. Even without exports, however, the opportunity for profitable capacity expansion is great. Domestic demand for cement is expected to grow rapidly due to reconstruction of Iraq's physical infrastructure, rising from 13.5 MTPA today to 27 MTPA by 2015 and to 59 MTPA by 2030.

- **Steel.** Iraq today has no steel capacity and must meet its 2 MTPA of domestic demand entirely through imports at an annual cost of \$1.2 billion. The MoIM proposes to rehabilitate a state-owned plant that is currently inoperative, providing capacity of 1 MTPA.

The locational cost advantage of domestic steel manufacture, combined with Iraq's relatively low cost of energy inputs, will make domestic steel production competitive with imports with respect to long steel products. Iraq's steel advantage in export markets, on the other hand, will be minimal, and the market for Iraqi steel is therefore likely to be limited to domestic customers. Even so, the opportunities for expansion of steel manufacture are significant. As economic reconstruction gears up, domestic demand for long steel is expected to increase substantially, rising to nearly 9 MTPA by 2030.

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- **Aluminum.** Iraq currently has no aluminum capacity, but the high energy intensity of aluminum manufacture gives Iraq a natural cost advantage that would likely place it in the most cost-efficient quartile of world aluminum producers. World demand for aluminum is expected to grow over the next decade at an annual rate of 6 to 7 percent as Asian countries continue to industrialize and as global rates of automobile ownership continue to rise. Iraq's potential cost advantage would position it as a strong competitor in this market.
  - **Bricks.** At the end of 2012, Iraq will have 29 MTPA of capacity for brick manufacture. Domestic demand exists currently for 43 MTPA, and is expected to grow rapidly with reconstruction, rising to 65 MTPA in 2030. Because of high transportation costs, domestically manufactured bricks would be in a position to displace imports if capacity were increased sufficiently.

All of these opportunities for capacity growth are estimated to be economically attractive, given appropriate pricing of energy. For this reason, they are strong candidates for private investment. The MoIM already has begun the process of developing new capacity by signing contracts with strategic partners in fertilizers, cement, and steel. Before private investment can be secured on a large scale, however, it will be necessary to provide assurance of long-term reliable supplies of gas and power, and to provide an industrial infrastructure that supports manufacture, distribution, and export of products.

Major indirect benefits can flow from establishing these primary industries. As investment cycles through the economy in the form of expenditures on support services and stimulation of downstream production, it generates further economic growth and employment. At present, however, Iraq's local services base is limited, capable of absorbing less than 10 percent of the value of industrial investment; much of the potential indirect benefit of that investment therefore is diverted into international content. In order to capture fully the potential multiplier effect of investments in primary industries, Iraq will need to pursue a comprehensive program of developing local capabilities and encouraging local content.

The strengths, weaknesses, opportunities, and threats of the linked industries sector may be characterized as follows:



## Exhibit 2 - 23: Linked Industries SWOT

<p><b>Strengths</b></p> <ul style="list-style-type: none"> <li>▪ Abundant and low-cost hydrocarbon resources suitable for conversion to industrial feedstock, fuel, and power</li> </ul>	<p><b>Weaknesses</b></p> <ul style="list-style-type: none"> <li>▪ Decrepit industrial plant with low availability</li> <li>▪ Chronic shortages of fuel, power, and feedstock resulting in low utilization of capacity</li> <li>▪ Underdeveloped infrastructure support</li> </ul>
<p><b>Opportunities</b></p> <ul style="list-style-type: none"> <li>▪ Rapidly growing domestic demand for building materials due to reconstruction</li> <li>▪ Cost advantage vs. foreign producers due to low-cost energy resources</li> <li>▪ Strong supplies of high-quality, low-cost ethane feedstock at a time when major foreign producers are experiencing ethane shortages</li> </ul>	<p><b>Threats</b></p> <ul style="list-style-type: none"> <li>▪ Delays or setbacks in developing the hydrocarbon resources or providing the power needed by industry</li> <li>▪ Delays in developing support infrastructure</li> <li>▪ Potential global overcapacity in export markets, causing severe price declines in petrochemicals, fertilizers, or aluminum</li> </ul>

These circumstances present one primary strategic choice:

- **Linked industries capacity.** Whether to develop industry to serve domestic markets only or to develop also a substantial export position.

### **2.7. The Oil & Gas Legal and Institutional Landscape**

In order to establish a baseline perspective on the energy sector’s legal and institutional landscape, a review was conducted of existing and proposed laws and organizational structures, a large number of stakeholders were interviewed, and benchmark comparisons were made with other hydrocarbon-rich nations. The findings from this research are presented in Appendix C. The current section summarizes those findings for each of the major energy subsectors.

The oil and gas legal and institutional landscape can be framed under five headings: the federal-regional balance, functional role separation, corporatization, operational integration, and private sector participation. Within each of these areas are challenges that INES needs to address.

**The balance of federal and regional jurisdiction.** The Iraqi Constitution of 2005 establishes that Iraq’s oil and gas resources are owned by the Iraqi people. Governance of these resources currently is divided between the federal Government of Iraq and the Iraq Federal Region of Kurdistan government. Authority for conducting and regulating federal hydrocarbon development and operations is vested in the federal Ministry of Oil, established by law 101 of 1976. Parallel authority over IRFK hydrocarbon resources is vested in the IRFK’s Ministry of Natural Resources.

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Although both federal law and the Oil and Gas Law of the Kurdistan Region (Law 28 of 2007) state that management of the region's hydrocarbon development is to be shared between the regional and the federal governments, the mechanisms for coordination have not been defined. In practice the IFRK and federal government operate independently of each other in managing oil and gas resources. The IFRK has pursued its own development policy, most notably in its separate award of development contracts to international oil companies under production sharing agreements.

This bifurcation of authority leads to duplication of effort and misalignment of plans. It presents difficulties in aligning production with national export commitments. It leaves authority over the planning and management of cross-regional and export pipelines and transport pricing unclear. It already has created disparate technical, financial and HSE standards among the various contracts concluded with international oil companies.

**Functional role separation.** Unlike many oil-producing countries,<sup>23</sup> Iraq makes no clear separation in governance accountabilities between policy-making, regulatory, and operational functions.

- **Policy-making responsibilities** in the oil and gas subsector typically include setting strategic direction, establishing exploration and production strategies, allocating production between domestic consumption and export, establishing pricing guidelines, coordinating priorities between the oil and gas industry and other critical national sectors, committing to environmental standards, and providing a framework for foreign investment. These issues require a strategic perspective stretching well beyond the energy sector and spanning many years. They are best addressed without the distraction of day-to-day regulatory and operating issues.

Iraq today has institutions at the highest level empowered to make such decisions, notably the Council of Ministers, supported by the Energy Affairs Committee. Below that level, however, numerous policy issues arise for which decision-making accountability is unclear. Stakeholders express uncertainty regarding responsibility for numerous critical policy issues, including the allocation of production targets among the various TSC's, the respective accountabilities of private operators and the MoO regarding gas infrastructure, and the establishment of clear allocation commitments to potential users.

- **Regulatory responsibilities** in the oil and gas sector typically involve specifying the standards and processes required to implement policy. A regulator typically details technical, safety, and environmental regulations to ensure the optimal management of resources. It collects and maintains information on operations and performance, audits compliance, and enforces standards. It sets criteria for licenses and may award licenses. A critical characteristic of a regulatory authority is impartiality. Its duty is to ensure that duly established national policies are implemented effectively and fairly.

In Iraq's oil and gas sector today the lack of a clear and strong regulatory function creates challenges in several areas. Potential investors regard the absence of an impartial regulatory authority and clear mechanisms for dispute resolution as a significant risk

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<sup>23</sup> Governance arrangements for the oil and gas sector vary widely among oil-producing countries. Some separation among policy, regulatory, and operational roles, however, appears to be almost universal. Algeria (Sonatrach), Brazil (Petrobras), Kuwait (KPC), Mexico (PEMEX), Nigeria (NNPC), Norway (Statoil), Qatar (QP), Russia (Rosneft, Gazprom), Saudi Arabia (Saudi Aramco), and the UAE (ADNOC) all have operating companies that are separate from the policy-making ministries that oversee them. In most of these countries a separate regulatory body also exists.

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factor. Without a regulatory authority to provide clear guidance, contractors are sometimes caught between conflicting policy directives from regional and federal governance agencies. Contractual undertakings and operational accountabilities are often ambiguous and need to be clarified through consistent interpretation and enforcement, but no clear authority exists today for providing this guidance

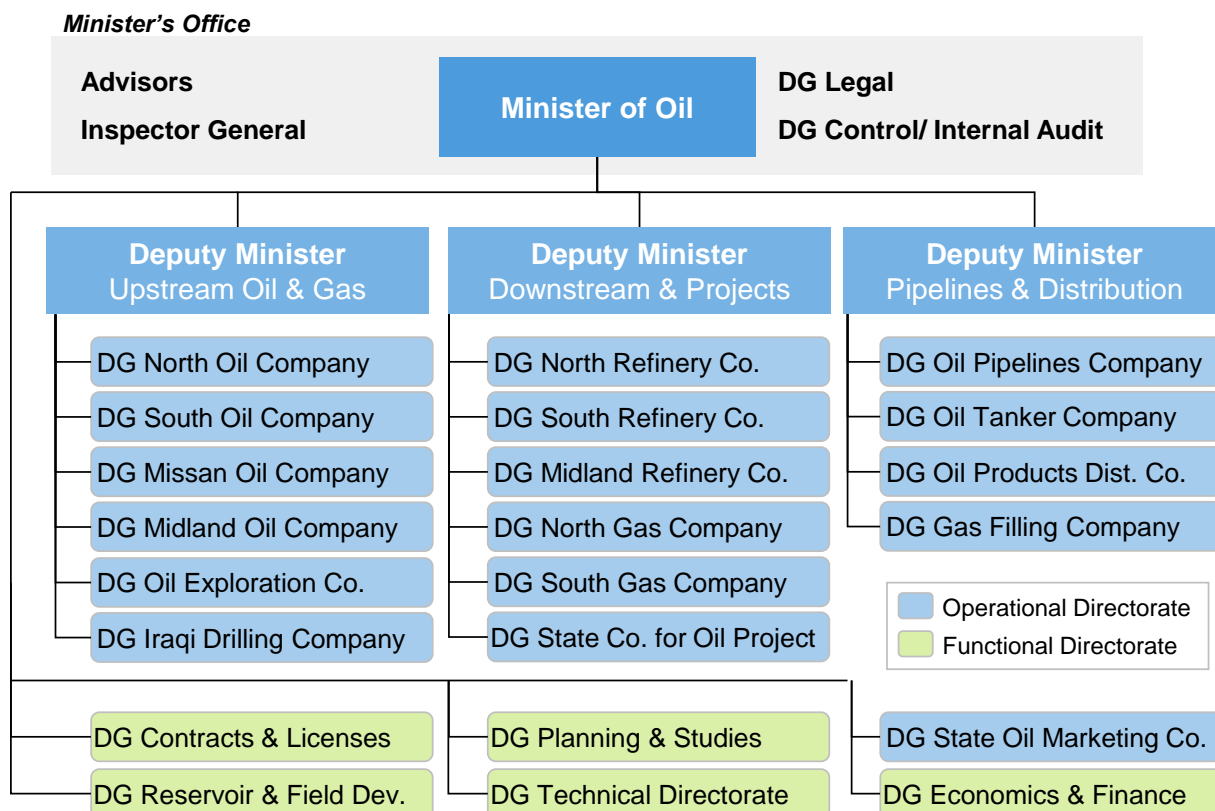
- **Operational responsibilities** in the oil and gas sector involve the management of economic resources to create economic value within the framework of established policy objectives and in compliance with regulatory standards. These responsibilities typically include development of oil and gas resources, investment in capital, management of assets, award and management of contracts, provision of customer service, and capture of revenue. In order to perform these responsibilities efficiently, operating entities require technical and managerial expertise, tactical flexibility, clear decision authority, and strong systems of accountability.

In Iraq today, however, the entities responsible for operations have relatively constrained operating authority. Each State Owned Enterprise (SOE) is headed by a Director General reporting to one of three Deputy Ministers in the MoO. Deputy Ministers oversee the operational performance of these companies, including operational budgets, procurement activities, human resources policies, and executive appointments. The Minister must approve business plans and capital expenditures.

The SOE's provide the main points of interaction with the international oil companies that have TSC's with the Ministry. Under each of the twelve contracts an SOE is assigned to sit on a Joint Management Committee with the responsible contractor. Due to the limited scope of SOE authority, however, delays in securing government review and approvals for operating plans appear to be common. Some contractors complain of political interference in the Joint Management Committees. They also complain that budget and procurement decisions that should be decided by the SOE's and Joint Management Committees are instead routinely referred to the upper echelons of the MoO.

The MoO today has responsibility for all these governance roles, but the boundaries among them are unclear. Operations are inhibited by bureaucratic oversight. Responsibility for policies and standards is not clearly specified, standards are not consistently and impartially enforced, and significant issues regarding policy clarification remain ambiguous. A clear separation of roles would improve transparency, expedite decision making, provide more focused oversight, and enhance the attractiveness of Iraq's oil and gas industry for investors.

## Exhibit 2 - 24: Organization of the Federal Ministry of Oil



**Corporatization.** Corporations are legally and financially independent entities governed under corporate law. They typically are governed by a Board of Directors responsible to shareholders, which can include (or even be limited to) the government. Typically corporatization provides more flexibility in financial, human resource, and procurement policies than is available to government departments. It encourages a focus on economic performance and efficient resource use, and promotes managerial and technical professionalism. A corporatized entity typically has access to a wider variety of funding sources than a centrally financed government department.

Although the SOE's in the MoO bear the name of company in accordance with Law No. 22 of 1997, they are not corporatized in the sense described here. They have the status of Ministry General Directorates and operate as government departments. Combining policy, regulatory, and operational roles, but exercising little independent authority, they exemplify the governance ambiguities characteristic of Iraq's oil and gas sector.

**Operational integration.** Within operations, the degree to which different spheres of oil and gas activity should be either integrated or unbundled varies among benchmark countries, depending on the need for operational coordination on the one hand and the desirability of specific transparency and focused management attention on the other hand. The MoO today contains 18 SOE's that are differentiated by their positions in the value chain and by their assigned geographical responsibilities. Coordination across geographies within a particular value-chain segment is managed at the Deputy Minister level, assisted by the Central Directorates at the Ministry headquarters. Coordination across value-chain segments, however, occurs only at the Ministerial level.

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Many natural gas activities within the MoO today, including production, separation, and transportation, are handled by entities like the South Oil Company, the North Oil Company, and the Oil Pipelines Company that have responsibility for both oil and gas. This arrangement has the advantage of facilitating coordination between the two subsectors, but it carries the risk that oil, the economically dominant commodity, will distract attention from the many challenges involved in managing Iraq's rapidly growing production of natural gas.<sup>24</sup>

Three challenges in particular may require a remapping of current operational boundaries:

- Gas gathering and processing. The TSC's assign responsibilities for gas gathering and processing, but no consistent mechanism currently exists for coordinating these plans to ensure that infrastructure links are properly made, that processing facilities are efficiently located, and that the gas pipeline network is aligned to consumption requirements and locations.
- Coordination of production plans. Each of the TSC contractors is operating under a separate contract and with a separate Joint Operating Committee. Coordination among these efforts is needed to provide evacuation infrastructure for oil and gas that is aligned and synchronized with production volumes.
- Coordination of delivery commitments. Allocation of oil flows between northern and southern export points and allocation of gas flows to power, industries, and retail markets will need to be determined. Appropriate infrastructure will need to be configured and developed to handle these flows, and day-to-day delivery commitments will need to be coordinated consistent with allocation priorities. Gas delivery especially will present complexities of system design and management.

**Private sector participation.** Under federal policies, direct private asset ownership in the oil and gas sector is currently permitted only in gas processing, in oil refining and in product distribution and retail. Private sector participation in federal upstream operations, marketing, and transportation is limited to service contracts. Under the policies of the IFRK, private sector ownership is permitted throughout the oil and gas industry.

Allowing private sector ownership is a different matter from actually attracting it. To this point Iraq has not been notably successful in engaging private-sector investment. A combination of targeted incentives, favorable pricing, and a structurally secure investment environment will likely be needed in order to attract significant foreign investment.

Iraq is currently considering a set of oil and gas laws that will address some of these concerns. If these laws are enacted, the following will likely be realized:<sup>25</sup>

- Broad policy-making authority would be assigned to a Federal Oil and Gas Council (FOGC). The FOGC would set federal policy for hydrocarbon resources, develop

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<sup>24</sup> The degree to which natural gas operations are separated institutionally from oil operations varies among benchmark countries. They are combined in the KSA and Qatar, partially combined in Norway and Algeria, and fully separated in Iran and Russia. Iraq's should be guided less by reference to best practice than by its own particular operational challenges and aims.

<sup>25</sup> These laws include the Federal Oil and Gas Law, the INOC Law, and the Law of Financial Resources. There are different versions of the draft laws that are currently being debated. The version referenced here is the one endorsed by the Council of Ministers in 2007

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strategies for exploration and development, and plan major pipelines. It would determine production levels consistent with national policy, fairly and proportionally based on the development plans of contracted development blocks. It would establish policies for contracting, including eligibility and selection criteria, and would develop model contracts. It would coordinate a national exploration program with competent regional authorities to confirm oil and gas reserves, and it would coordinate the development activities of regional authorities.

- Regulatory authority would be assigned to the Ministry of Oil. The MoO would draft regulations needed for the implementation of oil and gas policies, laws, and strategies, subject to FOGC approval. It would propose comprehensive plans to the FOGC for oil and gas exploration across Iraq in coordination with regional authorities, and classify regions based on oil and gas reserve probabilities. It would monitor and supervise oil and gas operations to ensure compliance with regulations, contractual terms, and international standards, and would audit the expenses incurred by license holders.
- All national oil and gas revenue would be collected by the Federal government through the Financial Resources Fund (FRF). The Federal government would prioritize the allocation of these funds to national needs. It would provide 17 percent of remaining funds to the IFRK and then to other regions and governorates based on population.
- Operational responsibility for upstream oil and gas development would be assigned to a new corporatized entity, the Iraqi National Oil Company (INOC). INOC would be responsible for carrying out the policies of the FOGC under regulations established by the MoO. It would explore, develop, manage, and operate Iraqi oil fields, and would manage transport and storage of oil and gas.
- Operational responsibilities for activities outside of upstream, including pipelines, refineries, marketing, and export facilities would continue to be managed directly by the MoO through existing SOE's.

These laws are currently under consideration by Iraq's Parliament.

## **2.8. The Power Legal and Institutional Landscape**

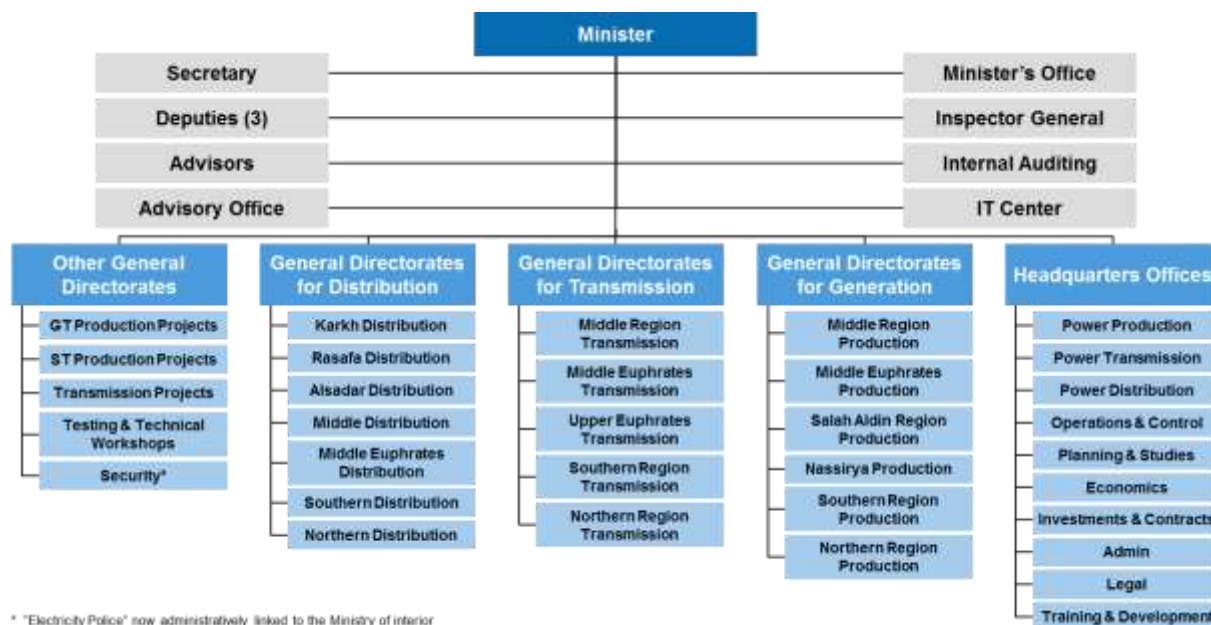
The legal and institutional landscape of Iraq's electricity subsector can be framed under headings similar to those used in characterizing the oil and gas subsector: the federal-regional balance, functional role separation, corporatization, operational integration, and private sector participation. In addition, as noted already in Section 2.5, the power subsector faces significant challenges with respect to pricing.

**The balance of federal and regional jurisdiction.** Governance of the power sector is divided between the federal Ministry of Electricity, which develops and manages power assets in all of Iraq outside the Iraq Federal Region of Kurdistan (IFRK), and the IFRK Ministry of Electricity, which performs those functions within Kurdistan. Iraq's 2003 Ministry of Electricity Law, which merged 19 operating subsidiaries of the previous Electricity Commission, includes the IFRK within the purview of the federal ministry. However, grid connections between the federal network and the IFRK network are limited, and in practice the two systems operate independently.



**Functional separation.** The federal MoE is organized around operational functions, with three General Directorates responsible respectively for generation, transmission, and distribution. Additional General Directorates and Offices provide planning and project support. During the course of the INES, the MoE, established under the Office of Planning and Studies, a department dedicated for solar and wind energy and the environment.

**Exhibit 2 - 25: Organization of the Ministry of Electricity**



Under this structure there is no institutional differentiation among policy, regulatory, and operational roles. Although institutional differentiation of governance roles is generally considered desirable,<sup>26</sup> the crippling infrastructure deficiencies of the Iraqi power sector today require the Ministry to focus primarily on operational challenges. Its paramount objective is to meet demand, and for that purpose the simplicity of the current organizational structure appears appropriate.

One critical function that is not included within the MoE is tariff setting. Tariffs are set by the Council of Ministers, and at present they cover only a small fraction of actual costs. It is not politically realistic to increase tariffs while power service is chronically unreliable, or to increase tariffs suddenly even after reliability is achieved. A mismatch between production cost and selling price therefore is likely to persist for several years. While it lasts, that mismatch will make it difficult for the MoE to encourage efficient consumption of power or to promote conservation effectively.

**Corporatization.** The MoE operates as a government department, not as a corporation. Given current tariffs, which cover only a fraction of costs, and given the urgent need for massive infrastructure improvement, the economic transparency and motivation provided by a corporate structure would be of little benefit today. Today the power subsector needs engineering solutions more than economic solutions. In coming years, however, as the basic needs of the power sector are satisfied, and as Iraq shifts its focus from the immediate challenge of meeting demand to the longer-term challenge of growing efficiently, corporatization could offer significant benefits.

<sup>26</sup> Separate regulatory entities are found in nearly every national power system. Within the MENA region, although operations are typically conducted by government authorities or by government-owned companies, every country but Libya has a separate regulator.

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**Operational integration.** The MoE is a vertically integrated utility. All components of the utility value chain - generation, transmission, distribution, and customer service - are managed within a single institution. This is an appropriate structure in the near term for an organization that must manage rapid improvement across all elements of the power system.

However, mechanisms for coordinating policies and plans between the MoE and other Ministries with which it is vitally linked are weak. Despite the MoE's dependence on reliable fuel supply to power its generation fleet, no formal fuel supply agreement exists between the MoE and MoO. The two Ministries agree on the overall volumes of fuel required, but have not performed the detailed joint planning needed to ensure timely delivery of the appropriate fuels to particular power plants. Maintenance schedules are not well coordinated, and joint contingency plans for potential fuel stock-outs have not been developed. As the needs of the generation fleet and the supply of fuel expand over the next few years, coordination with respect not only to fuel volumes but also infrastructure configuration will be critical.

Similarly, the informal coordination mechanisms that exist between the MoE and the MoIM have not yielded precise agreement on the power supply required to support industrial development plans.

Because the MoE's revenue covers only a small portion of actual operating costs, the Ministry is dependent on the general budget of the government. The Ministry of Finance coordinates the funding of operating budget while the Ministry of Planning coordinates the capital budgets. Budgets to fund MoE expansion have been approved, but close coordination among these ministries will be needed to ensure that funds are released on schedule to support an aggressive program of generation expansion and T&D rehabilitation.

**Private sector participation.** At present there is no private sector investment participation in Iraq's power system. Initiatives have been launched to attract Independent Power Projects (IPP's), but none has reached fruition. Until firm guarantees can be provided regarding fuel availability and price, power off-take, logistical support, and sovereign backing of financial commitments, the risk of IPP investment will be high, and the cost of power from IPP's will likely seem excessive. Iraq's power system, and the infrastructure that supports it, need to stabilize in order to attract sustained interest from IPP's.

In summary, the institutional structure of Iraq's power subsector today is basic. Within the federal jurisdiction of the MoE, governance functions and operational activities all are integrated within a single governmental entity. The challenges faced by the power subsector today also are basic. A more complex institutional structure would not necessarily be better suited to those challenges than the current structure. Even in the short term, however, coordination between the MoE and other governmental entities needs to be strengthened. In the longer term, it will be important to revise the institutional structure so that it can be responsive to economic signals and so that it encourages efficient power supply and consumption.

A Ministry of Electricity Law is currently under review that will help position the MoE to serve Iraq's long term power needs. It gives the Ministry the authority to propose tariff levels proportional to operating expenses and to structure tariffs to correspond to different consumption categories. It empowers the MoE to enforce tariff collection through suspension of service or through the imposition of financial penalties. Tariffs will continue to require approval from the Council of Ministers and the Council of Representatives.

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An electricity Regulatory Law is also under consideration that establishes a regulatory Department in the MoE, reporting directly to the Minister. This Department would have authority to issue regulations and technical codes, to define the scope of activities to be managed through licenses, and to award licenses according to processes and criteria it establishes. As an initial step toward establishing this function, the MoE already has set up an internal regulatory office.

For the present, the MoE's principal institutional challenge will be to secure detailed resource understandings and coordination protocols with other Ministries, and to develop the internal capabilities required to plan and manage within three years a rapid expansion of generation and a comprehensive strengthening of transmission and distribution.

## **2.9. The Linked Industries Legal and Institutional Landscape**

The same descriptive framework applied to the governance of oil, gas, and power can be applied as well to linked industries.

**The balance of federal and regional jurisdiction.** Outside the IFRK, industries fall primarily under the jurisdiction of the federal Ministry of Industry and Minerals (MoIM). Within the IFRK, industries fall primarily under the jurisdiction of the IFRK Ministry of Trade and Industry (MoTI). The IFRK and the federal government pursue largely independent paths. The scope of linked-industry activities in the IFRK is currently confined to cement and bricks; in the remainder of Iraq it includes also steel, fertilizers, petrochemicals, and potentially aluminum.

**Functional role separation.** The MoIM manages these energy-intensive industries through eight state-owned enterprises.<sup>27</sup> Each SOE by law enjoys nominal financial and management independence, and each has its own board of directors responsible for company strategy. However, all major management decisions, including issuance of annual budgets and annual reports, require approval by the Minister, and any decisions regarding private-sector participation in ownership or potential mergers with other companies or SOE's requires approval by the Council of Ministers.

In practice, then, the MoIM exercises substantial operational control over the SOE's, and there is little separation between policy, regulation, and operations. By imposing pervasive administrative review over operating decisions, this arrangement constrains the commercial flexibility and initiative of the operating companies. Also, by failing to provide an independent policy and regulatory authority to define commercial and environmental standards, frame market rules, and fairly enforce commitments, it increases risk for private-sector investors.

**Corporatization.** The SOE's operate under corporate structures, but lack the independence typically associated with such structures. In effect they operate today as departments of the Ministry.

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<sup>27</sup> The SOE's currently responsible for linked industries are the Iraqi State Company for Cement, the Southern Cement State Company, the Northern Cement State Company, two State Companies for Iron and Steel, the State Company for Petrochemical Industries, the State Company for Fertilizers (Southern Part), and the State Company for Fertilizers (Northern Part).

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**Operational integration.** The SOE's within the MoIM operate independently of each other. However, they must coordinate with other Iraqi entities for various purposes, including supply of fuel, power, and feedstock resources.

**Private sector participation.** Although private foreign participation and investment are critical for the development of Iraq's industries, international investors are cautious about investment in Iraq. At present, there is no clear policy defining targeted foreign investment levels or acceptable ownership shares, establishing a framework of investment incentives, or providing streamlined administrative processes.<sup>28</sup> Although the MoIM has responsibility for developing industrial parks, its mandate is limited to commissioning master plans for the industrial parks. In order to progress from planning an industrial park to actually developing one, the MoIM must rely on other federal and governorate authorities for land allocation, hydrocarbons supply and construction of shared infrastructure. It is challenging to establish and sustain the levels of intense inter-Ministerial teamwork needed to accomplish such a project when responsibility for its execution is so diffuse.

Foreign direct investment is particularly beneficial when it leads to the development of local employment and the engagement of local suppliers and support services. The MoIM, however, has not yet established goals or incentives in order to encourage this kind of local content.

The MoIM currently has plans to address several of these issues. Over the next three years it intends to develop an Industrial Strategy, to be overseen by an Industrial Committee. It also intends to draft legislation allowing for expedited privatization of SOE's in partnership with international investors, and to strengthen the regulatory framework governing private investment.

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<sup>28</sup> Iraq today is considered a challenging country for private investment. In the 2011 Doing Business report prepared by the World Bank and the International Finance Corporation Iraq was ranked 166 out of 183 countries. Ranking of countries is based on nine criteria: starting a business, dealing with construction permits, registering property, getting credit, protecting investors, paying taxes, trading across borders, enforcing contracts, and closing a business.

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### 3. Baseline of Socio-Economic and Environmental Situation

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#### 3.1. Overview

As Iraq's energy sector develops it will inevitably impact the country's broader economy, environment, and society. A major aim of the INES is to ensure that this impact is as favorable as possible. The present chapter describes the current baseline of socio-economic and environmental conditions that must be considered in framing the INES. Section 3.2 reviews the role of the energy sector with respect to Iraq's broad socio-economic situation, and Section 3.3 reviews that role with respect to Iraq's environmental situation.

#### 3.2. Socio-Economic Situation and Contribution of the Energy Sector

Iraq's baseline socio-economic situation can be characterized under five headings:

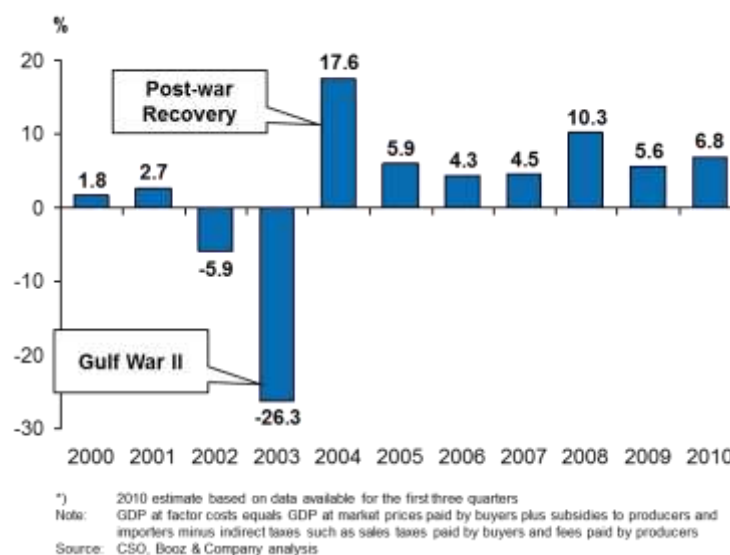
- GDP and economic diversification
- Employment
- Public finance and debt
- Monetary policy and balance of payments
- Standard of living and human development index

Developments in the energy sector have the potential to strongly affect each of these areas.

**GDP and economic diversification.** Iraq's total 2010 GDP was \$145 Billion.<sup>29</sup> Its per-capita GDP was \$4,900. This figure places Iraq in the middle of the third quartile of all countries. It represents a real decline of roughly 60 percent since 1979, a stark reflection of the economic loss that Iraq suffered during 40 years of war and sanctions.

Following the 2003 war, Iraq has experienced seven years of variable economic growth, averaging approximately 8 percent per year. However, not until 2009 did GDP recover to its 2001 pre-war GDP level.

**Exhibit 3 - 1: Real Iraqi GDP Growth at Factor Costs**



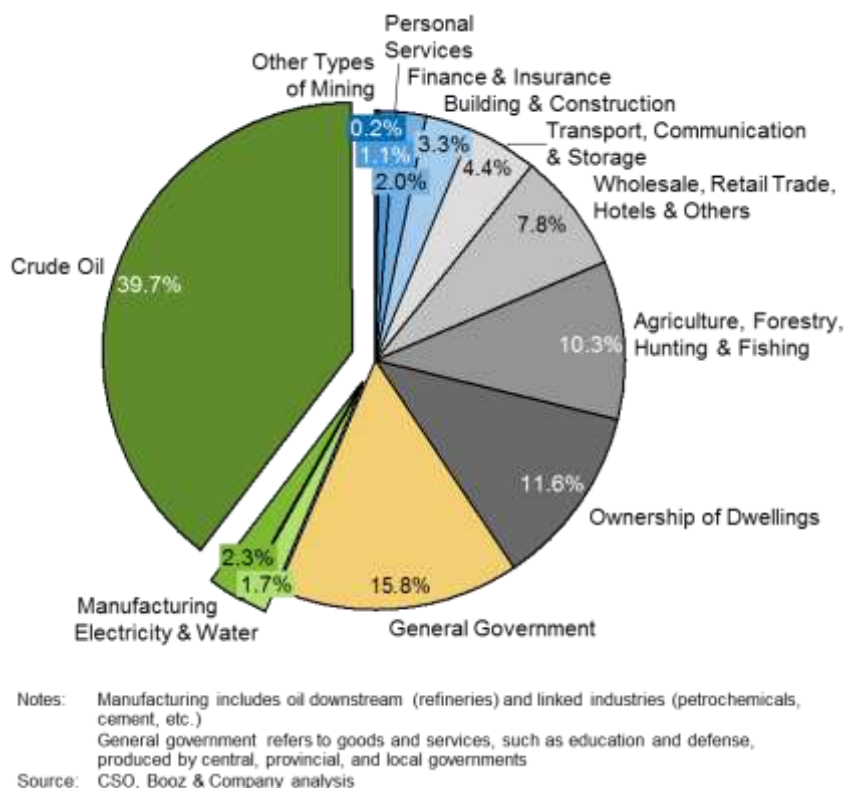
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<sup>29</sup> Nominal GDP expressed in U.S. dollars and adjusted for purchasing power parity



The economy is heavily dependent on crude oil production, which constitutes nearly 40 percent of GDP. It is estimated that the oil sector supports indirectly an additional 40 percent of GDP through oil-funded government expenditures, subsidies, and private-sector support services. Iraq's manufacturing sector is negligible, and must get by with inadequate supplies of power and fuel. Agriculture today is constrained by limited water resources and poor infrastructure. Overall, the private sector represented 38% of GDP in 2010.

**Exhibit 3 - 2: Sector Contributions to Iraq's 2010 GDP**



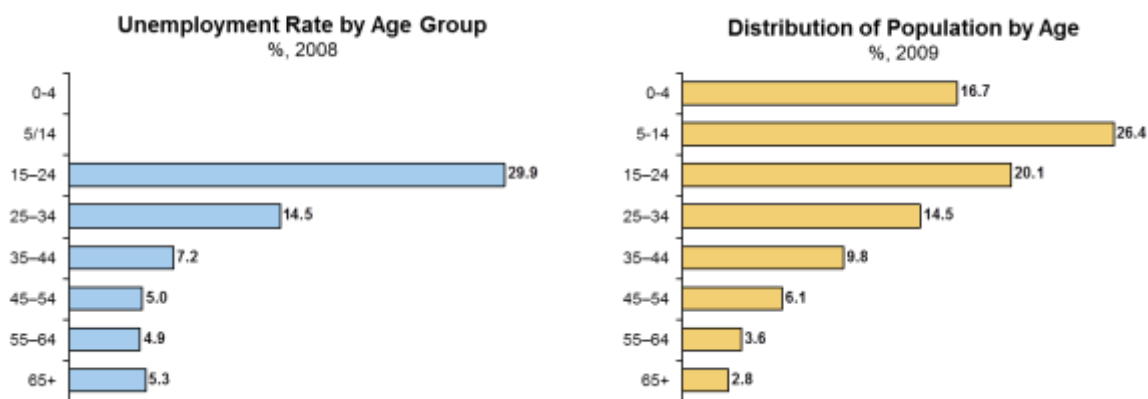
**Employment.** From 2004 to 2010, employment grew at a rate of about 5 percent, reflecting government employment growth of 18 percent a year and private-sector employment growth of less than 2 percent a year. As a consequence, government employment during that period rose from 16 to 31 percent of total employment. Today government employment growth is slowing as Iraq attempts to reduce the public-sector drain on economic resources. This policy will shift most of the burden for future employment growth to the private sector, which continues to be severely constrained by resource shortages, particularly in electricity.

The official unemployment rate has declined from about 25 percent in 2004 to 15 percent today.<sup>30</sup> However, unemployment is nearly 30 percent among people aged 15 to 24, an age group that will grow rapidly, far outpacing the rate at which the relatively small portion of the population older than 55 is likely to retire. Unless the rate of job growth increases, this demographic wave will bring rising social hardship and discontent.

<sup>30</sup> The official unemployment rate reflects the percentage of the labor force that is out of work but actively seeking employment. If the potential labor force is expanded to include people who would willingly work but are not seeking employment because they are discouraged by poor employment prospects, the unemployment rate in Iraq is estimated from CSO data to approximate 50 percent.

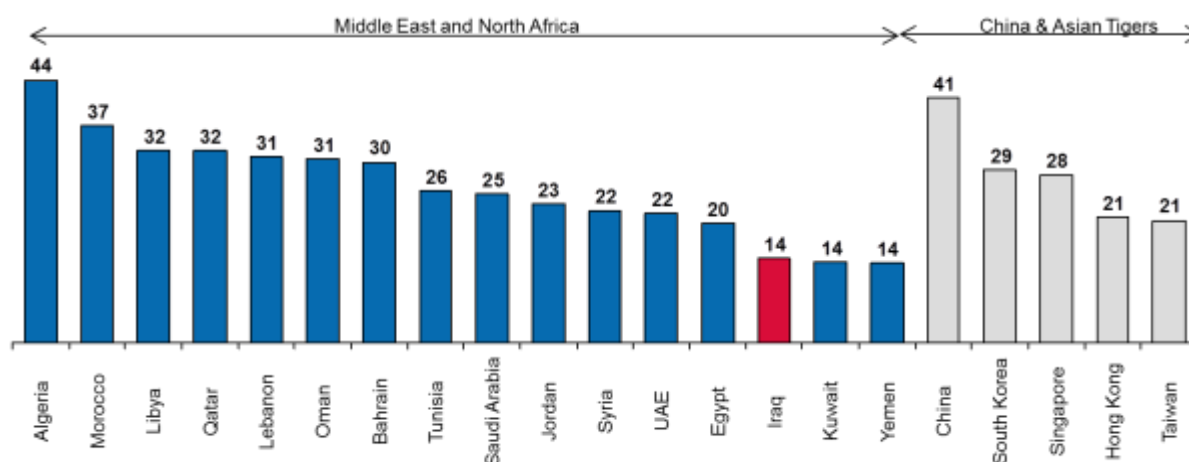


### Exhibit 3 - 3: Age Distribution of Unemployment and General Population



**Public finance and debt.** Compared with regional benchmarks and with investment rates in rapidly developing countries, Iraq's overall level of investment is low. Approximately 70 percent of Iraq's federal budget goes to operating expenses to support the expansive public sector and to fund direct subsidies. Given its major infrastructure gaps, Iraq will need substantially increased investment budgets to sustain growth and to improve prosperity.

### Exhibit 3 - 4: Investment as a Percentage of GDP

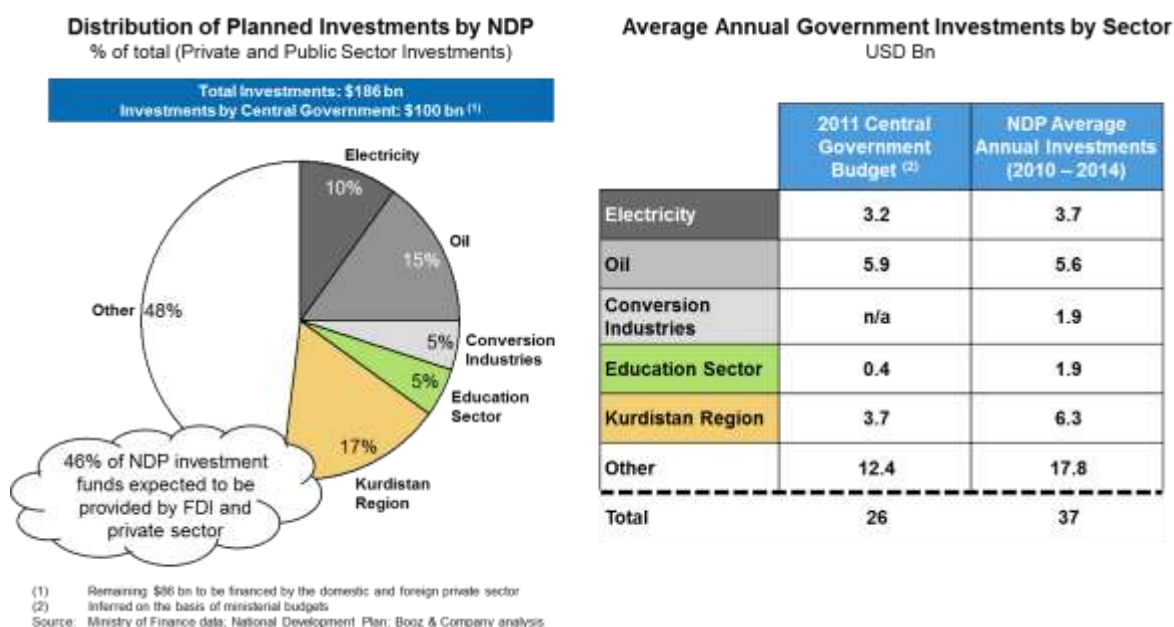


Source: Iraq - Investment 2008 CSO, 2009-2010 IMF, country statistical office for China, Singapore, Hong Kong, South Korea and Taiwan, Booz & Company analysis

Iraq's National Development Plan (NDP) envisages a major increase in total investment levels over the coming three years. Nearly half of the planned investment is expected to come from international investment and from the private sector. To this point, however, Iraq has been relatively unsuccessful in securing significant amounts of direct foreign investment.<sup>31</sup> In order to meet NDP investment expectations Iraq will need to introduce institutional reforms to encourage foreign investment or else double the planned rate of government-funded investment.

<sup>31</sup> Between 2003 and 2010, the amount of actual foreign direct investment in Iraq amounted to a little over \$8 Billion, less than 5 percent of the amount that foreign investors announced that they planned to invest during that time.

### Exhibit 3 - 5: National Development Plan Investment Forecast 2010-2014



Moreover, Iraq will need to improve its efficiency in actually making budgeted expenditures. Between 2006 and 2010 delays in procurement, in project approvals, and in project execution contributed to a 25 percent average shortfall in actual capital disbursements compared to budgeted amounts.

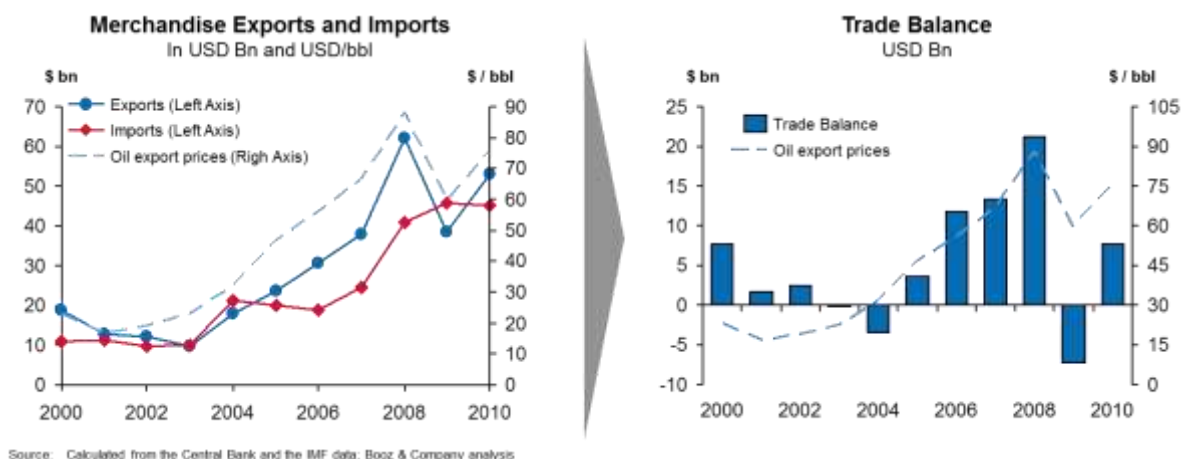
Partly due to this under-disbursement, and partly due to favorable oil prices, Iraq in 2011 held accumulated reserves of approximately \$60 billion,<sup>32</sup> deposited in central and commercial banks and in the UN-established Development Fund for Iraq. While this reserve provides Iraq some fiscal flexibility, Iraq also has external debt of \$92 billion on which it is technically in default, making it difficult to fund deficits through commercial borrowing. For this reason, the timing as well as the amount of revenue flow from the energy sector to the Iraqi government has great importance.

**Monetary policy and balance of payments.** 90 percent of Iraq’s government revenue today comes from sales of crude oil. Favorable oil prices have supported a positive trade balance over the past six years (turning negative only in 2009 when world oil prices fell). The Iraqi Dinar’s exchange rate is fixed by the Central Bank of Iraq (CBI). With increasing oil exports the CBI adjusted the exchange rate to roughly 85 US cents per 1000 dinars from roughly 70 US cents in 2006. This adjustment to strengthen the exchange rate has helped hold current inflation to a rate of 5 to 6 percent - generally considered low for a transitional economy.

On the other hand, a strong exchange rate favors imports and adds to the difficulty of developing domestic industry. Moreover, the dependence of a strong exchange rate on the value of oil exports underscores the economy’s vulnerability to oil revenue. Should oil prices or volumes decline significantly, the exchange rate could fall and inflation could rise, and the government’s fiscal balance would become even more tenuous.

<sup>32</sup> Estimated based on PMAC input

### Exhibit 3 - 6: Iraq's Balance of Trade (2000-2010)



**Standard of living and human development index.** Iraq ranks 105 among countries according to the UN's Human Development Index (HDI), slightly higher than its ranking in per capita GDP. The HDI captures three dimensions of development: life expectancy at birth, education level, and standard of living. Iraq's average life expectancy of 68.5 years is lower than that in neighboring countries (74.6 in Syria, 73.3 in Saudi Arabia, 73.1 in Jordan, and 71.1 in Iran.) Its education index, although higher than Syria's is lower than Iran, Jordan, or Saudi Arabia's. About 40 percent of Iraq's population is near or below the poverty line. Each of these measures is expected to improve as Iraq's national wealth increases and as resources are invested in human services and economic diversification.

The energy sector has a critical role to play in bringing about this improvement. As oil revenues grow, Iraq will have the resources needed to support reconstruction in other areas of the economy. Investment in gas and power infrastructure particularly could spur growth in other sectors of the economy, notably industry and private commercial enterprises. It also could contribute immediately to the physical well-being of Iraq's people by making electric power available and reliable. With growth in the private sector, incomes and social stability would improve, and foreign investment would increase, creating a virtuous cycle of sustainable economic growth.

To create this virtuous cycle Iraq will need to address four major near-term challenges:

- *Cash flow.* Iraq needs to sequence its development plans as much as possible to generate self-funding resources. Iraq's existing debt and its limited borrowing capacity will require it to balance carefully its investment outlays and its cash flows so as to minimize even short-term fiscal deficits. This need will determine which development priorities need to be accelerated and which need to be delayed.
- *Institutional capacity.* Iraq needs to strengthen its institutional capacity to deploy effectively the cash resources generated through increased oil production. Government execution of spending plans has consistently fallen short due to red tape and overstretched management. Government skills in planning, procurement, budgeting, contracting, and project management will need to be enhanced rapidly as Iraq's hydrocarbon resources are monetized. International private-sector capabilities will play an important role in Iraq's development, but these too will need to be effectively managed.

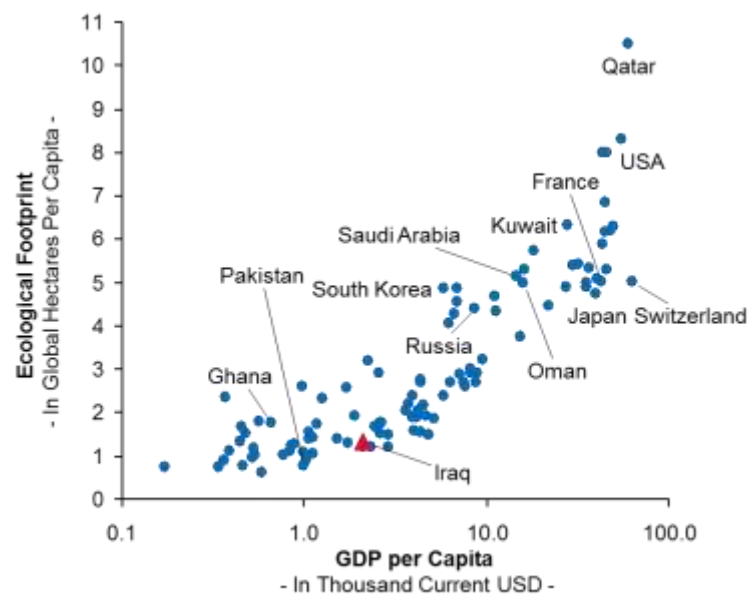
- *Human resources.* During the past decades Iraq has lost much of its human capital due to economic and educational stagnation and due to emigration of talented professionals. Iraq needs to restore this human resource deficit.
- *Business environment.* Iraq needs to improve its business environment by establishing independent regulatory institutions, streamlining government approval and oversight processes, clarifying institutional policies and roles, and expanding the scope of the private sector. These reforms are needed not only to attract foreign investment but also to unlock the potential of Iraq's own population.

If Iraq can navigate through these immediate challenges it will likely find itself on a course of long run liberalization in which price subsidies are reduced, the financial sector is expanded, the legal framework is solidified, and competition in even strategic industrial sectors is permitted. For the present, however, Iraq's main task will be to strengthen the capacities of its existing institutions and to manage an immediate upgrade and expansion of its infrastructure.

### 3.3. Environmental Situation and Impact of the Energy Sector

As Iraq builds infrastructure and increases economic activity, it will affect the environment in ways both negative and positive. The negative impact will arise directly from increased economic activity. The greater the amount of production and resource consumption, the greater is the stress imposed on air, land, and water. This connection between economic growth and environmental stress is widely observed, and is to a large extent unavoidable.

Exhibit 3 - 7: Ecological Footprint and. National Wealth (2009)



Source: Global Footprint Network; Living Planet Report (2010), WWF; World Economic Outlook (2010), IMF

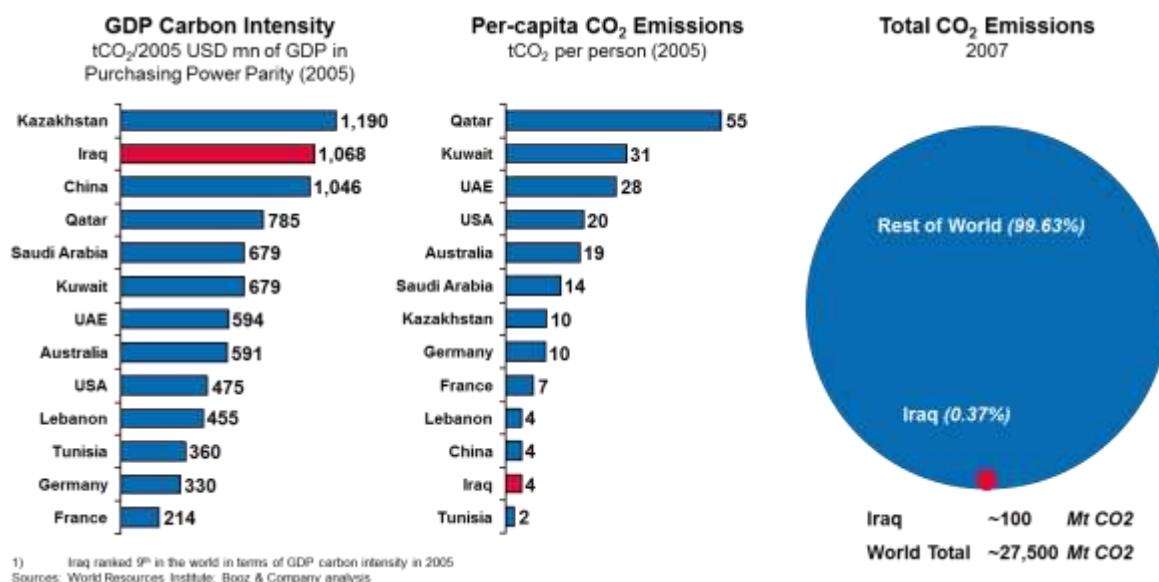
Growth can provide a positive environmental impact as well, but the positive impact depends on deliberate choices regarding technology, production processes, and physical location. Iraq today has significant environmental challenges that economic growth, properly managed, can ameliorate. INES needs to take into account both the environmental stress and the environmental improvement that can come with energy-sector development.

The environmental stresses imposed by the energy sector today can be characterized under five headings:

- Greenhouse gas emissions
- Emission of air pollutants
- Use of freshwater resources
- Discharge of liquid effluents
- Solid waste generation
- Land use

**Greenhouse gas emissions.** The patterns of climate change attributable to global emissions of greenhouse gases constitute a serious environmental threat to Iraq. Diminished water levels due to lower rates of precipitation, increased water salinity due to seawater incursion into Iraq's rivers, longer and more frequent periods of drought, more frequent and more severe dust storms, higher temperatures, and increased desertification are already evident. These trends are likely to increase as the global environment warms. Although Iraq's small economic footprint makes it a minor contributor to these global patterns in absolute terms, its contribution relative to economic output is high. Iraq's methods of production and industrial practices placed it ninth among the world's most carbon-intensive countries in 2005.

**Exhibit 3 - 8: Iraq's Contribution to Global GHG**



In 2009, the energy sector accounted for 72% of Iraq's GHG emissions. These emissions are attributable to three main factors, each of which is a critical concern of INES:

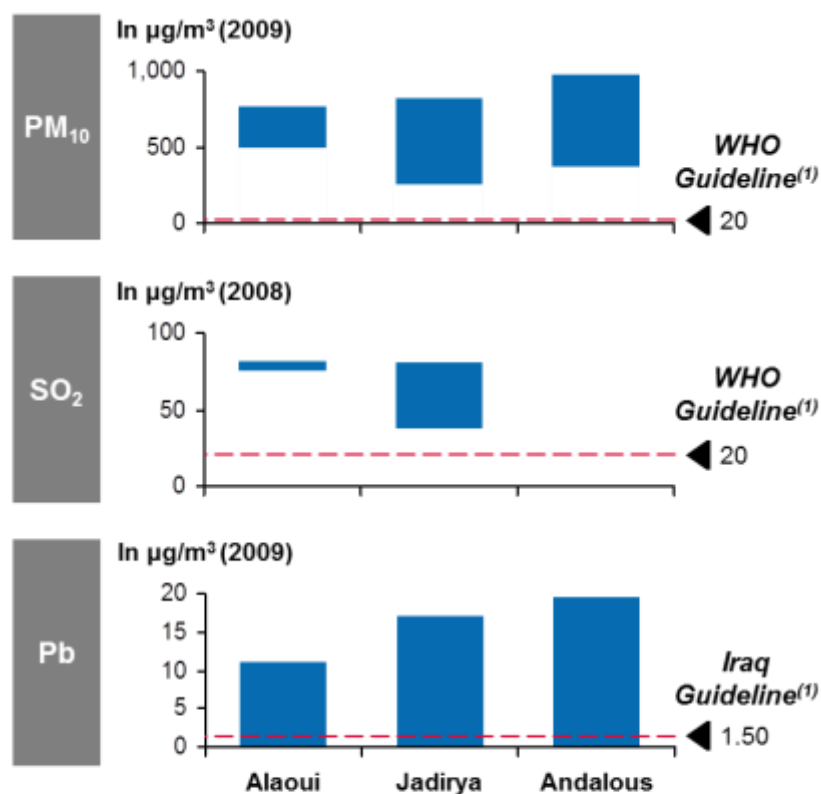
- Power fuel. In power production Iraq relies heavily on oil products, in particular diesel fuel and fuel oil, rather than cleaner natural gas. In 2009 the power sector caused 50 percent of Iraq's overall emissions of greenhouse gas.
- Gas flaring. 43 percent of Iraq's current raw gas production is flared at the wellhead for lack of gathering and processing infrastructure. This expedient not only wastes a natural resource but also damages the environment. In 2009 the carbon dioxide released into the

atmosphere by flaring constituted 60 to 80 percent of oilfield GHG emissions. This volume represented 14 percent of the GHG produced in Iraq by all sectors of the economy.

- Poor fuel economy. Iraq’s transportation fleet operates inefficiently as a consequence of substandard fuels and aging vehicles. In 2009 the transportation sector contributed 13 percent of the country’s GHG emissions.

**Emission of air pollutants.** Iraq’s urban areas suffer from air pollution levels that are well in excess of international health guidelines. These pollutants can have adverse effects on human respiratory, neurological, and immune systems. In addition, as they settle or as they are spread by wind and rain they can cause acidification and pollution of water and soil.

**Exhibit 3 - 9: Air Pollutant Concentrations in Baghdad**



1) WHO Air Quality Guideline is at 20 µg/m³ for annual mean of PM10 concentrations and 20 µg/m³ for 24-hour mean of SO2 concentrations; Lead emission standard is set for a rolling three-month average; standard for 24-hour average is set at 2 µg/m³; available measures from SoER (2010) are monthly averages

Source: *State of the Environment Report 2008 and 2009*, MoEnv, U.S. EPA; WHO Air Quality Guidelines; Booz & Company analysis

These heavy concentrations of air pollutants are attributable to five main factors:

- Reliance on diesel generation in urban centers. Because of shortages in grid-supplied power, private diesel generators are widely used, supplying an estimated 30 percent of total Iraqi power consumption. Diesel units typically produce 50 to 60 times the NOx emitted by gas plants as well as significant amount of SO<sub>2</sub>. In urban areas the local concentration of private diesel units poses a particular problem, degrading ambient air quality and creating chronic noise pollution.



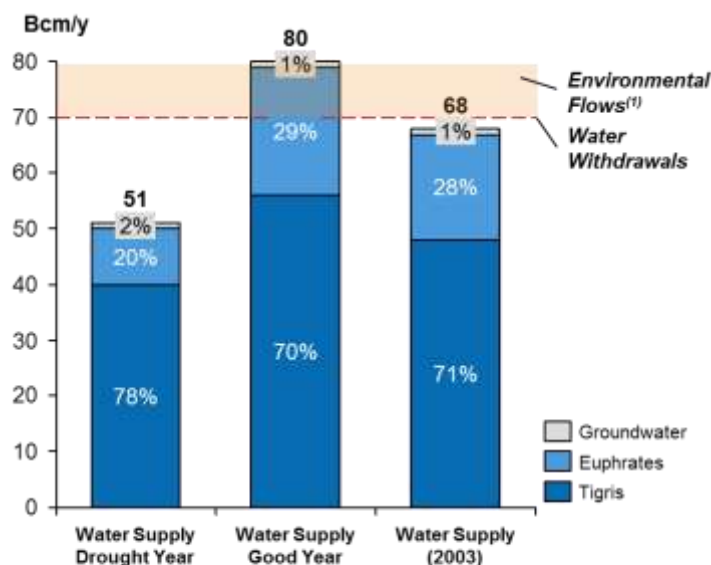
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- Substandard transportation fuel. The low quality<sup>33</sup> of transportation fuels produced in Iraq has significant environmental impact. The sulfur content of Iraqi fuel exceeds international standards by a factor of 1000, causing high emission of SO<sub>x</sub> and sulfate particles. The lead additives used to compensate for low octane levels cause the release of lead compounds. The lead and sulfur in fuels also damage catalytic converters that are relied on to reduce emissions of other pollutants like CO and NO<sub>x</sub>.
  - Gas flaring. In addition to releasing vast quantities of greenhouse gas, flaring creates significant air pollution: SO<sub>x</sub> compounds, particulates and hydrogen sulfides. The air in regions surrounding oil fields has particulate and SO<sub>2</sub> concentrations that substantially exceed WHO air quality standards
  - Inefficient power production and refinery processes. The high sulfur content of fuel oil and crude oil used in power plants and refineries, combined with old equipment that provides inefficient levels of fuel combustion, create high levels of SO<sub>x</sub> and particulate emissions. The location of many power plants and refineries close to population centers exacerbates this problem.
  - Limited use of air pollution control equipment. Iraq's industrial plant is obsolete. Pollution control devices that are standard in the design of modern industrial facilities are absent from most Iraqi factories. In the cement industry, fewer than 25 percent of the plants in operation have functional precipitators.

**Use of freshwater resources.** The Tigris and Euphrates rivers account for 99% of Iraq's freshwater resources. Virtually all of the Euphrates flow and two-thirds of the Tigris flow originate outside of Iraq and are vulnerable to upstream water diversion beyond Iraq's immediate control. This circumstance, combined with fluctuations in rainfall, causes river flow to vary from 50 billion to 80 billion cubic meters per year. Since typical annual withdrawals within Iraq amount to 70 bn m<sup>3</sup> per year, and an additional 10 bn m<sup>3</sup> are needed to sustain river ecosystems and marshlands, Iraq's water consumption and supply are in precarious balance.

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<sup>33</sup> The octane rating of Iraq-produced gasoline ranges from 74 to 85, compared to Euro IV standards of 95 to 98. Iraqi gasoline sulfur content of 10,000 ppm compares to the Euro IV standard of 10 ppm. The lead content of Iraqi gasoline is 0.2 g/liter, compared with no lead allowed under Euro IV standards.

**Exhibit 3 - 10: Iraq's National Water Balance**



1) Provision of water within rivers to maintain downstream ecosystem, mainly to support the Marshlands  
 Source: FAO Aquastat (2009); Iraq Country Water Resource Assistance Strategy; addressing Major Threats to People's Livelihoods (2006); World Bank; Booz & Company analysis

Iraqi oil production at present makes relatively low demands on the country's water supply - constituting less than one quarter of one percent of the country's total withdrawals. However, as oil production increases the need for water will grow. 75 percent of Iraq's oil reserves are in carbonate reservoirs that are not suitable for gas injection and that have limited aquifer support. They require water flooding to maintain reservoir pressure. As fields are depleted, the water needed to provide incremental production will grow disproportionately. Under current production plans the water needs of oil fields could rise to more than 3 percent of Iraq's total fresh water withdrawal levels. Meanwhile, the economic growth that is expected to accompany increased hydrocarbon production will place further demands on Iraq's already stressed water supply.

It is therefore desirable to find ways other than freshwater withdrawal for supplying water to oil operations. Two sources can potentially be developed for this purpose. The first is water produced in oil drilling. This "produced water" comes out of oil fields and can be re-injected after appropriate treatment. At present, however, the treatment facilities needed for this purpose do not exist. In the absence of these facilities, produced water is simply injected into non-oil-producing geological formations or into ponds to evaporate. This water contains significant amounts of dispersed oil, dissolved organic components, treatment chemicals, and salts. It damages soil and can infiltrate freshwater aquifers.

The second potential alternative source of water is treated seawater from the Gulf. It too requires substantial infrastructure investment for intake, treatment, and piping. Iraq currently plans to develop a Common Seawater Supply Facility (CSSF) for this purpose, to be built in the south to supply the southern oil fields. CSSF supply is expected to reach approximately 0.4 bn m<sup>3</sup> per year by 2024, but oil production requirements by then may be twice that amount, even with reinjection of produced water.

**Discharge of liquid effluents.** Iraq lacks the infrastructure needed to capture and treat the liquid waste generated by industrial processes: oil and grease and other hydrocarbon mixtures, salts, metals, and mercury. These materials are all toxic to varying degrees, affecting human respiratory and neurological systems, and some are highly carcinogenic.

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According to surveys conducted by Iraq's Ministry of Environment, approximately one-third of liquid effluents from industrial facilities is discharged onto land, another third into rivers, and one-fifth into the sewerage network, which lacks the chemical treatment capabilities and capacity needed to handle these effluents. Less than 15 percent of liquid effluent waste is captured or recycled. In addition, oil and gas upstream production processes discharge untreated produced water into ponds, where it can cause soil and shallow aquifer pollution, or into geological subsurface structures, where it can contaminate nearby deep aquifers.

**Solid waste generation.** Similarly weak control is exercised over solid waste generated through industrial processes. The energy sector generates solid pollutants including chemical-laden drilling waste from upstream production, tank bottom sludge, scrap material, spent catalysts, and discarded oil drums. The unmanaged disposal of solid waste leads to soil contamination and dispersion of potentially toxic materials. Iraq lacks sufficient waste infrastructure capacity to collect and treat industrial solid waste in accordance with environmental guidelines. Today industrial waste in all sectors is typically left on site or sent to landfills for disposal with municipal waste.

**Land use.** The energy sector accounts for approximately 2 percent of total land use in Iraq. Most of this land use involves upstream oil operations. As energy development proceeds, and especially as oil infrastructure grows, encroachments on populated areas and on agricultural land will increase. These encroachments will need to be managed so as to accommodate different land uses and to optimize the value to which land is put. As Iraq expands its land use, it also will have to deal with left-over ordnance from its recent wars. According to UN estimates 20 million landmines and 2.6 to 6.0 million cluster bombs contaminate Iraq's oil fields and farmlands.

Many of these environmental challenges can be addressed effectively through infrastructure development. Gas flaring, power generation inefficiency, poor power availability, substandard transportation fuel, and excessive water withdrawal will all be ameliorated once a functioning natural gas system and an efficient power generation fleet are in place, once refineries are upgraded, and once water treatment facilities are built. In this respect, balanced development of the energy sector will significantly improve the sector's environmental impact notwithstanding increases in production level.

Other challenges, such as pollution from industrial processes, will require technological and locational choices that depend on governmental policy and regulation. Control and handling of liquid and solid wastes in all sectors of the economy will require strong environmental management by the government. The location of power generation and heavy industry away from urban centers and rivers will require coordinated land planning.

Environmental management at the national level involves four areas of activity. Iraq is stronger in some of these areas than others.

- **Environment policy setting.** Iraq's formal commitment to environmental sustainability is strong. The Constitution establishes environmental sustainability as a national priority, and the National Development Plan reflects that commitment in its vision and objectives. These objectives include promoting sustainable development, monitoring the environment, protecting air quality, protecting water from pollution, ending desertification, promoting environmental awareness, reinforcing regional and international environmental agreements, and developing and building capabilities in environmental management.

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- **Development of a regulatory framework.** Laws are in place covering nearly all important environmental areas: emissions into air, effluents into water and onto land, water use, waste management, decommissioning and abandonment, and facility design.<sup>34</sup> Locational restrictions, pollution-control equipment standards, and self-monitoring requirements are also established.
  - **Enforcement.** Iraq's system of enforcement is not yet as strong as its formal policies and regulations. Sanctions are not clearly specified or administered, and inspectors lack a system of graduated, proportional penalties to induce compliance. The financial and human resources available to the Ministry of Environment are not sufficient to provide full coverage of all affected industries. Encouragingly, the Ministry of Environment is expanding rapidly, growing from a staff of 700 in 2006 to a staff of 1600 in 2011. This increase in staff will need to be accompanied by a strong program of technical and administrative training and development. Staff also will require the support of strong IT systems and an integrated national database, neither of which the Ministry currently has.
  - **Monitoring.** The Ministry of the Environment prepares annual reports on the state of the environment, but the detailed and consistent collection of data on emissions and effluents over time needed for systematic enforcement is lacking. The Ministry will need to develop a comprehensive set of indicators across all environmental areas so that it can identify trends, track progress, and detect emerging issues.

As the Ministry of Environment develops the capabilities to monitor and enforce the strong environmental policies that Iraq has adopted, it also will need to develop mechanisms for coordination with other government agencies - in particular the Ministries of Oil, Electricity, Industry and Minerals, and Water Resources. These Ministries should constitute joint action plans and working committees to address specific environmental challenges. They should collaborate in developing processes for permitting and licensing, and they should share common environmental databases.

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<sup>34</sup> Iraq's regulatory coverage is consistent with international best practice, with two exceptions: no clear limitations are specified concerning discharge of liquid effluents onto land, and no explicit provision regulates decommissioning of industrial facilities so as to restore the natural environment.

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## 4. Strategy Framework

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### 4.1. Overview

Strategy consists of determining the means to achieve a desired result. The INES strategy framework therefore begins with a statement of aim: the INES vision. From that vision it establishes a set of valuation criteria against which potential choices can be compared.

Attaining that vision will involve numerous - indeed hundreds - of choices. Among this multitude, however, the primary choices identified in Chapter 2 are the most significant. How these choices are made and combined will define Iraq's energy strategy.

In order to make these choices, an understanding of the energy sector's basic economic components is needed: supply, demand, and resource allocation priorities. These are the basic INES building blocks that determine the potential flow of energy resources, the value to be gained from them, and the infrastructure needed to capture that value.

This current chapter lays out the INES strategy framework: the vision, the evaluation criteria, and the building blocks. The following chapter, Chapter 5, discusses the choices and plans that result.

### 4.2. Vision Statement

The INES vision statement is grounded in the baseline analysis provided in Chapters 2 and 3. Clearly, Iraq's energy sector offers great potential for creating national wealth and for supporting a diverse economy and a productive society. However, it also is beset with obstacles: weak infrastructure, poorly focused governance institutions, and underdeveloped skills. These problems span all elements of the energy sector.

Over the course of numerous discussions with the INES Project Steering Committee regarding these opportunities and pitfalls, it was recognized that a principal aim of INES must be *coherence and comprehensiveness*. The energy sector is composed of interconnected parts. The challenges in one subsector cannot be solved without solving challenges in the other subsectors. Although the many institutions within the energy sector will have specific agendas, they need to pursue them in harmony to a larger common agenda.

It also was recognized that INES must be *sustainable* in the face of changes in circumstance and across a wide range of contingencies. It should establish a basic framework of objectives and initiatives that is robust under a wide range of contingencies, while providing room for adaptation in the details.

The major *environmental impact* of the energy sector was acknowledged, and a commitment was made to pursue energy development in ways that best serve Iraq's environmental objectives.

In addition to adopting these principles, the Project Steering Committee agreed on several specific policy goals:

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- *To meet domestic energy needs.* In light of Iraq’s abundant energy resources, and its desire for economic stability amid a politically evolving region, Iraq should aim to achieve energy security - to supply its domestic needs for energy and energy products as much as possible through its own domestic resources and manufacture.
  - *To encourage economic diversity.* Iraq’s economic vulnerability to oil prices and production levels, and the distortion that any dominant source of wealth can introduce into a national economy, require a plan of energy development that encourages long-term economic diversification and balance.
  - *To improve the country’s standard of living.* As Iraq emerges from decades of war and sanctions, it will need to invest heavily in infrastructure, education, industry, and health. The energy sector must supply not only the financial resources needed for this investment but also the power, the fuel, and the feedstock needed for sustaining economic activity and improving personal welfare.
  - *To create employment.* Iraq’s growing population needs to be provided opportunities for productive contribution. The energy sector itself can provide employment opportunities, but more importantly it can stimulate the broad growth in the rest of the economy needed for diverse and widespread employment growth.
  - *To assume an important role in regional and global energy markets.* Iraq’s resource advantages give it the opportunity to re-establish the country as a responsible, dependable, and valuable member of the international community. By means of its energy resources, Iraq can achieve an influential and respected role in the world economy.

These principles and goals resulted in the following INES vision statement:

*“Develop the Energy sector in a coherent, sustainable and environment-friendly manner to meet domestic energy needs, foster the growth of a diversified national economy, improve the standard of living of Iraqi citizens, create employment, and position Iraq as a major player in regional and global energy markets”*

### **4.3. Strategy Evaluation**

Based on this vision statement, five quantitative dimensions of evaluation have been defined. These dimensions provide a means for evaluating and comparing the impacts of any given strategic choices and for recognizing potential trade-offs among the different goals stated in the INES vision.

- **Energy security** is defined as the proportion of domestic demand for energy- related products that is supplied from domestic production. The aggregate measure is calculated as the arithmetic average of these proportions for each product in each year between 2012 and 2030. The higher the performance on this dimension, the fewer energy-related imports are required and the less vulnerable Iraq is to external disruption of supplies.
- **Government value maximization** is defined as the net present value of projected government cash flow from the energy sector, using a nominal discount rate of 7 percent. This cash flow figure nets out capital and operating expenses from revenue. The higher the performance on this dimension, the more funds will be available for investment in

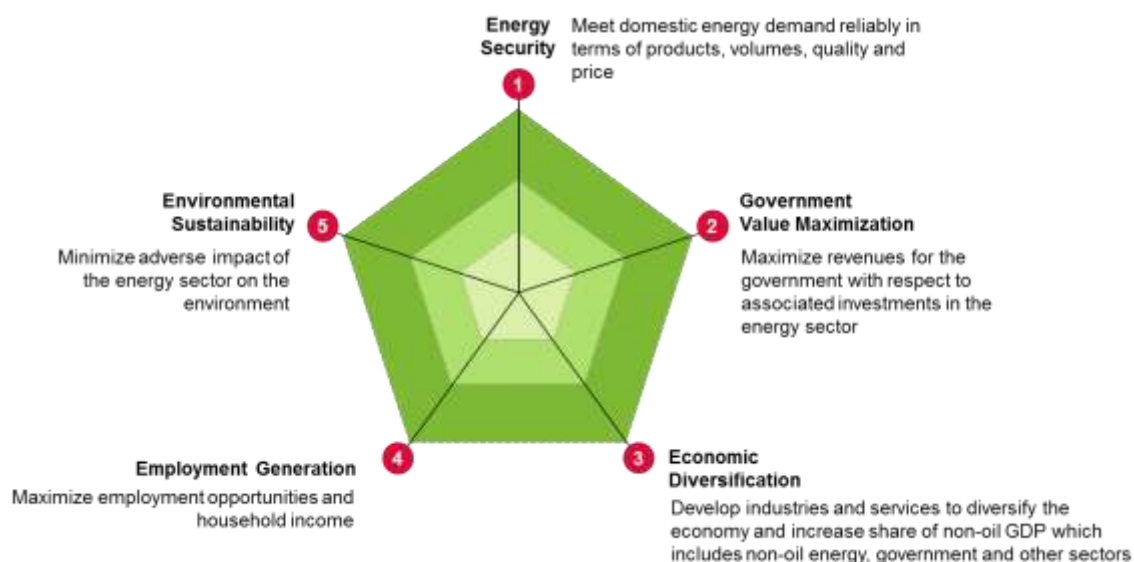


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broad economic development: transportation, schools, communications, health, housing, and general welfare.

- **Economic diversification** is defined as the ratio of real non-oil and gas GDP to total real GDP. The higher the performances on this dimension, the less vulnerable the economy is to swings in oil price or oil production, and the more balanced the country's social, educational, and economic development.
- **Employment generation** is defined as the number of jobs created as a consequence of energy-sector development. This number consists of three categories of employment: (1) direct employment within the energy sector due to energy-sector activity, (2) indirect employment in the non-energy private economy induced by government re-investment of energy revenue and by the improved availability of fuel and power, and (3) increments to government employment necessitated by significantly increased levels of government investment and economic activity.
- **Environmental sustainability** reflects the environmental stress imposed by the energy sector on a scale from 1 (for worst) to 5 (for best). The indicator corresponds to the weighted average of five components: GHG emissions (10%), particulate emissions (20%), SOx emissions (20%), lead emissions (20%), and water withdrawals (30%).

**Exhibit 4 - 1: Strategy Evaluation Dimensions**



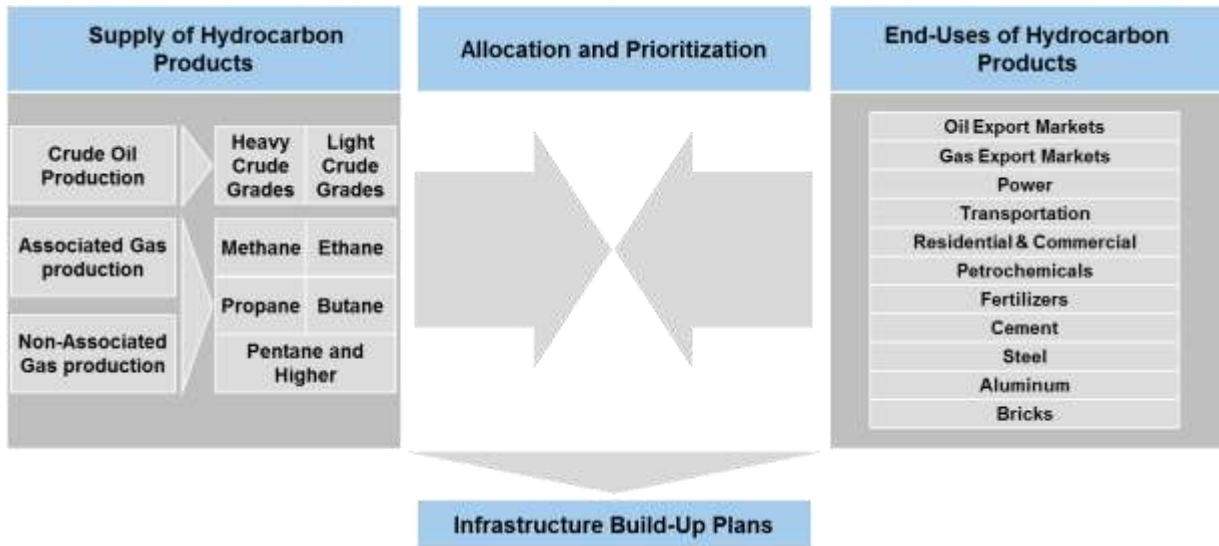
#### **4.4. INES Building Blocks**

The vision statement establishes what INES aims to accomplish. The strategic objectives provide evaluation criteria against which potential strategies can be compared.

In order to accomplish this vision and to satisfy these criteria, it is necessary to identify the basic components of Iraq's energy sector and to understand the ways in which they interact. These components and their relationships constitute the building blocks of any feasible energy strategy. They fall into three categories: the quantity and type of energy *supply* that can be made available, the quantity and type of *end-uses* to which that supply can serve, and the *allocation and prioritization* of supply to end-uses. These building blocks determine Iraq's

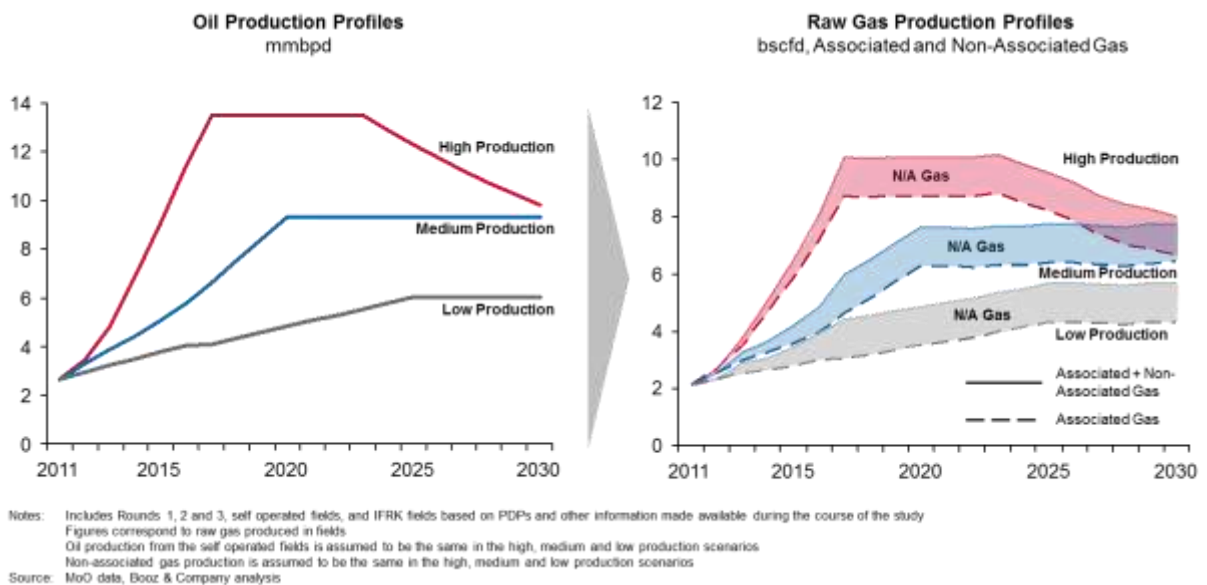
needs for energy infrastructure and the appropriate sequence and schedule of infrastructure development.

**Exhibit 4 - 2: INES Building Blocks**



**Supply.** As discussed in chapter 2, the potential year-by-year supply of crude oil and gas is described by three production profiles: High, Medium, and Low. The volumes of oil and gas produced under these profiles, together with their particular composition as estimated from current field development plans, determine the supply of hydrocarbon products potentially available. These products include different potential grades of crude oil and the various separable components of raw gas such as methane (C<sub>1</sub>), ethane (C<sub>2</sub>), propane (C<sub>3</sub>), and butane (C<sub>4</sub>).<sup>35</sup>

**Exhibit 4 - 3: Oil and Gas Supply Scenarios**

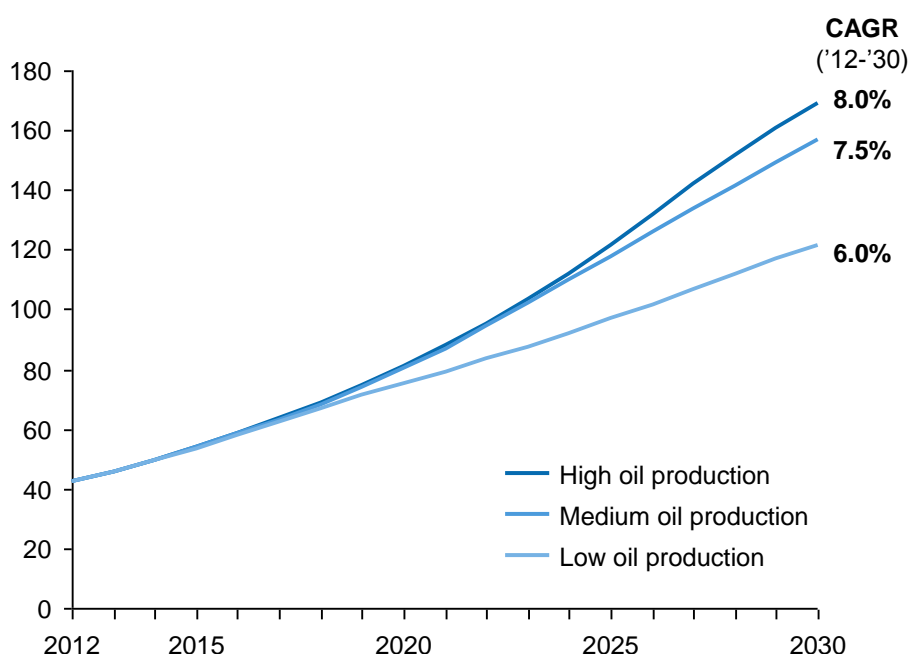


**End-Uses.** Demand consists of two broad components: export and domestic. *Domestic demand* for energy end-use products is strongly correlated with macro-economic growth factors in

<sup>35</sup> Please see Appendix E for further discussion of these hydrocarbon products and their potential applications.

the non-oil sectors of national economies. Because these growth factors are sensitive to government investment levels, which in turn depend substantially on oil revenue, different Iraq oil production scenarios are associated with different levels of domestic demand for end-products. Demand projections also reflect an expectation that Iraq will engage in substantial reconstruction during the next five years. This effort is expected to provide above-average levels of economic growth and in particular to accelerate demand for construction-related products such as bricks, cement, and steel.

**Exhibit 4 - 4: Iraqi Real Non Oil & Gas GDP Growth Forecast  
Under Alternative Oil Production Profiles**  
Billion Iraqi Dinars (1988 base year)<sup>36</sup>



Between 2010 and 2030 Iraq's non-oil GDP is expected to grow at a compound annual rate of 7.5% under the medium oil production scenario. Iraq's population is expected to grow during this period at a rate of 2.8%. Based on these forecasts, and applying correlations observed in other countries, domestic demand for power, transportation, heating and cooking fuels, cement, steel, bricks, aluminum, fertilizers, and petrochemicals has been calculated for the period between 2012 and 2030.<sup>37</sup>

<sup>36</sup> The Government of Iraq uses 1988 as its base year for calculating real GDP. For the sake of consistency, INES uses the same convention in projecting real GDP.

<sup>37</sup> Please see Appendix E for specific domestic demand analyses regarding each product and for more detailed assessments of export opportunities.

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**Exhibit 4 - 5: Forecasted Domestic Demand at Medium Oil Production**

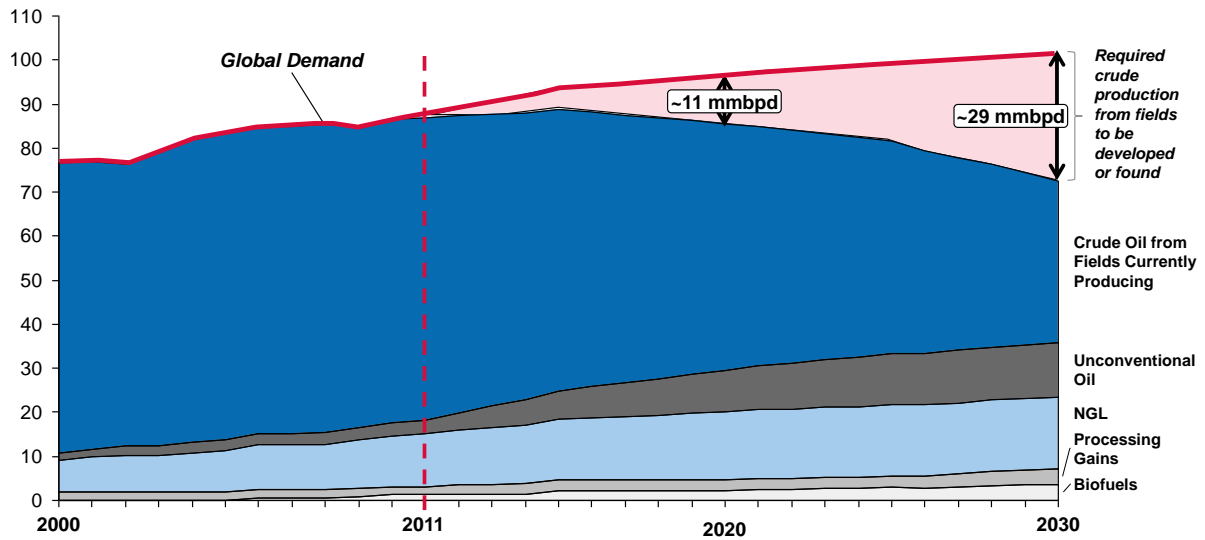
<b>End-Use Application</b>	<b>2012</b>	<b>2020</b>	<b>2030</b>
Power peak demand (GW)	16	24	36
Transportation			
- Gasoline (kbpd)	141	211	279
- Jet fuel (kbpd)	5	9	12
Heating & Cooking (residential and commercial)			
- LPG (000 Tons/d)	4.0	6.0	8.0
- Kerosene (kbpd)*	46	44	42
Steel (MTPA)	2.9	5.9	8.7
Cement (MTPA)	19.2	39.7	58.2
Bricks (MTPA)	43.0	55.0	65.0
Aluminum (MTPA)	0.1	0.3	0.4
Urea (MTPA)	1.1	1.9	2.5
Petrochemicals (MTPA)	0.2	0.6	1.0

Note\*: expected to be displaced by LPG and power

The *export potential* for Iraq's energy products is estimated on the basis of global and regional market demand and Iraq's potential for establishing a competitive advantage.

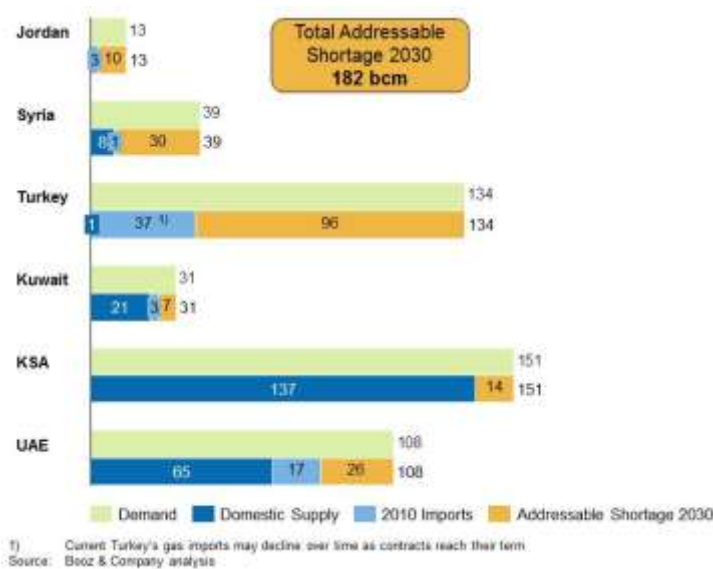
- Crude oil.** According to estimates by the International Energy Agency (IEA), worldwide demand for oil over the next twenty years will increase by slightly less than one percent per year. During that time, worldwide output from currently producing fields is expected to decline by 5 percent per year. Given the resulting need for additional world oil supply, and given Iraq's low oil production costs, it can be assumed that Iraq is likely to find markets for its crude oil production under any of the contemplated production scenarios. How much additional production Iraq will be able to inject into the world market without causing a material decline in world oil price is less clear. A range of scenarios for Iraqi oil exports by 2020 were assessed based on current market conditions. As these conditions change and supply and demand equilibrium shifts, the impact of Iraq's production needs to be continually reassessed.

Exhibit 4 - 6: World Liquids Supply by Type (IEA 2012)



- Natural gas.** Iraq's future production of natural gas also is likely find receptive export markets. Substantial gas shortages are expected over the next twenty years in the Middle East. Iraq has abundant, though currently underdeveloped, supply, and it has existing pipeline infrastructure that could be rehabilitated to support exports to the region. INES assumes that regional markets will be available for as much dry gas as Iraq produces, so long as infrastructure is available and reliable supply can be guaranteed

Exhibit 4 - 7: 2030 Middle East Gas Balance by Country  
bcm



In the LNG market, global supply and demand appear to be in balance until at least 2014. Beyond that timeframe, as shale gas reserves are developed in North America and elsewhere, the supply-demand situation is uncertain. However, the amount of LNG currently under consideration by BGC is relatively small (6 bcm/year, one LNG train) and is likely find a market.

## Exhibit 4 - 8: Global LNG Liquefaction Capacity vs. Demand bcm



Source: BP Statistical Review of World Energy 2011, Deutsche Bank Energy Seminar 2010, EIA, GRIAGL, Booz & Company analysis

- Transport fuels.** Today there is a modest global shortage of gasoil, consisting of substantial European deficits that are balanced through inter-regional trade by surpluses in the Middle East and the FSU. There is a small global surplus of gasoline, consisting of deficits in the Asia-Pacific region and North America that are balanced by surplus in the Middle East and Latin America. The long-term global supply balance for both products is uncertain, particularly with the development of hybrid transportation technologies. An export market is likely to be available for Iraq's production of gasoil and gasoline, but will depend on evolving market dynamics that are difficult at present to predict.
- LPG.** The Middle East currently exports LPG to Asia, but Asian demand growth is expected to outstrip current Middle East surpluses by 2020. Iraq LPG exports could help fill that gap.
- Power.** Regional power demand is growing at a rate of 7 to 10 percent each year. In the long term Iraq's advantage in natural gas production could position it to become a regional power exporter and to take advantage of reserve-sharing efficiencies.
- Petrochemicals.** In petrochemicals Iraq has a strong potential competitive position due to the abundance of its natural gas reserves and the high ethane content of those reserves. Other suppliers from the Middle East are facing long-term ethane shortages that are likely to drive up their costs, giving Iraq an advantage in serving a global market that is expected to grow at more than 4 percent per year.
- Fertilizer.** Iraq has an opportunity as well in the global fertilizer market, which is expected to grow at a rate of nearly 5 percent per year. Iraq has abundant supplies of methane, which provides the primary feedstock for fertilizers, and could likely make inroads into this market, particularly through exports to South Asia.
- Aluminum.** World demand for aluminum is expected to grow at a rate greater than 5 percent and will likely provide a long-term export opportunity given Iraq's potential cost advantage in methane.



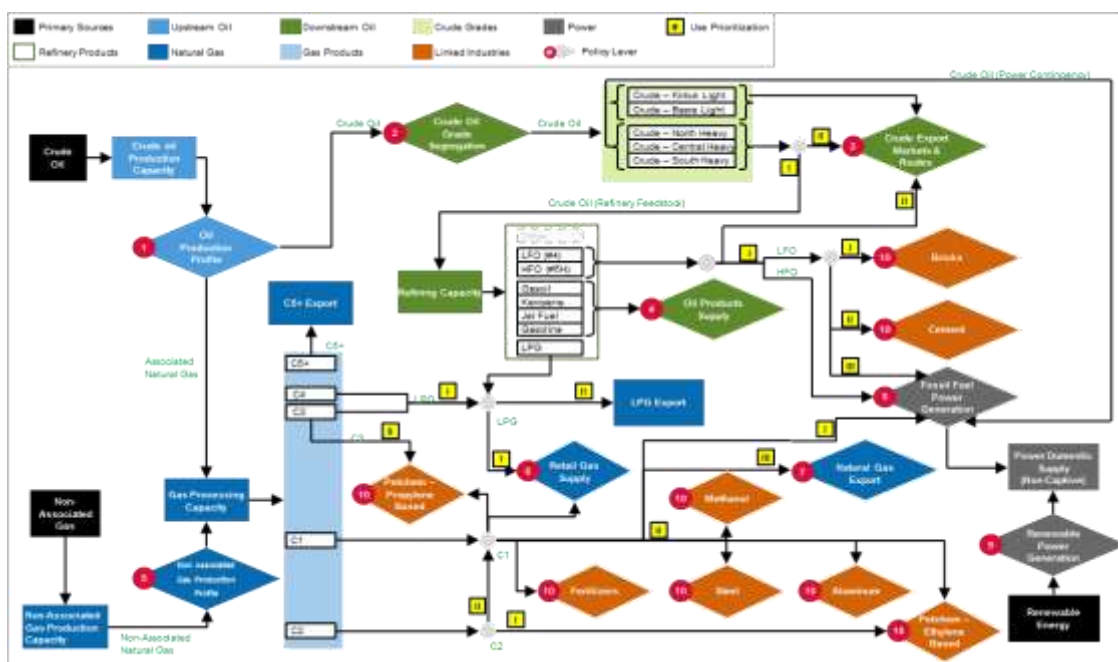
- **Construction materials.** Because transportation constitutes a significant portion of the delivered cost of steel, bricks, and cement, it is not apparent that Iraq has any significant export advantage in these products. Given the rapidly growing domestic demand for these products, however, significant industry growth can be achieved simply by serving domestic needs.

Iraq, then, appears to have strong export potential in crude oil, dry gas, petrochemicals, fertilizers, and aluminum. It can expect to find opportunistic export markets for refined products. Its potential to export steel, bricks, and cement appears limited.

**Economic Allocation.** Given these potential supplies and end-uses, and the multiple conversion steps required to connect the two, a large number of options are possible regarding volume allocations. Sifting through these options and comparing them to each other requires a tailored economic model. An Integrated Energy Model (IEM) accordingly has been developed to capture the interactions of the energy sector’s many components and to calculate the consequences of alternative allocation choices.

Exhibit 4-9 displays the primary nodes of the IEM and indicates the paths of interconnection that shape overall system results. The model is built around five core calculation modules corresponding to upstream oil, downstream oil, natural gas, electricity, and linked industries. These modules include supply and demand profiles for the various energy products produced in each of the subsectors. They also include technical assumptions regarding technology and infrastructure and financial assumptions concerning product value and investment requirements. The IEM integrates these interdependent modules to determine product flows and to establish an overall energy balance under any given set of financial, capital, allocation, and timing assumptions. Combining these outputs with assumptions regarding environmental and macroeconomic impact, the IEM generates performance assessments aligned with the five strategic evaluation metrics of the INES vision.

**Exhibit 4 - 9: Integrated Energy Model (IEM) Schematic**

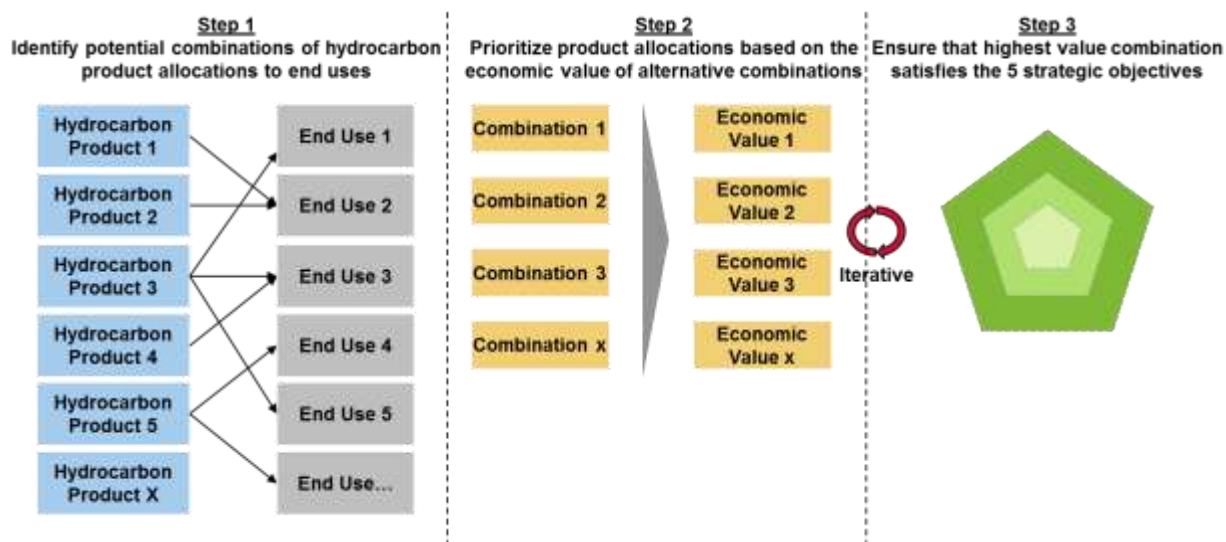


Product values in the IEM have been assigned at international price levels. The price of crude oil historically has been a fundamental driver of oil-product prices; as crude price rises or falls, oil-product prices tend to rise or fall commensurately. Regression analysis over time indicates strong persisting correlations among these products. It is assumed for modeling purposes that international hydrocarbon product prices will retain the same general value relationship to each other that they have demonstrated historically. The costs of transport and conversion at each step of the value chain have been estimated on the basis of regional unit-cost benchmarks.<sup>38</sup>

Employing these price and cost assumptions, and factoring in costs of conversion and transport, the IEM has assessed virtually all feasible allocation combinations that match available product volumes to projected levels of demand (Step 1 in Exhibit 4-10). For purposes of defining these feasible combinations, it is assumed that all supply is allocated to some purpose, either to domestic consumption or to export, and that all domestic demand is met either from domestic sources or from imports. For example, a combination that exports all crude oil will need to satisfy domestic needs for refined products entirely through imports.

Because any particular use creates greater or less value than other uses, and because the costs of conversion and transport vary among uses, these different allocation combinations yield different overall system economic outcomes (Step 2 in Exhibit 4-10). They also have different impacts on the other dimensions of INES performance: energy security economic diversity, employment creation, and environmental sustainability. These additional impacts are assessed along with economic results to identify the allocation combination at any given level of production that best satisfies the INES strategy evaluation dimensions (Step 3 in Exhibit 4-10).

**Exhibit 4 - 10: Approach to the Prioritization of Hydrocarbon Allocation**

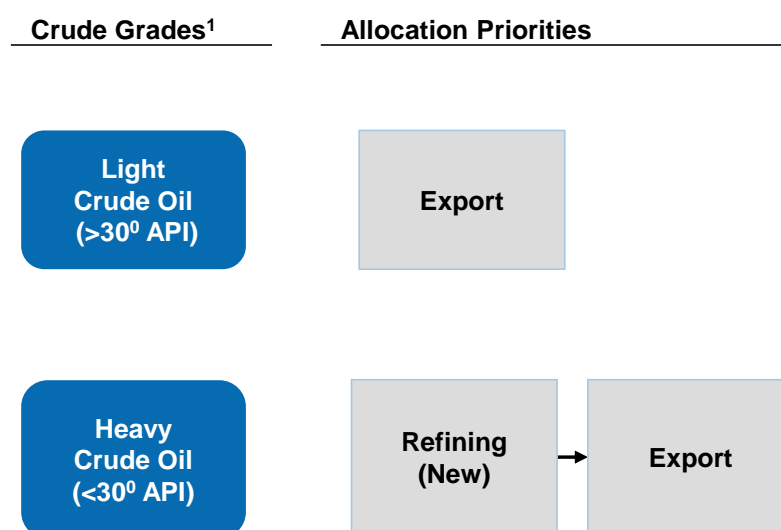


<sup>38</sup> Please see Appendix G for details of price estimates and cost assumptions and for regression analyses of the relationships between crude oil price and oil-product price.

An important finding from this process is that the preferred priority sequence calculated for each product is valid under a broad range of supply assumptions. Whether oil production levels are low, medium or high, the priority of allocation for each hydrocarbon product remains the same. What varies under these different scenarios is not the priority sequence but rather how far along the priority sequence available volumes can reach. On the other hand, the priority sequence is sensitive to timing, since an otherwise desirable pattern of deployment might not yet be supportable by existing infrastructure. This sensitivity to timing is an important factor in designing the INES investment plan.

The INES prioritization sequence for each major hydrocarbon product can be summarized as indicated in the following three exhibits. In each sequence the higher-priority use should be satisfied before the next priority is addressed.

#### Exhibit 4 - 11: Allocation Sequence of Crude Oil Grades

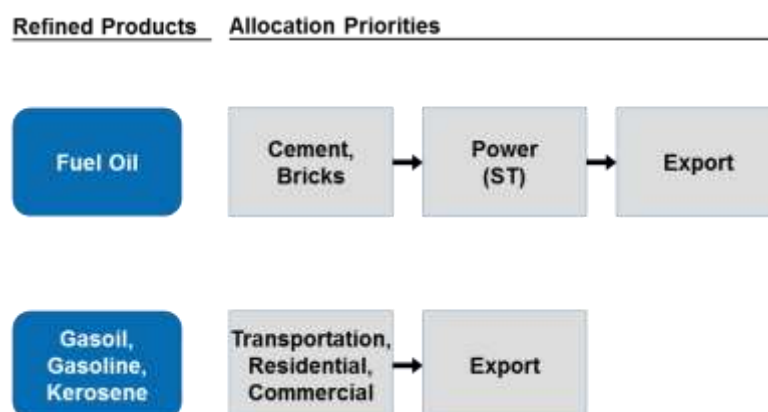


1) The API ranges of different grades correspond to the weighted average of the APIs of produced crudes that are blended together to constitute the particular grade

Source: Booz & Company analysis

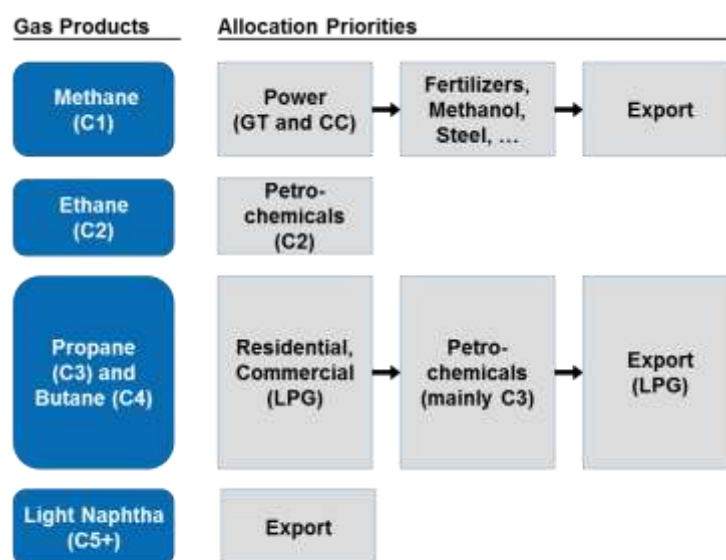
- Light crude grades (above 30 API) command a price premium in international markets and create the greatest value for Iraq as an export product. This preferred allocation sequence for light crude is constrained in practice, however, by the configuration of current Iraqi refineries, which at present are able to refine only light grades of oil. Until refineries are upgraded, light crude will need to be diverted from export to refineries as needed to sustain domestic production of refined oil products. Once that need is satisfied, light crude should be exported.
- Heavy crude oil (below 30 API) provides most value to the energy sector when allocated to refineries. By displacing light crude as a refinery feedstock, it frees light crude for export. This is an advantageous trade-off, because light crude is less expensive to transport and is more marketable in world markets than heavy crude. Heavy crude also is a more suitable refinery feedstock than light crude for conversion into the oil product mix that Iraq needs, assuming that refineries of sufficient complexity are available to process it. Until those refineries are developed, heavy crude will need to be exported.

## Exhibit 4 - 12: Allocation Sequence of Refined Oil Products



- The value of fuel oil for Iraq's energy sector is greatest when applied to cement and brick manufacture. After that need is satisfied, fuel oil should next be assigned to power production from steam turbines.<sup>39</sup> The natural gas displaced by this allocation has higher-value applications elsewhere. The fuel oil remaining once demand from manufacturing and power generation has been met should be exported.
- Light and middle distillates like diesel fuel, gasoline, and kerosene are needed to serve domestic transportation, residential, and commercial demand. To the extent that there is an excess of any of these products, it should be exported.
- Current and projected refinery configurations are not planned to yield heavy naphtha. For purposes of ethylene and propylene petrochemical chains, ample amounts of ethane and LPG's will be available, and heavy naphtha will not be needed. In the event that heavy naphtha is produced in the future, it could be used as a petrochemical feedstock for aromatics, or it could be exported depending on market conditions.

## Exhibit 4 - 13: Allocation Sequence of Gas Products



Note: INES distinguishes between light and heavy naphtha; Light naphtha refers to the product of gas processing with hydrocarbon chains of more than 5 Carbon atoms (C5+); heavy naphtha is a product of refining with chains up to ~12 Carbon atoms  
 Source: Boaz & Company analysis

<sup>39</sup> Fuel oil should not be used in gas turbines, as it is not only less thermally efficient for that purpose than natural gas but also increases significantly the maintenance cost of generation units.

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- Because of the generation efficiencies to be gained from using natural gas in power production, the most valuable allocation of methane (C<sub>1</sub>) is to power. To the extent that methane displaces crude oil from power applications, it frees up those products for higher-value allocation to export. Once power needs are met, methane's highest-value application is to industry, where it can fuel heat, steam, or captive power, and where it can provide feedstock to fertilizer and methanol plants. The projected quantities of methane available after 2015 are ample to cover both power and industry requirements. In the meantime, whatever methane supplies are currently being used by industrial plants should continue to be provided to them.
  - Ethane (C<sub>2</sub>) is a valuable feedstock for petrochemicals. It should be separated and provided to petrochemical plants as needed.
  - LPG's highest value use is for domestic and residential consumption. Once that demand is satisfied, LPG should be allocated to petrochemicals for use in propylene and butadiene chains. The remaining LPG after petrochemical needs are satisfied should be exported.
  - Light naphtha (C<sub>5+</sub>) can be used in petrochemicals, but provides lower margins than ethane. Since Iraq will have sufficient ethane to support its planned petrochemical capacity, light naphtha's highest value for Iraq will come from export.

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## 5. Strategy Formulation

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### 5.1. Overview

The review of Iraq's baseline conditions provided in Chapter 2 posed several strategic choices. Section 5.2 of the current chapter provides recommendations with respect to each of those choices, based on the framework of vision, metrics, and building blocks discussed in Chapter 4. These recommendations lead to an integrated plan of objectives and initiatives, set forth in Section 5.3. This plan constitutes the economic dimension of INES: the investments, the cash flows, the resource allocation and phasing, and the economic impact. Section 5.4 evaluates the projected results of this plan, and Section 5.5 identifies its principal sensitivities and risks. The following chapter, Chapter 6, addresses the institutional support and reforms needed to implement this plan successfully.

### 5.2. Strategic Choices

The energy sector baseline review presented in Chapter 2 identified several fundamental strategic choices. How these choices are resolved defines Iraq's energy sector strategy.

#### Exhibit 5 - 1: Strategic Choices

- **Oil production:** What level of crude production to achieve and by when
- **Crude oil segregation:** What segregation approach to adopt and what discrete crude grades to create
- **Refineries:** Whether Iraq should import, be self-sufficient, or export refined products; what capacity and configuration of refineries to develop and by when
- **Crude oil commercialization:** What global markets to serve and what export routes to develop
- **Balancing gas production and demand:** How best to serve domestic needs and export opportunities, given volumes of production that are largely set by Iraq's oil production agenda
- **Generation technology mix:** What technology mix to choose for Iraq's generation fleet given the fossil fuel supply in order to provide the power Iraq needs in the most efficient, environmentally sustainable way
- **Linked industries capacity.** Whether to develop industry to serve domestic markets only, or to develop also a substantial export position



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## **Oil production.**

Expected oil production is the foundation of INES projections for hydrocarbon product volumes, energy sector infrastructure requirements, and economic and environmental outcomes. For reasons discussed in Chapter 2, oil production forecasts today are uncertain. Accordingly INES has defined scenarios reflecting High, Medium, and Low production profiles<sup>40</sup>. For purposes of strategy development, a base case production expectation needs to be set. Alternative scenarios can then be used to test the sensitivity of strategic choices to this base-case assumption.

The INES short-term target for oil production follows the production levels agreed to by TSC field operators. Over the next three years production should ramp up at the fastest feasible pace, and field operators should push to achieve their committed volumes, consistent with the High production profile. The cash flow generated from this production increase will initiate a vital sequence of energy-sector investments that need to be made immediately. For this reason increased oil production has the highest priority.

During this ramp-up period, the field operators will be learning more about their assigned oil fields. They will be preparing analyses culminating in the submission of Field Development Plans (FDP's) and Enhanced Development Plans (EDP's) that will describe in detail the potential and the costs involved in long-term field development.<sup>41</sup> Based on these reports, which will be submitted by the end of 2013, Iraq will have far more knowledge about its oil fields than it has today, and will be in a strong position to set long-term production policy based on confirmed reserves and best practices in field management.

The recommended short-term production target will position Iraq in 2015 to move toward any of the three long-term production scenarios. If Iraq chooses to target the Low-production plateau, it can hold steady at the level of production already achieved. If it chooses the High-production plateau, it can continue on the ramp-up path it is already following. If it chooses the Medium-production plateau, it can continue increasing production, but at a slower ramp-up rate.

Pending the establishment by 2015 of revised long-term production targets, INES takes the Medium production profile as the base case for infrastructure planning. This appears now to be the most likely of the three production profiles. It also limits the costs of being wrong. Planning infrastructure commitments now based on the High scenario could lead to unnecessary investment if production comes in lower; planning for infrastructure based on the Low scenario could lead to stranded resources and bottlenecks if production comes in higher. The Medium-scenario infrastructure could be expanded within an acceptable lead time if needed to accommodate higher production than planned, and it could be downsized for lower production without undue overinvestment.

The INES oil production target is thereby hedged. The ramp-up rate for the next three years aims at a minimum production level of 4.5 mmbpd by the end of 2014. This ramp-up target is consistent with any of the long-term plateau projections. For purposes of long-term infrastructure planning INES assumes the base-case production plateau of the Medium

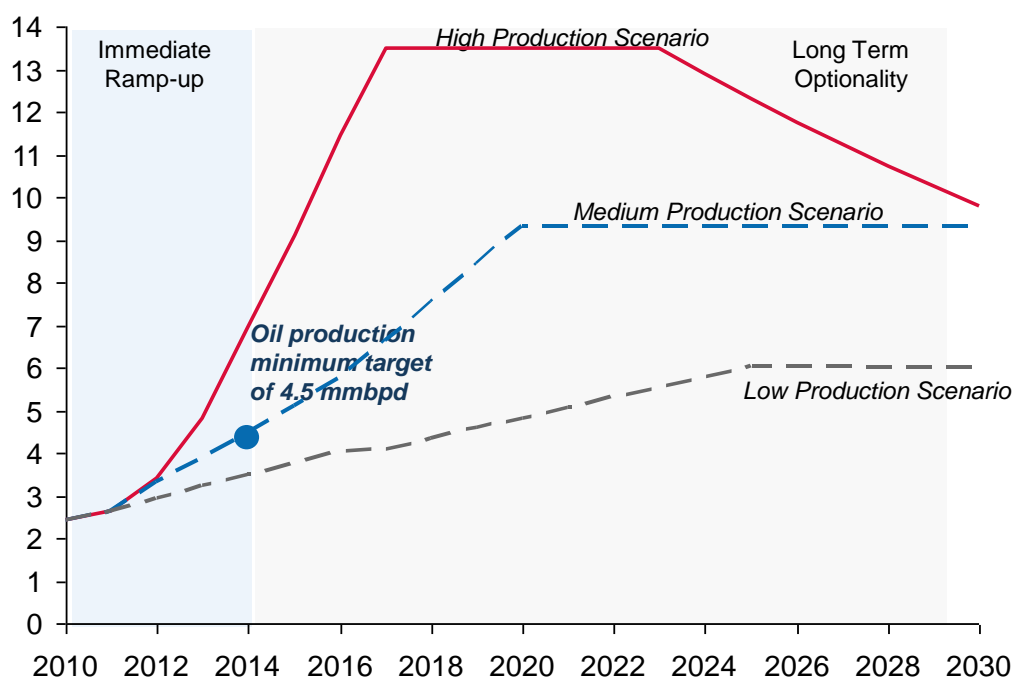
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<sup>40</sup> Please refer to Chapter 2 for a discussion of the basis for the three profiles. Further details are provided in Appendix A.

<sup>41</sup> Field Development Reports apply to greenfield production; Enhanced Development Reports apply to brownfield production.

profile for the present, and recommends that a reset of production targets be made in 2014 based on information then available.

**Exhibit 5 - 2: INES Oil Production Targets**  
mmbpd



The optionality provided by this choice is valuable not only in light of current supply uncertainties but also in light of world market dynamics. Long-term IEA projections suggest a shortfall of world oil supply of approximately 11 - 29 mmbpd between 2020 and 2030.<sup>42</sup> Iraq will be a major contributor to filling this gap, but not the only one, and discontinuities in demand are inevitable. The more oil Iraq adds to supply, all other things being equal, the greater the likelihood that price will decline.<sup>43</sup> As part of the long-term production policy that Iraq sets beginning in 2015 it should aim for a level of production capacity that gives it flexibility to manage its production output dynamically in view of evolving market conditions.

Iraq was one of five founding members of OPEC, and it continues to be a member, although since 1998 it has received no official production allocation. During the late 1980's Iraq's OPEC production allocation was approximately 15 percent of total OPEC production. At that

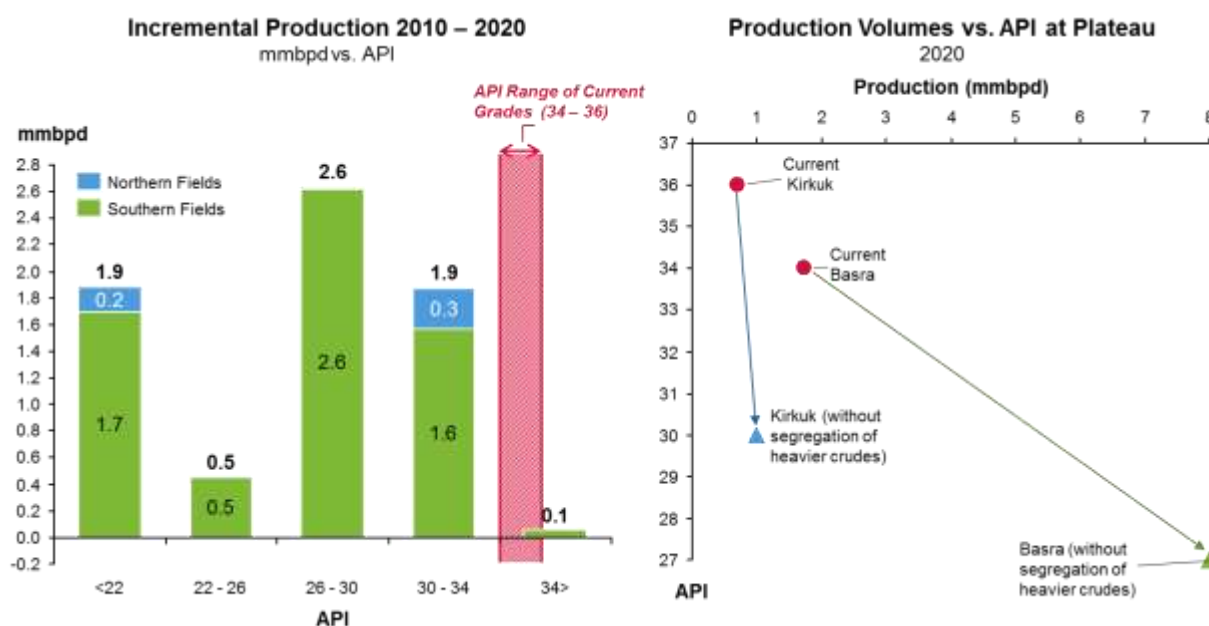
<sup>42</sup> Please refer to Exhibit 4-6. The projected shortfall is based on existing sources of supply.

<sup>43</sup> At high-scenario production levels, Iraq would contribute about 3 mmbpd more to world oil supply than at medium-scenario production levels. If prices are the same between the two scenarios, then the former obviously produces substantially more cash flow. The NPV's of the 2012-2030 cash flows become equal, however, if the price at high production is assumed to be \$10 lower than the price at medium production. Whether a 3 mmbpd increment in supply (3% of projected 2020 world demand) would likely have a \$10 impact on world oil price (9% of average assumed price) is arguable, but the risk that returns might diminish at some point of increased production clearly needs to be considered and continually evaluated.

same allocation level, Iraq would be allocated production of 4.5 mmbpd in 2015, roughly equivalent to level of exports that are expected in that year under INES.<sup>44</sup> Under the base-case scenario, Iraqi exports will plateau at 8 mmbpd beginning in 2020. This level of output or higher implies an adjustment to Iraq's traditional share of OPEC production.

**Crude oil segregation.** Iraq's current oil production is exported under market recognized brands of light crude, Basra Light and Kirkuk. Based on the known characteristics of the crude oil reservoirs of oil fields currently under development, (the 12 TSC oil fields, self-operated fields, and IFRK fields), operators will be able to increase production levels from these fields only by drawing increasingly on reservoirs with heavier grades of crude. As production increases, therefore, the average API specification and the crude assay of Iraq's current brands will likely deteriorate.

**Exhibit 5 - 3: Projected Impact of Increased Oil Production on Oil API Grades**



This deterioration presents a potential threat to Iraq's marketing position. Because refineries typically are designed to process crude grades that fall within a specification range of assays and API ratings, they have difficulty adapting to delivered crude that falls outside that range. Consequently, brand stability is an important marketing asset, especially for establishing long term supply contracts.<sup>45</sup> Moreover, because heavy crude grades require more complex and more expensive processing than light crude grades, they are priced at a discount to lighter grades. The brand stability and commercial value of Iraqi oil will be weakened by ongoing deterioration of Iraq's established light grades.

Iraq's brand reliability and price positions can be sustained if new Iraqi production is segregated into separate grade categories. Instead of blending all crude production from

<sup>44</sup> Oil export volumes are lower than oil production volumes, since some oil production is diverted to refineries, and some is used directly in power generation. Total OPEC output for 2015 is expected to be 31 mmbpd, according to the OPEC's 2011 World Oil Outlook.

<sup>45</sup> In 2010, Iraq had 35 term contracts for Basra Light and 10 term contracts for Kirkuk grade in its three main markets – Asia, Europe and Americas

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reservoirs of varying oil characteristics into the same stream, heavier production could be segregated into separate streams and channeled through a dedicated evacuation system. Such segregated streams could then be marketed and sold as crude grades with distinct crude specifications and assays, without compromising Iraq's established brands.

Crude segregation entails additional costs both upstream at the well-head and downstream in the evacuation system. The finer the discrimination among discrete grades, the lower the volumes of each grade and the higher the costs of developing dedicated infrastructure to segregate and evacuate them. Striking a favorable balance between the benefit and cost of segregation requires attention to four considerations:

- The composition of reserves in each reservoir. Each reservoir pay-zone has a different composition of oil and will yield different specifications varying along a continuum. Grade categories need to be established along this continuum that are large enough to be useful and differentiated enough to enhance market value.
- Field location. In order to minimize the additional infrastructure required for segregation, grade categories should be established that group production from geographically proximate fields. Consolidation of crude from multiple nearby sources into a single blending point will simplify transport and evacuation.
- Field development. Over time, the characteristics of oil produced from the various oil fields will evolve as field development taps into new reservoirs and pay-zones with different oil specifications. Grade categories should be defined to accommodate these shifts without the need for frequent rebranding. Conversely, field operations and development plans should be phased to comply with whatever grade segregation schemes and marketing policies are established.
- Market demand. The differential values assigned to particular grades and assays depend on developments in worldwide refining capacity, configuration, and margins. For grades with high market demand, an ideal segregation scheme would preserve existing specifications and avoid quality deterioration. For new grades with lower market demand, it would be prudent as the global refining landscape evolves to lock in long-term contracts with refineries designed for these new grades and to maintain brand identity consistent with those contracts.

Based on these considerations and based on available field data,<sup>46</sup> INES recommends the following approach to crude segregation:

- Southern Production. Many of the fields in the South (Missan group, Halfaya, W.Qurna, Rumaila etc.) draw on a mix of heavy reservoirs (e.g., Mishrif, Sadi, Khasib,

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<sup>46</sup> The reservoir characteristics of Iraqi oil fields have not yet been fully analyzed, and phasing plans for various reservoir pay-zones have not yet been consistently reported.<sup>46</sup> The proposed INES segregation plan uses data from the Preliminary Development Plans (PDP's) that were submitted by field operators in 2010. The PDP's of 6 fields (Rumaila, WQ2, Majnoon, Zubair, Halfaya and Gharraf), representing 62% of current plateau production commitments, provide clear phasing plans for reservoir production. The PDPs of 4 fields (WQ1, Badra, Qaiyarah and Najma), representing 24% of plateau production commitments, provide no reservoir phasing information. Missan Group, Ahdab, East Baghdad, Kirkuk, Bin Umar, IFRK, and other smaller fields have not submitted any field development plans. Where data is not available, INES assumes a prorated production from each field's constituent reservoirs.

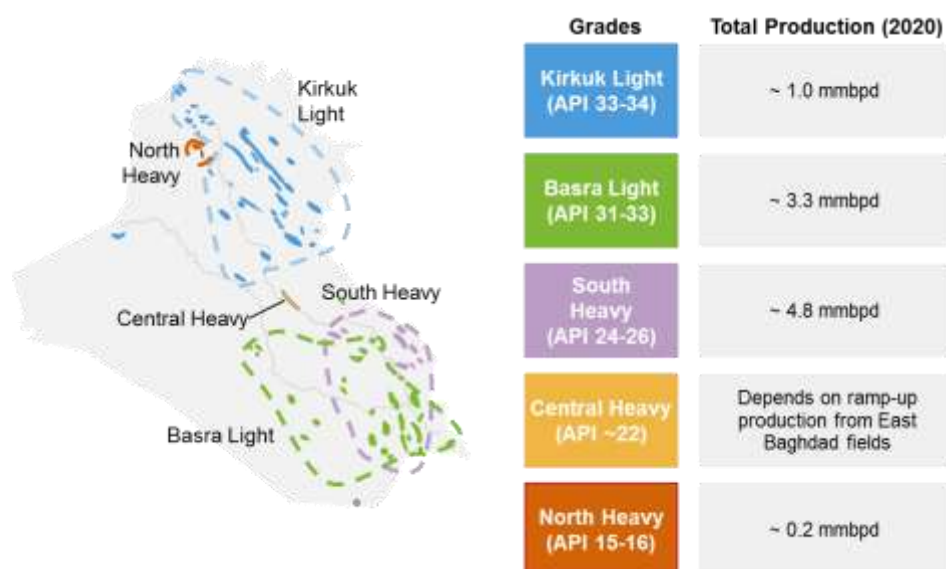
and Amadi) and light reservoirs (e.g., Yamama and Nagma). By segregating production at the reservoir level in each field, the existing Basra Light grade can be maintained.

- **Northern Production.** Most of the heavy crude from northern production will come from the Najma and Qayarah fields. By segregating Najma and Qayarah streams from the production of other northern fields, the existing Kirkuk grade can be preserved. Because the characteristics of reservoir pay-zones in the Najma and Qayarah fields are similar, segregation can occur at the field level.
- **Central Production.** Production in central Iraq is expected to come primarily from the heavy crude reservoirs of the East Baghdad field. As this field ramps up, the crude oil it produces can be captured into a separate grade.

This approach leads to five distinct crude grades.

- **Basra Light** will be maintained, with an API rating of approximately 31-32. This grade will comprise production from the lighter reservoirs of Rumaila, West Qurnah 1, Majnoon, Zubair, Badra, and Bin Umar
- **Kirkuk Light** also will be maintained, with an API rating of approximately 33-34. This grade will comprise production from Kirkuk and other IFRK fields, as well as Bai Hassan, Jambur, and Khabbaz
- **South Heavy** will be established as a separate grade to accommodate production from Missan Group fields and from heavy reservoirs in the Zubair, Rumaila, and West Qurnah fields. The resulting API rating will be approximately 24-26
- **North Heavy** will be established as a separate grade to accommodate production from the northern fields of Najmah and Qayarah. The resulting API rating will be approximately 15-16
- **Central Heavy** will be established to accommodate production from East Baghdad fields, if those fields are developed.

**Exhibit 5 -4: INES Recommended Scheme of Crude Segregation**





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This segregation scheme provides well differentiated crude grades. It preserves existing high-value light brands, and it clusters the heavier brands so as to facilitate transport to refineries or to evacuation points. The low volumes and the interior location of North Heavy production (and Central Heavy production if East Baghdad field is developed), make these grades appropriate for domestic consumption. South Heavy crude, on the other hand, will be produced in sufficient volume and in close enough proximity to Basra export facilities to be appropriate for export as a distinct brand. Moreover, the export of a distinct South Heavy grade through Basra will not require additions to the downstream evacuation system beyond what would be required in the absence of segregation. Incremental segregation costs for South Heavy will be limited to upstream facilities.

As TSC and other operators finalize their FDP's and ERP's, the phasing of reservoirs, volumes of crude produced, and crude specifications may differ from current INES assumptions. A separate study should be commissioned once the FDP's and ERP's are submitted to revise this crude segregation scheme as appropriate in light of new information.

**Refineries.** As noted in Chapter 2, the capacity and configuration of Iraq's existing refineries are currently inadequate to serve domestic demand or meet international quality standards. With economic and industrial revival, Iraq will need either to increase its imports of refined products or to upgrade its domestic refinery capacity.

The evaluation criteria established in the INES vision point strongly toward a refinery strategy of domestic self-sufficiency. With appropriate improvements in refinery capacity and configuration, domestic production will be less costly to the Government than imports. Domestic production will serve the objectives of energy security, economic diversification, and employment growth. If Iraq increases refinery capacity sufficiently, it also has the option at some point of exporting refined products. This is not an immediate INES priority in light of other needs, but may be considered in the medium and long term depending on world market conditions

The advantages of domestic production depend on the development of a modern and efficient Iraqi refinery system. Such a system would aim to satisfy several criteria:

- World-class scale. World-class refineries typically reach optimal efficiencies of scale at capacities greater than 300 kbpd. Iraq's future refineries should be designed to this size or larger. Existing subscale and inefficient refineries should be either expanded and upgraded or selectively phased out.
- Alignment of yield with demand. Iraq's refineries today produce an oversupply of fuel oil and an undersupply of gasoline and gasoil. The demand for gasoline and gasoil is expected to grow rapidly, at compound annual rates of 4.5% and 6% respectively. Iraq's future refineries should be configured for deeper conversion than they provide today, in order to reduce yield of fuel oil and increase yield of light and middle distillates.
- Alignment with available crude grades. In addition to providing deeper conversion capabilities, Iraq's future refinery configurations should accommodate heavier grades of crude than they can accommodate today. The lighter grades currently consumed by refineries are better suited to export markets; they are easier than heavy grades to transport, they provide higher netbacks, and they have established customers.



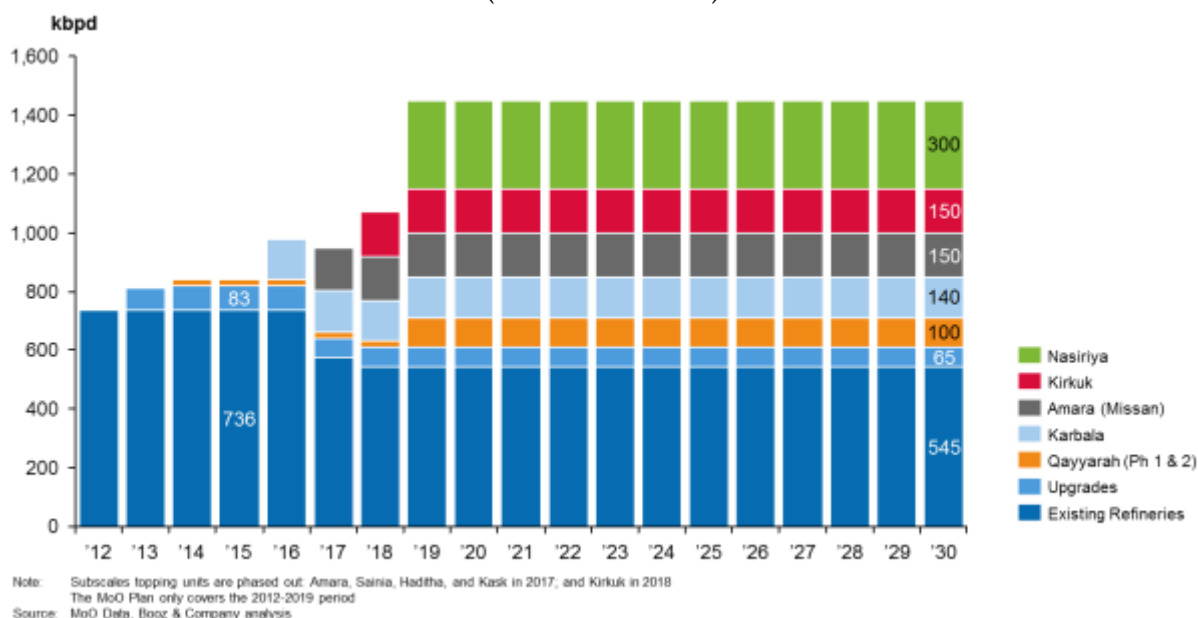
Heavier grades also have assays that favor the middle distillate yields Iraq increasingly will need.

- Alignment of capacity increments with demand growth. Demand for refined products will grow on a continuous trajectory, but new refinery capacity will be added in discrete steps. Supply capacity and demand will therefore seldom be perfectly aligned, but the timing of capacity additions should nonetheless be planned to provide as close as a fit as possible.
- Efficient refinery location. The relatively high cost of transporting heavier crude grades can be reduced by locating refineries close to heavy-crude production fields. Infrastructure costs also can be reduced by building refineries close to existing or planned pipelines, storage facilities, and distribution networks. In the event that a future refinery is developed to serve export markets, transport costs can be reduced by locating it near an export terminal.

The MoO's existing plan to upgrade and expand Iraq's refinery system in the short- to medium-term will significantly improve Iraq's refinery capabilities.

- 840 kbpd of new refinery capacity is planned through the addition of 5 refineries, to be constructed at Karbala (140 kbpd in 2016), Amara (150 kbpd in 2017), Kirkuk (150 kbpd in 2018), Nasiriya (300 kbpd in 2019), and Qayyarah (100 kbpd in 2019).
- Existing refineries are to be upgraded - the Daura refinery from 120 to 140 kbpd in 2013, the Basra refinery from 165 to 210 kbpd in 2013, and topping units at Haditha and Kask.
- 210 kbpd of inefficient topping capacity will be phased out in 2017-18, including units in Samawa, Najaf, Diwania, Nasirya, Amara, Sainia, Haditha, Kask, and Kirkuk.

**Exhibit 5 - 5: MoO Refinery Expansion Plan**  
(as of March 2012)



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The MoO plan also uses heavier crude grades as refinery feedstock, and provides logistical advantages by locating refineries close to heavy oil production in Missan (Amara) and Qayyarah. Planned refineries in Karbala and Nasiriya are well located close to the North-South pipeline, and the planned Kirkuk refinery is located close to northern fields. However, only the Missan (Amara) and Qayyarah refineries are expected to use heavy crude grades. Light crude will constitute roughly 80 percent of Iraq's overall refinery feedstock.<sup>47</sup>

Because the MoO refinery plan is already in the early stages of implementation, including the commissioning of FEED studies, commitments to provincial governorates, and issuance of tenders, this plan has been incorporated into INES and is the basis for INES investment and cash flow projections. When compared against the criteria noted above for the design of a future refinery system, however, the current plan could be improved in some respects.

- Except for Nasiriya, the proposed new refineries will have capacities of 150 kbpd or less, which is generally considered too small for optimal efficiency.
- Most of the planned refinery capacity, with the exception of Missan (Amara) and Qayyarah, is expected to use light crude as feedstock, which is a suboptimal use of light crude when heavy crude is also available.
- While alignment of yield and demand is improved by the MoO plan, it could be tightened further. Fuel oil will continue to be in surplus, gasoline will be in surplus after 2018, and gasoil will be in deficit after 2024. (Since the MoO plan does not extend beyond 2020, this gasoil deficit can be corrected through introduction of additional capacity, but that will likely create a further oversupply of fuel oil and gasoline.) A more complex configuration of refineries, combined with greater use of heavy crude feedstock, would improve this alignment.
- Surplus gasoline will be available for export after 2019 under the plan, but this surplus will be created at points that are not advantageous for export. Refinery products would likely be more competitive for export if they were produced at a single world-scale refinery located close to export infrastructure.

Depending on the degree of flexibility the MoO may have in the future to deviate from this existing plan, it should consider two potential alternative plans. Each of these alternatives employs larger-scale facilities, provides more complex refinery configurations with deeper conversion capabilities, includes greater proportions of heavy crude as feedstock, and locates refineries closer to field locations, infrastructure, or export terminals. Each of these options likely would require higher initial capital outlays than the MoO plan, but the benefits gained over the long term through improved scale efficiencies, higher netbacks from freeing up lighter crudes for export, and better alignment of product yield to demand appear economically to justify the additional early capital cost.<sup>48</sup>

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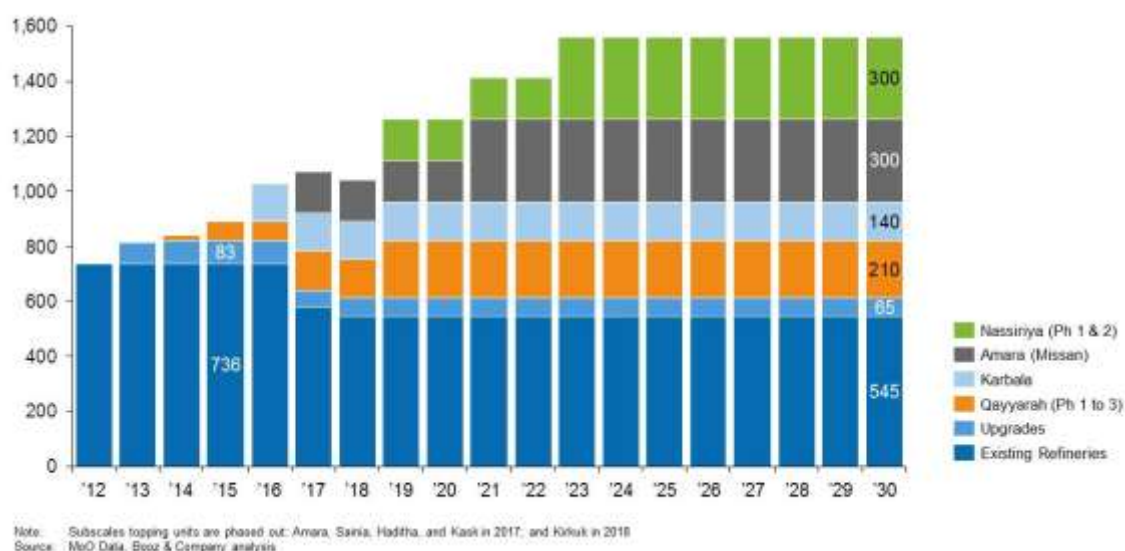
<sup>47</sup> Under the MoO plan, the new Kirkuk refinery will process Kirkuk Light. The new Karbala refinery will process crude from the North-South strategic pipeline, which will carry predominantly light crude. The new Nasiriya refinery will process a mixture of Basra Light and some heavier grades from the Nasiriya field. Existing refineries will continue to process light crudes.

<sup>48</sup> Economic comparisons between the MoO plan and the alternatives discussed are problematic, since they cover different time spans. Making adjustments for that discrepancy, it appears that Option 2 would add approximately USD 6 billion to the net present value of INES, compared to the existing plan. That advantage consists of \$2 billion from improved product yield and earlier displacement of

Option 1 represents a modified version of the existing plan. Option 2 represents a clean-slate redesign.

- Option 1 - Modified MoO Refinery Plan.** Under this option, the Amara (Missan) refinery is expanded to 300 kbpd by 2021 and is configured to process South Heavy crude and to provide deeper conversion. The Nasiriya refinery also is configured to process South Heavy crude from nearby fields (e.g., Nasiriya, Garraf, etc.) and to provide deeper conversion. It is built in two phases of 150 kbpd each, coming on line in 2019 and 2024. Capacity at the Qayyarah refinery is increased in line with Najma & Qayyarah North Heavy production, reaching 70, 140, and 210 kbpd by 2015, 2017 and 2019 respectively, and providing an option for integrated base-oil production and lubricant blending plants. The new Kirkuk refinery is not built.

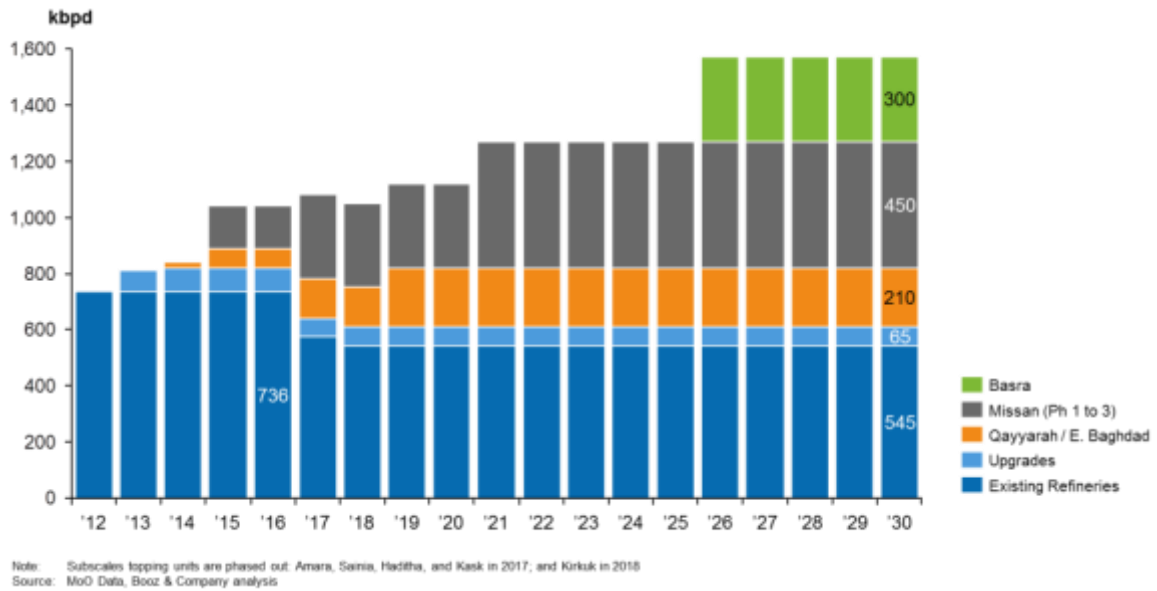
**Exhibit 5 - 6: Option 1 - Modified MoO Refinery Plan**



- Option 2 - "Clean-Slate" Refinery Plan.** Under this option, which attempts to optimize future refinery development without constraints imposed by existing plans, a complex refinery is built in Missan in two to three phases, reaching 450 kbpd total capacity and capable of processing South Heavy crude. The Qayyarah refinery plan is the same as in option 1. In the long term a new 300 kbpd export-oriented refinery is built in Basra, configured to process South Heavy crude and to provide deep conversion.

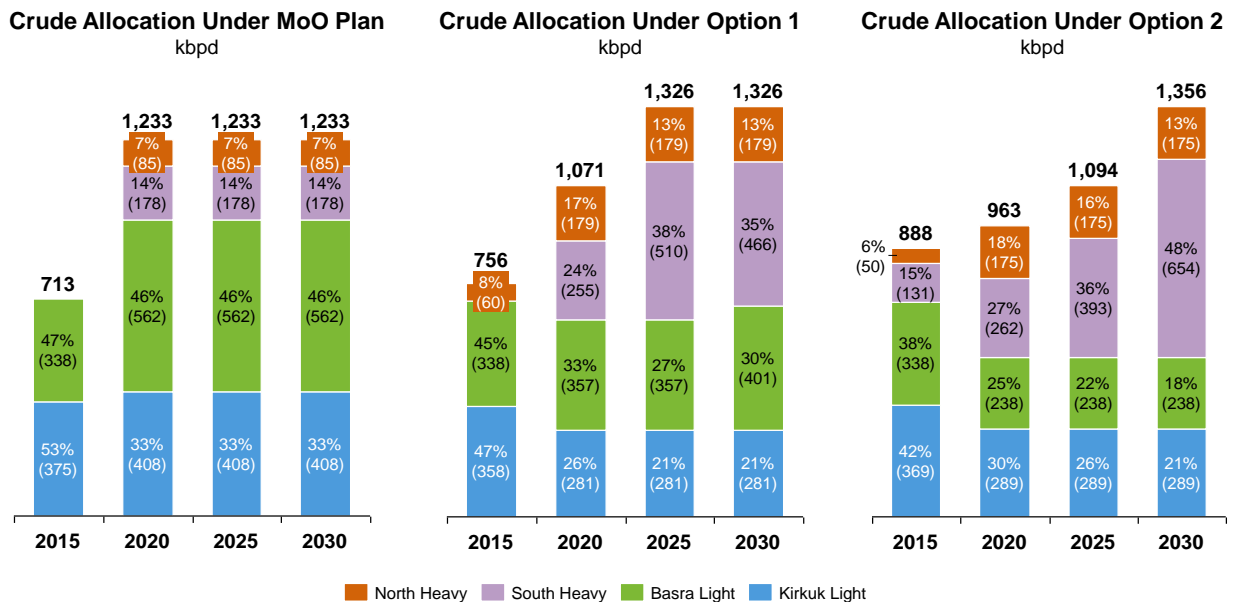
imports, \$3 billion from freeing up light crude for export, and \$1 billion in overall capital efficiency from improved economies of scale.

### Exhibit 5 - 7: Option 2 - Clean-Slate Refinery Plan



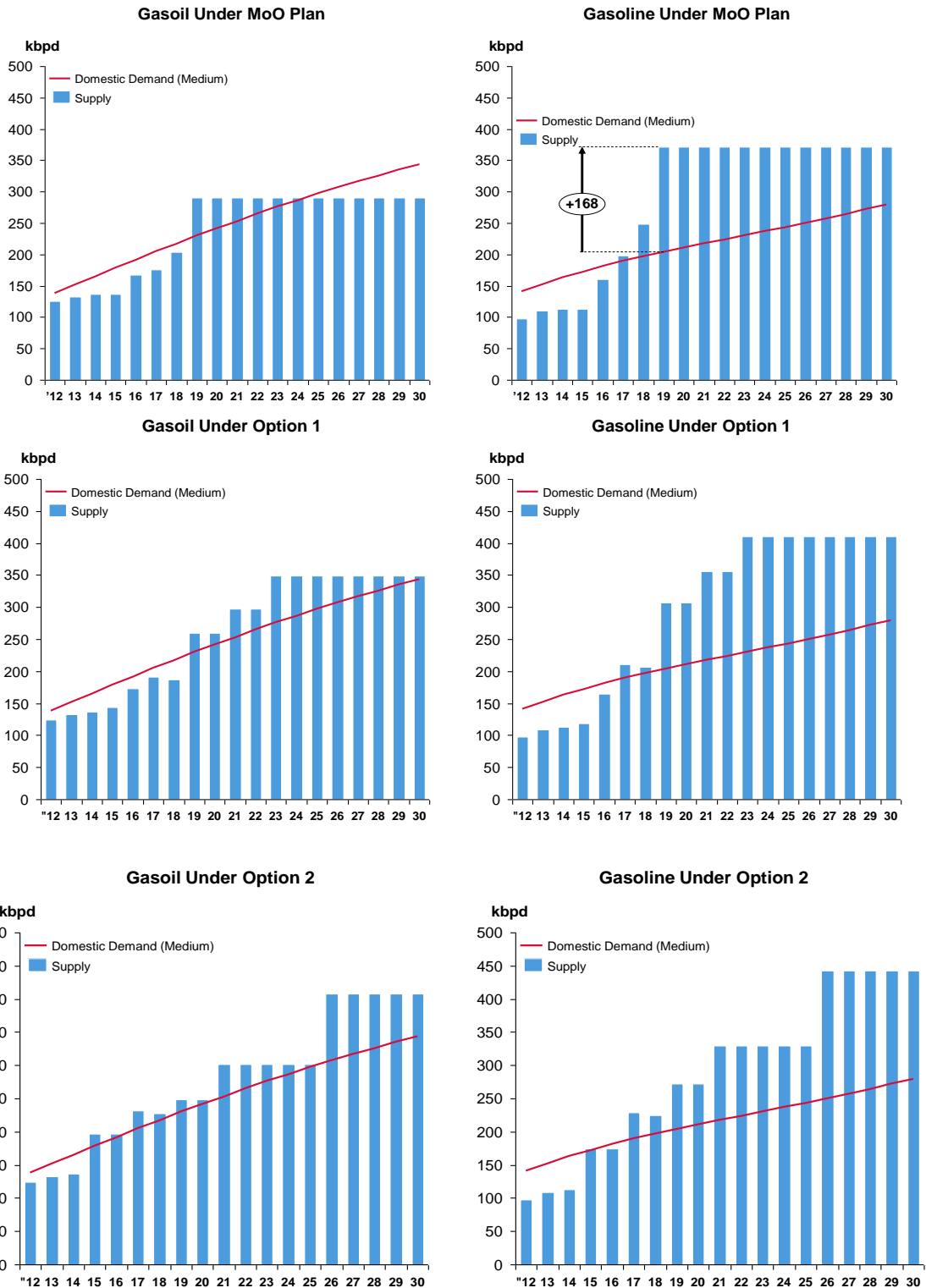
Under these alternative plans, existing refineries will continue to process light crudes, but the new plants would process heavy crudes. The overall light crude percentage of feedstock would drop from 80% in the existing plan to 40-50%.

### Exhibit 5 - 8: Comparison of Crude Oil Allocation Under Alternative Refinery Plans



Since new refineries are configured for deeper conversion, the alternatives also would align more closely with evolving domestic demand.

## Exhibit 5 - 9: Comparison of Gasoil & Gasoline Supply / Demand



To date, the MoO has not been successful in attracting private-sector investment for refineries. Projects that provide greater scale efficiency will make refineries more attractive for investors, but other financial incentives are likely to be needed as well. Iraq currently provides tax and tariff benefits and a discount of 5 percent on the price of crude oil, but these benefits evidently have not been sufficient to overcome investor perceptions of commercial and execution risk.

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In order to reduce at least commercial risk, the MoO should consider providing a larger discount on crude feedstock, guaranteeing off-take of refined products at defined prices, and providing guarantees of power and feedstock delivery.<sup>49</sup> Additional incentives such as provision of land and infrastructure may also be necessary. The MoO should commission a study to determine the level and mix of incentives required and should consult with refinery companies to understand more fully what is required to induce investment. The level of incentives appropriate in the short term may not be required in the long term as supplies, prices, and demand in Iraq become more predictable.

As discussed in Chapter 2, the existing system for distributing and retailing refined products is substandard. Over the next three years the MoO should develop a comprehensive plan for reforming this sector. The pipeline network for white products needs to be expanded to reach demand centers and depots across the country. The fuel oil pipeline network and road tanker fleet need to be expanded as well to convey currently stranded volumes of fuel oil to power plants, cement plants, and brick plants. Gasoline and gasoil storage needs to be expanded to align with international standards and located so as to provide balanced geographic coverage. The installation of meters at injection and withdrawal points across the distribution system need to be completed to provide accurate information on volume flows, and control stations need to be established to monitor and manage these flows.

The quality and availability of gasoline retail stations could be substantially improved by building more stations in high-demand areas, increasing retail margins to incentivize investments in service quality, and establishing and enforcing a code of operating and safety standards. Gasoline retail should be opened to entry by international retailers, and existing OPDC stations should be divested to the private sector.

Comprehensive improvements of this kind in the refinery and distribution system would be highly beneficial to the environment. New and modernized world-class refineries would include systems for treating and recycling the effluent waste that today typically ends up untreated and poorly contained in nearby ponds. The products of new and modernized refineries would meet Euro IV standards, thereby sharply reducing SO<sub>x</sub> emissions and eliminating lead emissions from Iraq's automotive fleet. Improved refinery and retail facilities would permit the introduction of improved operating standards for waste management, resource efficiency, and safety.

**Crude oil commercialization.** The principal strategic issues Iraq faces in commercializing its crude oil are what markets to serve, what volumes to allocate among those markets, and what routes to use in order to access those markets. Addressing these inter-related issues requires Iraq to weigh potential infrastructure costs, market netbacks,<sup>50</sup> and strategic risk.

At present Iraq has access to all three of the world's major crude oil markets – Asia, Europe and America. Iraq can transport its southern crude production to the Arabian Gulf at Basra; from there it can ship crude to Asia through the Indian Ocean, to Europe through the Suez

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<sup>49</sup> Alternatively, the MoO could adopt a model where private refineries there are paid a contracted rate to convert crude into refined products. Both supply and demand risk are borne by the government. This arrangement gives refineries a risk profile similar to that of regional independent power projects (IPP's) operating under power conversion agreements. These projects, which are subject to execution risk but not commercial risk, typically can be financed on favorable terms.

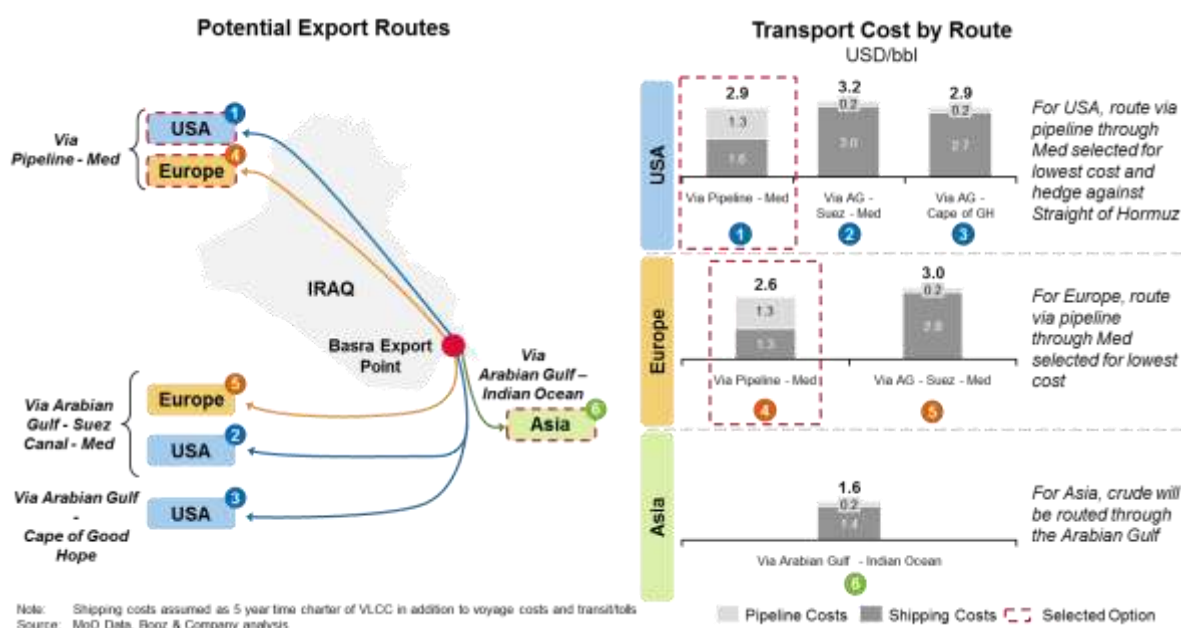
<sup>50</sup> Netback is the difference between the price at which crude is sold at its destination market and the cost of transporting it there from the production field via pipes and ships.



Canal, or to America through the Suez Canal or around the Cape of Good Hope. Iraq can transport its northern production through a pipeline across Turkey to the Mediterranean Sea at Ceyhan; from there it can ship crude through the Mediterranean to Europe or America. By rehabilitating the damaged North-South Strategic pipeline that once linked southern and northern production fields, Iraq could increase its routing options by providing a northern evacuation route for southern production, which will constitute more than 90 percent of Iraq's total export volume.

Exhibit 5-10 compares the transport costs (and therefore the netback) for exports from the South to the principal world markets. The highest netback for southern Iraqi crude is achieved by shipping to Asian markets through the Arabian Gulf. The next highest netback is achieved by routing crude through northern pipelines to the Mediterranean and shipping to Europe. To the extent that Iraq sells southern crude to America, the netbacks of routing through northern pipelines to the Mediterranean compared to routing through the Arabian Sea around the Cape of Good Hope are roughly equivalent.

**Exhibit 5 - 10: Main Crude Oil Export Routes and Associated Transport Costs**



Although Asian markets provide Iraq the highest netbacks, reliance on a single market or a single route carries risks. Regional economies grow and contract at different rates, and routes are subject to specific sources of interruption. For the sake of risk diversification, Iraq historically has placed about half its crude in Asia and the other half in Europe and America.<sup>51</sup> Asian market is expected to have largest growth in demand and offer Iraq with the highest netback when routing its crude from its southern terminals through the Arabian Gulf. Recognizing this, INES however proposes that Iraq avoid over-reliance on any single regional market or any single route. INES therefore recommends an evacuation system that provides Iraq the capacity to place a larger proportion of its crude to Asian markets via southern terminals, while offering the flexibility to route up to half its production through its northern boundaries to the Mediterranean and Red Sea as a hedge against Strait of Hormuz.

<sup>51</sup> In 2009 Iraqi crude oil was allocated 44% to Asia, 27% to Europe, 28% to America, and 1% to Africa.

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In addition to flexibility, the route through Iraq's northern boundaries to the Mediterranean also provides the most economic transport to serve western markets. Under this policy of route diversification, Southern production will be sent to America via the Mediterranean rather than via the Cape of Good Hope, although both routes provide roughly equivalent netbacks.

INES provides for additional route diversification through the construction of separate transit pipelines through Turkey, Syria and/or Jordan.<sup>52</sup> With these evacuation routes from the North, and with a reconstructed North-South link, Iraq will have sufficient route diversity to handle most contingencies. The evacuation pattern resulting from these choices of routes and markets would result in approximately half of Iraq's crude production passing through the North and Western boundaries and half through the Southern boundaries.

These route and market choices, combined with the crude segregation and refining plans discussed earlier, result in the following commercialization strategy:

- *Kirkuk Light* will be evacuated through northern pipelines to Mediterranean export points, and from there will be shipped to Western markets. Before *Kirkuk light* is exported, however, it will be allocated as needed to existing refineries in the north (like Baiji) that are configured to process only light grades.
- *Basra Light* will be exported via both Mediterranean and Arabian Gulf shipping points (including Red Sea in case Jordan pipeline option materializes). A portion of *Basra Light* will supplement *Kirkuk* in providing the volumes necessary to achieve Iraq's market diversification targets. The similar specifications of *Basra Light* and *Kirkuk* make them commercially fungible and avoid the need for dedicated evacuation infrastructure in the North. Of the *Basra Light* that remains in the South a portion will be allocated to existing and planned refineries (*Basra*, *Daura*, *Karbala*, *Nasiriya*) that are close to the North-South pipeline and configured to process only light grades. The remainder will be exported through the Arabian Gulf to Asian markets.
- *South Heavy* will be evacuated through the Arabian Gulf to Asian markets. This disposition minimizes the segregation and transportation costs involved, and maximizes the netbacks available to this grade. It also positions *South Heavy* to serve the growing number of refineries that are expected to be developed in Asian markets. *South Heavy* additionally will support the feedstock needs of the *Missan* (*Amara*) refinery and the potential export-oriented *Basra* refinery. In the longer term, Iraq could further strengthen its market position in Asian crude markets by developing overseas Asian refineries to lock in *South Heavy* off-take.

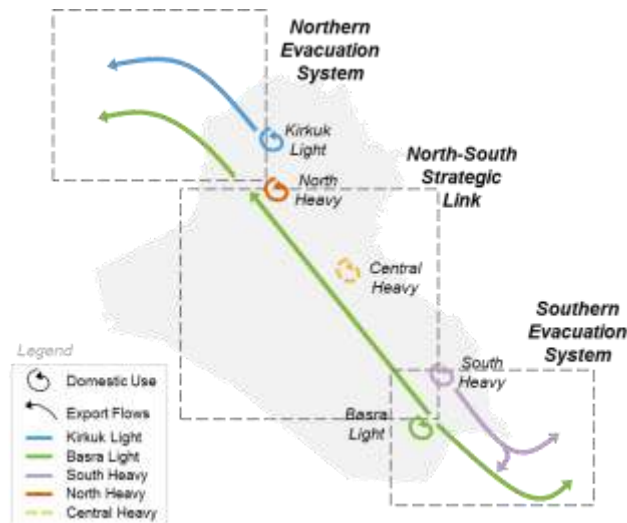
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<sup>52</sup> The pipeline through Turkey from *Kirkuk* to the port of *Ceyhan* is operational, although capacity-constrained due to war damage. It needs to be refurbished. A pipeline through Syria from *Kirkuk* to the port of *Baniyas* has been inoperative since 2003 due to war damage. Iraq and Syria have agreed to rehabilitate that pipeline and to build a new parallel pipeline as well.

An additional potential export route could be developed by constructing a new pipeline to the Red Sea, through Jordan to *Aqaba*. Due to pipeline costs, this route would be substantially more costly than the Arabian Gulf for transporting crude to Asian markets. It would be more costly than the northern route for transporting crude to the West, due to both pipeline costs and shipping costs associated with the Suez Canal. This new route could justify the associated loss in netback given geopolitical risk management especially the risks associated with implementing the Syria pipeline.

- *North Heavy* and *Central Heavy* do not require evacuation. They will be allocated to domestic refineries, configured to make efficient use of their characteristics. Until those refineries are commissioned, these heavier grades should be allocated to power and industry.

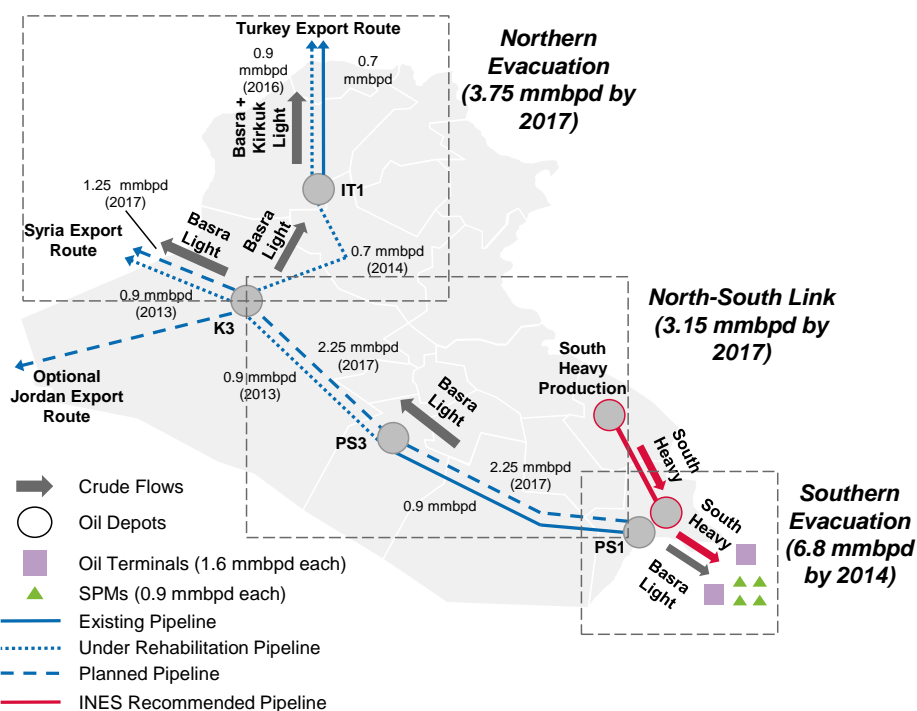
**Exhibit 5 - 11: Crude Oil Evacuation Pattern**



This evacuation pattern will require substantial infrastructure development.

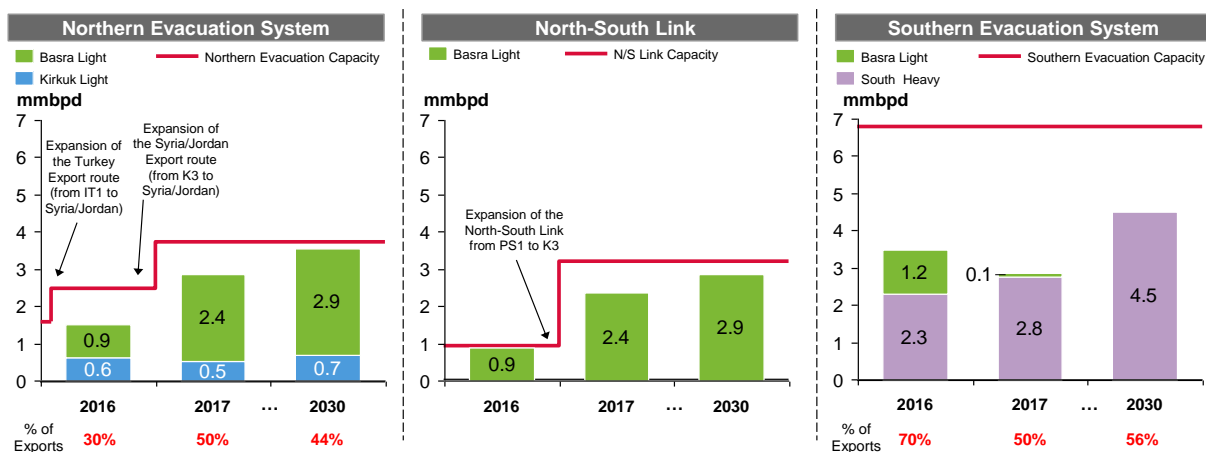
- *The northern evacuation system*, which currently is limited to 0.7 mmbpd through the Turkey pipeline, will expand to 3.75 mmbpd by 2017. The Turkey pipeline itself will be rehabilitated and expanded to a capacity of 1.6 mmbpd. The existing but inoperative pipeline through Syria will be rehabilitated to carry 0.9 mmbpd, and a new parallel pipeline through Syria will be constructed to carry 1.25 mmbpd. Both Syria pipelines will carry light grades of crude. The pipeline between northern oil depots K3 and IT1 will be rehabilitated to a capacity of 0.7 mmbpd to allow flexibility in evacuation either through Syria or Turkey.
- *The southern evacuation system* will be expanded from its 2011 terminal capacity of 2.0 mmbpd to an overall capacity of 6.8 mmbpd by 2014. This expansion will involve the addition of four Single Point Mooring buoys (SPM's) offshore, each with a capacity of 0.9 mmbpd. Two of these new SPM's have recently been commissioned. It will involve an increase in capacity at the Khor Al Amaya Oil Terminal (KAAOT) from its current capacity of 0.4 mmbpd to possibly 1.6 mmbpd. The Al Basra Oil Terminal (ABOT) will remain at its current capacity of 1.6. In addition to this expansion in terminal capacity, the pipeline system from southern fields to Basra terminals needs to be built. INES provides that 2.0 mmbpd of this new evacuation pipeline and terminal capacity will be dedicated for transport of South Heavy grade.
- *The North-South Link* will play a critical role in moving Basra Light to northern evacuation points, and in providing overall system flexibility. The segment of the North-South Strategic Pipeline that lies between PS3 and K3, which is currently damaged, will be rehabilitated, so that the entire pipeline between PS1 and K3 will be capable of carrying 0.9 mmbpd by 2015. Additionally a new parallel line is planned from PS1 to K3 that will carry 2.25 mmbpd by 2017. The total capacity of the North-South link at that time will be 3.15 mmbpd.

**Exhibit 5 - 12: Crude Oil Evacuation Infrastructure**



Under the INES plan evacuation capacity will be adequate, and will be backed by sufficient redundancy, to export all produced crude grades reliably. The Southern Evacuation System will provide sufficient spare capacity to accommodate “High” production levels by 2014 if they materialize. This spare capacity also will provide a cushion against delays in expanding the Northern System or against any outages that may occur at ABOT and KAAOT.

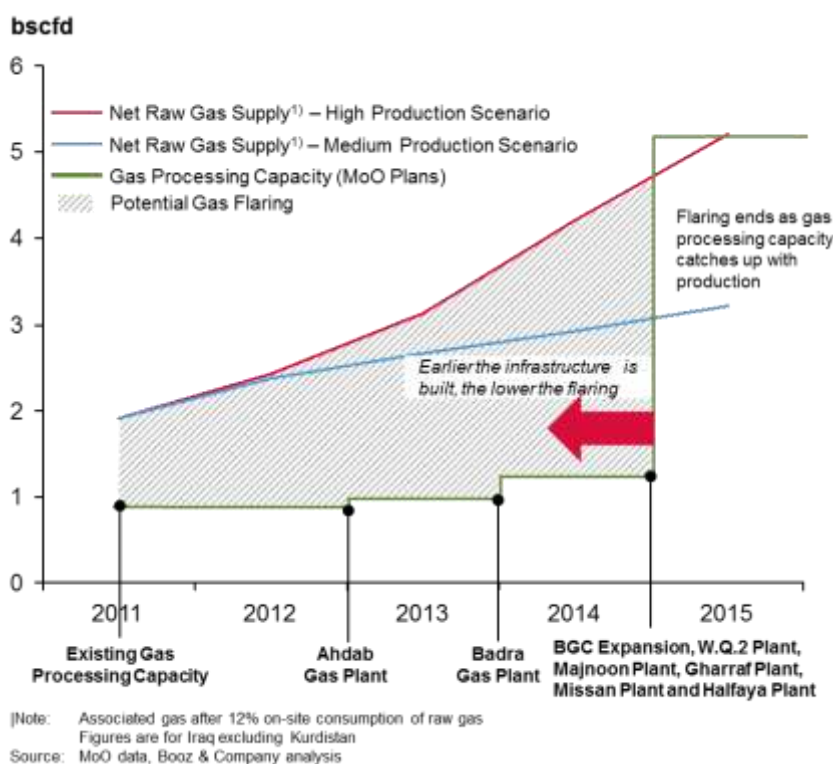
**Exhibit 5 - 13: Crude Oil Evacuation Infrastructure Capacity and Volumes (2016, 2017 and 2030)**



**Balancing gas production and demand.** The infrastructure needed for gathering, processing, and transporting natural gas is planned to be in place by the end of 2015. At that point, all domestic needs for natural gas are expected to be met, and gas flaring due to production

stranded at the wellhead is expected to cease. Thereafter this infrastructure will be expanded to keep pace with growing production.

**Exhibit 5 - 14: Raw Gas Production and Processing Capacity**



Because associated gas is produced as a by-product of oil production, however, natural gas supplies will continue to grow even after it has satisfied domestic demand. Beginning in 2016 or 2017, Iraq will likely find that it has a surplus of natural gas, and it will need to find an outlet for that surplus.

Clearly, export would be desirable, and several potential export customers may be available. Turkey, Syria, Europe, and many of the countries of the GCC are in need of gas supplies. In order to serve any of these markets, however, pipelines would need to be built specifically for that market, and long-term supply and off-take commitments would need to be made.

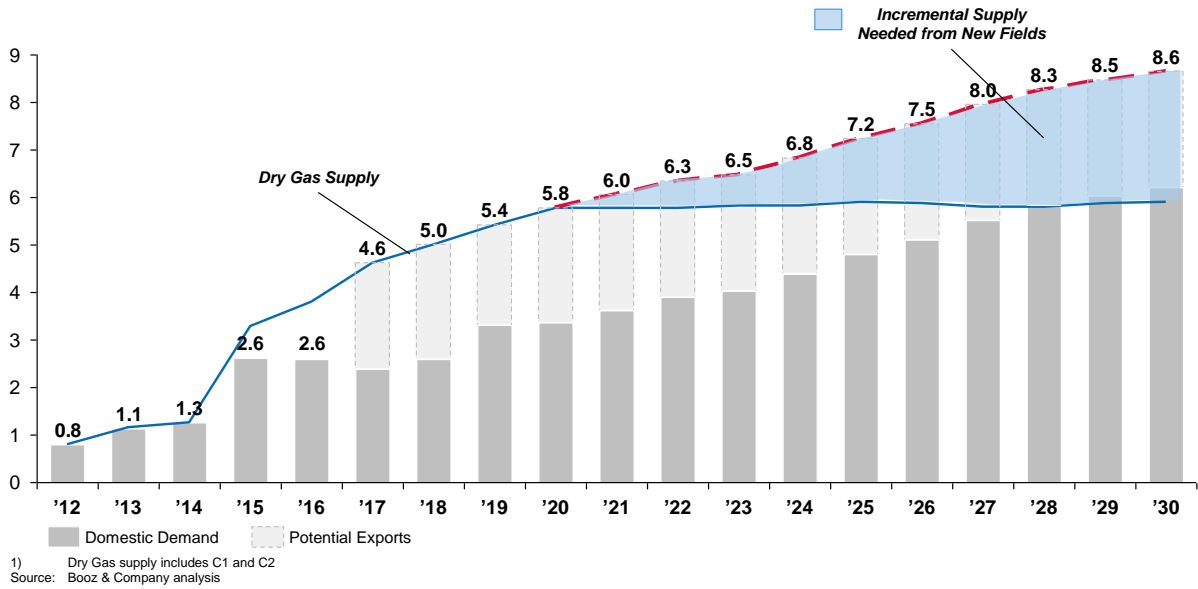
The surplus of associated gas expected to emerge around 2017, however, will be only temporary. By 2020 production of associated gas will likely reach a steady state, while domestic demand will continue to grow. The surplus will shrink and eventually disappear.

In order to solve the problem of this temporary exportable surplus, it is necessary to lock in export customers. In order to lock in export customers it is necessary to sustain that surplus beyond its present expected duration. Iraq therefore faces two interrelated tasks, to find customers and to secure new reserves.<sup>53</sup>

<sup>53</sup> Some of the surplus gas could be exported as LNG without requiring lock-in to long-term supply contracts. However, it may be difficult to secure funding even for LNG facilities if Iraq's gas surplus is expected to be only temporary. LNG export can be part of the solution to the temporary surplus challenge, but it is not a sufficient solution, and it does not obviate the need for development of long-term gas reserves.

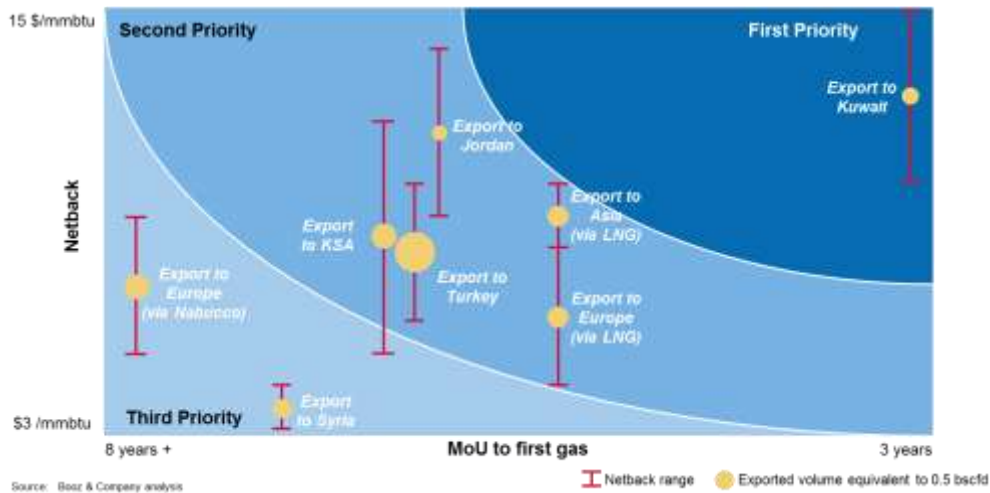


### Exhibit 5 - 15: Projected Mid-Term Gas Surplus



Since the projected surplus is expected to materialize by 2016, finding customers is the more urgent of these tasks. In order to have contracts and pipelines in place within four years, Iraq needs to focus on prospects that appear feasible in the near term. Bilateral arrangements are more promising for this purpose than multilateral arrangements, and shorter pipeline routes are more promising than longer routes. Exhibit 4-27 maps export opportunities on two axes, projected netback vs. likely speed of negotiation and construction.<sup>54</sup> The highest priority opportunity is a pipeline to Kuwait, followed by LNG to Asia and pipelines to Jordan, Turkey, and the KSA.

### Exhibit 5 - 16: Prioritization of Near-Term Gas Export Opportunities



<sup>54</sup> For purposes of this prioritization “netback” is defined as the expected selling price of gas in the target market minus midstream costs. Midstream costs include pipeline costs for piped gas and liquefaction, transportation, and regasification costs for LNG. Netbacks are displayed as a range due to uncertainty over the actual selling price that can be negotiated in each market. “Time to first gas” is the estimated time required from the signing of a Memorandum of Understanding with a specific buyer to the beginning of export.



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Based on this prioritization, Iraq should take several steps:

- Develop a commercial agreement to supply gas to Kuwait and rehabilitate the existing Kuwait pipeline. This export option could be brought on line by 2016 or 2017, and could provide off-take for approximately 0.4 bscfd.
- Develop a Liquefied Natural Gas (LNG) facility at Basra. This LNG liquefaction terminal, which is already contemplated as an optional expansion under the commercial terms establishing the Basra Gas Company, could be brought online by 2016 or 2017, with a capacity of 0.6 bscfd. Because this production requires no particular long-term customer, but rather would enter the global world LNG market, the need for international negotiation is minimized.
- Pursue separate, simultaneous export discussions with Turkey, Jordan, and KSA. Each of these opportunities will require a bilateral agreement and the development of a new dedicated pipeline. Off-take capacity for these three projects could be as high as 1.4, 0.3, and 0.9 bscfd respectively.

The total capacity of all these opportunities if they are successful could be as high as 3.2 bscfd. While this capacity, once completed, will be ample to absorb the projected surplus of 2.4 bscfd, timing is a critical concern. The surplus is expected to reach the 2.4 bscfd level by 2018; to bring a sufficient number of these export options to completion by then will require early action and expedited follow-through. Commercial discussions need to be launched and MoU's signed. Technical and commercial requirements need to be specified, followed by engineering design and finally construction. The typical lead time for such a project ranges from 3 to 8 years, leaving little margin for error as surplus accumulates.

While these marketing and infrastructure activities are progressing, a parallel path of gas exploration and production needs to be pursued. The aim of this effort will be to secure sufficient gas production capacity to sustain long-term export commitments and to continue supplying long-term domestic gas demand. This new capacity will need to be managed as a balancing commodity. To avoid either wasteful flaring or intermittent shortage, the actual production of this gas will need to be calibrated to evolving volumes of supply, demand, and export.

Production flexibility of this kind requires the development of non-associated gas. Non-associated gas constitutes nearly 60 percent of Iraq's total estimated gas reserves, but because of the abundance of associated gas from producing oil fields, these non-associated reserves have been underdeveloped to this point.

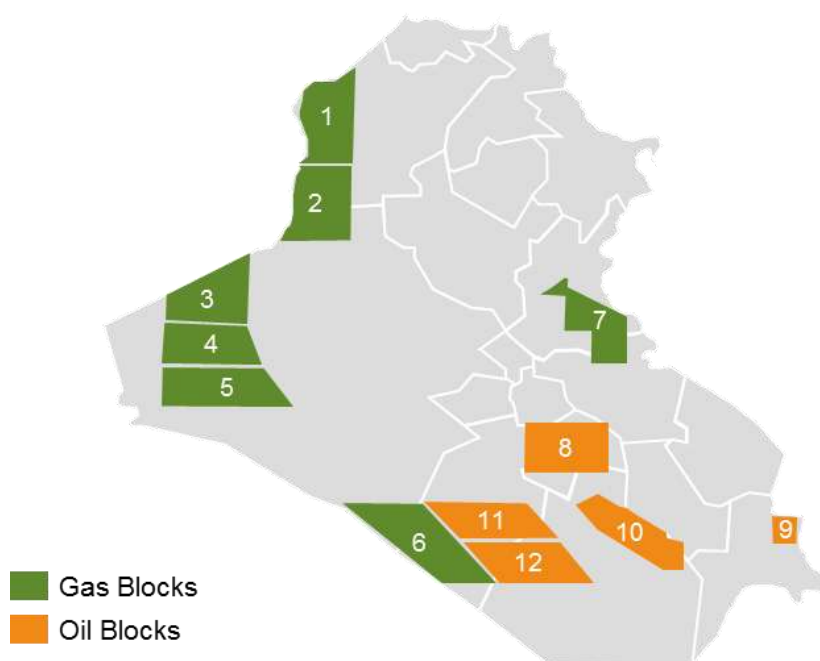
Round 4 in the MoO's bidding series called for the exploration and development of seven blocks of non-associated gas fields as well as additional oil fields. The non-associated gas fields are estimated to contain 30 tcf of gas reserves, ultimately capable of producing between 2 and 3 bscfd. The response to Round 4 was lukewarm potentially due to perceived risk-reward unattractiveness. Development of these gas reserves should be given priority. Contracts should provide for development of early reserve estimates in order to confirm that long-term export commitments can be made. Contracts also should be framed so as to incentivize development of production *capacity* while preserving flexibility in the management of production *output*.<sup>55</sup> Iraq should consider conducting exploration activities itself through MoO entities, tendering out development contracts once reserves are identified.

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<sup>55</sup> In addition to providing flexibility in the management of gas volumes for export, non-associated gas will play an important role in sheltering the domestic economy against geopolitical disruption. Today

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### Exhibit 5 - 17: Round Four Bidding Blocks



In addition to dry gas, Iraq's processing plants also will produce Liquid Petroleum Gas (LPG) and light naphtha. Domestic demand for LPG, consisting primarily of retail consumption and petrochemical applications, will continue to grow through the INES period, but not sufficiently to absorb production. The resulting surplus can be exported to Asia, where LPG demand is rising faster than world production.

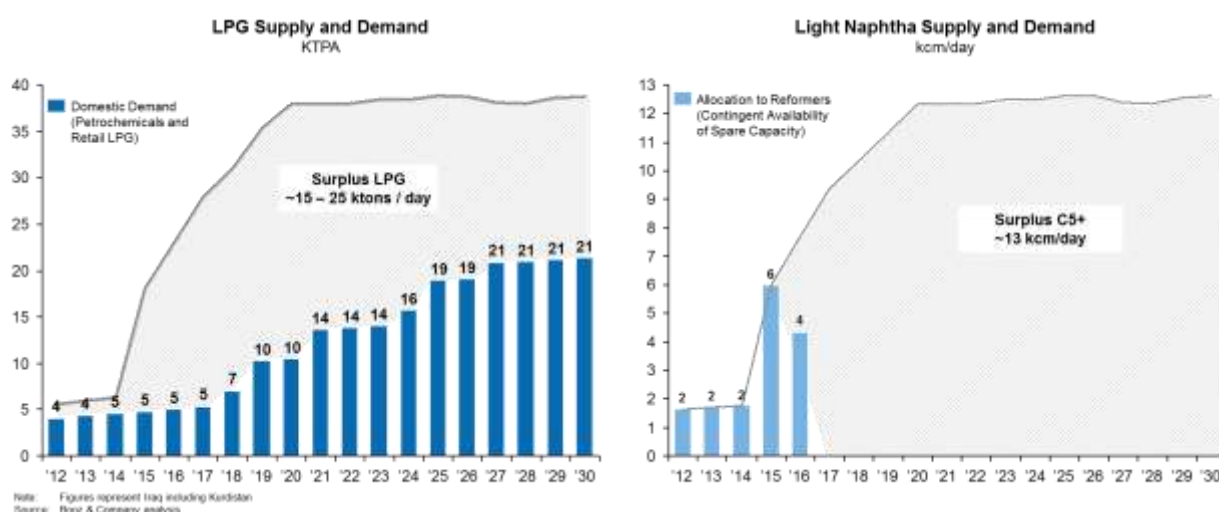
Light naphtha will continue to be needed in the short term as refinery feedstock for reforming into gasoline. As new refineries come on line and the yield of gasoline improves, light naphtha will no longer be required for the gasoline pool. Nor will light naphtha be required by petrochemical plants, which will have abundant supplies of ethane. After 2017, virtually all light naphtha produced in Iraq will be available for export.

Infrastructure connecting gas processing plants and refineries to LPG end-users will need to be expanded, and bottling capacity close to domestic demand centers will need to increase. Storage facilities and terminal facilities will need to be developed in the South for both LPG and light naphtha.

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Iraqi gas production is highly dependent on oil production. In the event that a future export disruption causes a temporary suspension or reduction in oil production, it would have the same effect on gas production. A temporary reduction in oil production would affect government revenue, but the impact of that effect could be managed through reserve funds. A temporary reduction in gas production, however, would immediately disrupt power and industry, with cascading consequences for the domestic economy. Under such circumstances, the availability of non-associated gas capacity would have great value.

## Exhibit 5 - 18: Projected Exports of Gas Products



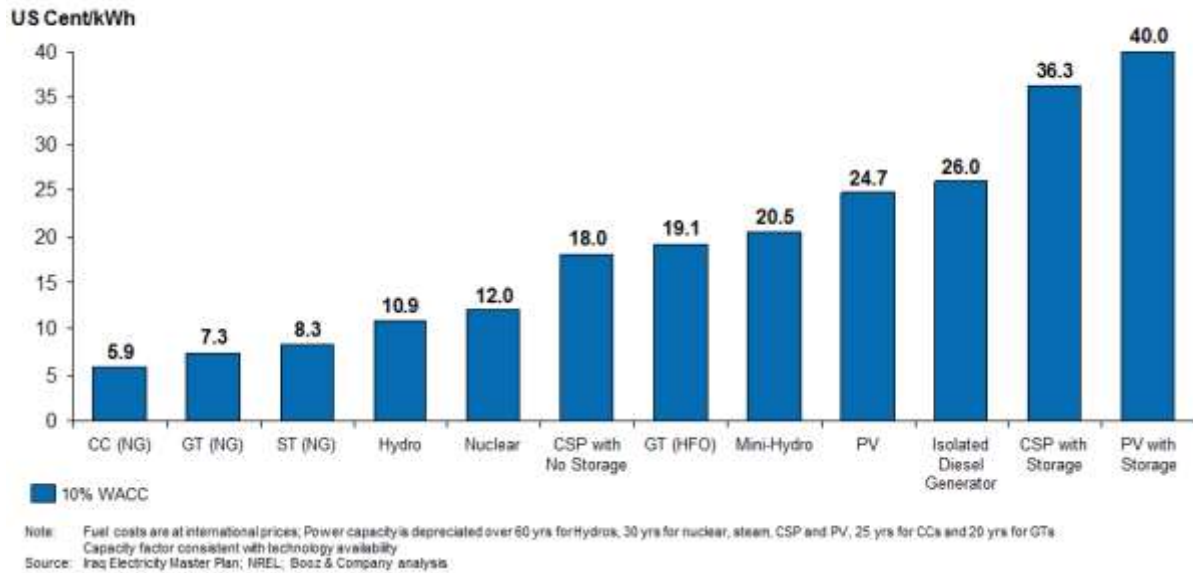
**Power generation technology mix.** INES incorporates the MoE's existing short-term generation expansion plan, which will add 22 GW of capacity to the MoE generation fleet by the end of 2016. At that point the power system will have sufficient available capacity (after adjusting for local operating conditions and expected technical losses) to meet peak demand with a reserve margin of 15 percent.<sup>56</sup> Thereafter, INES recommends continued expansion of the fleet to keep pace with demand growth, combined with displacement of less efficient technology with more efficient technology.

The long-term capacity plan aims to achieve the lowest total cost of power production, while retaining some degree of fuel flexibility and providing for long-term introduction of renewable technology. In light of these objectives and in light of the relative costs of available power technology (see Exhibit 4 -30), the capacity plan contains four main elements:

- **Build new CCGT capacity.** Combined Cycle Gas Turbines (CCGT's) are the most cost-effective and fuel-efficient technology for meeting base-load and mid-load demand. Because of their thermal efficiency, they are also the least environmentally damaging of fossil-fuel technologies. The only fossil-fuel capacity added beyond 2016 will be CCGT units.
- **Maintain Steam and Gas Turbine Capacity.** The Steam Turbines (ST's) and Gas Turbines (GT's) installed during the short-term capacity ramp-up will be retained. GT's provide efficient peak-load capacity, and both ST's and GT's can run on either gas or liquid fuels. If a portion of the fleet is capable of using a fuel other than gas, Iraq will gain useful flexibility in managing its gas supply-demand balance.

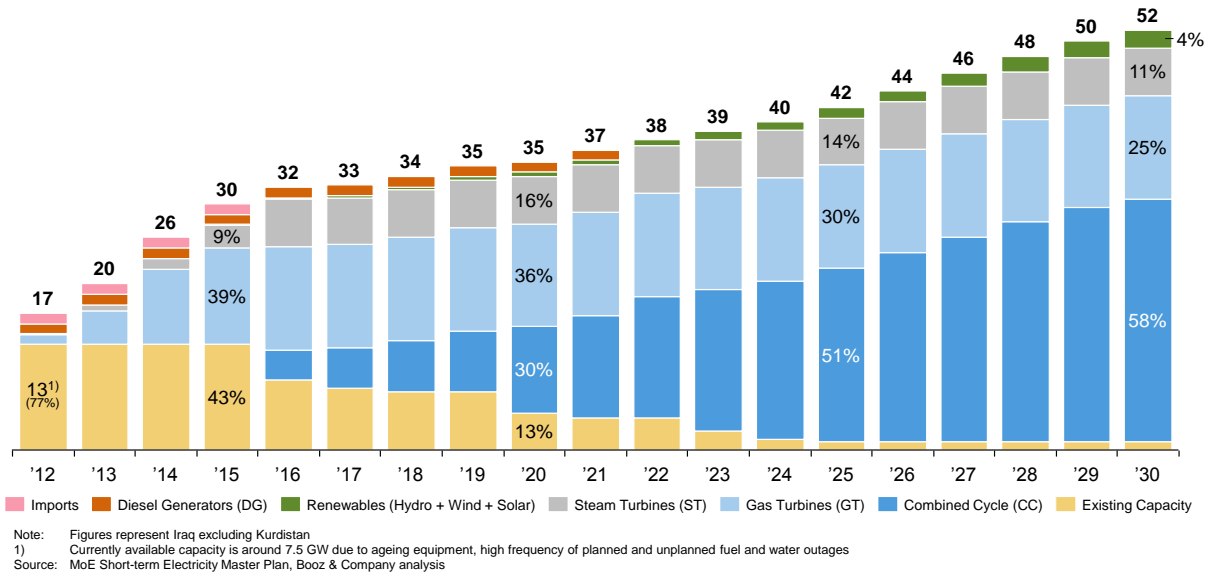
<sup>56</sup> Projections of Iraq's generation demand and capacity do not include the IFRK. Demand estimates include demand from industries, including those who may choose to self-generate their power, and capacity estimates include whatever captive capacity those industries might build.

## Exhibit 5 - 19: Levelized Cost of Electricity Production by Technology (2010)



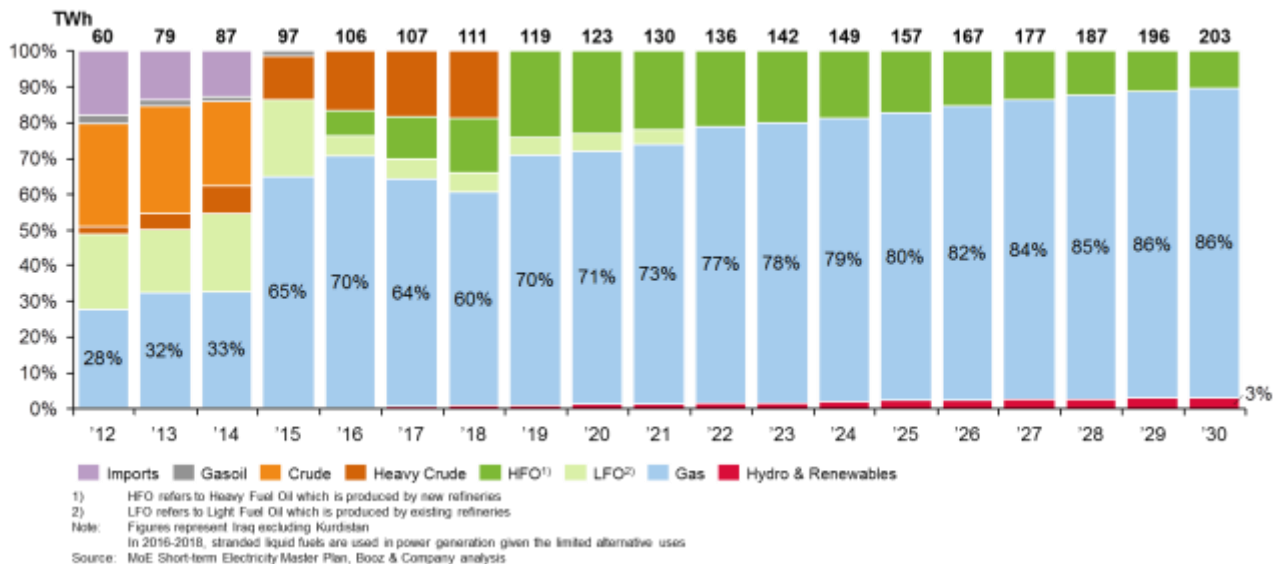
- **Retire less efficient generators.** As new capacity becomes available, old plants will be progressively retired, starting with those that are least efficient and most environmentally damaging, and phasing out all existing plants by 2026. New plants can be developed at the same locations to take advantage of existing infrastructure. All MoE diesel generators will be phased out by 2021. Once reliable grid power is available, the current widespread operation of expensive private diesel units is expected to diminish to negligible levels.
- **Develop renewable capacity.** In the short-term, the focus of renewable generation is to supply remote off-grid locations. MoE's current plan to install hybrid solar and wind plants is appropriate as a cost-effective and environmentally sound substitute for remote diesel generation. In the medium- to long-term, the INES plan provides for development of solar and wind power capacity for connection with the grid. A solar map of Iraq should be developed to find appropriate locations for large on-grid solar generation. A similar investigation should be made into wind potential, particularly in the northern part of the country. Finally, a technical study should be commissioned to assess Iraq's long-term potential for hydro-power development. By 2030 it is expected that renewable capacity will exceed 2 GW, approximately 4 percent of system installed capacity. The renewable capacity could increase to 8 percent of system installed capacity if KRG renewable penetration is considered. This target is aligned to the 2030 ambitions stated by most of the regional oil-rich countries. Depending on the results of these recommended studies, the target mix of renewables in Iraq's generation portfolio can be revised.

**Exhibit 5 - 20: Planned Expansion of Iraq's Installed Generation Capacity**



Over the course of INES, Iraq will shift to a predominantly gas-fueled power supply. Natural gas, which fuels one quarter of power production today, will fuel four-fifths by 2030. Imports will end in the short term. Crude, heavy crude, and LFO all will be phased out and redeployed to export, refineries, and industry. Through these shifts in power sources, fuels will be allocated to their highest-value uses, and the economic and environmental cost of the power sector will be minimized.

**Exhibit 5 - 21: Evolution of Energy Sources for Power Supply**



**Linked Industries capacity.** Iraq today spends more than \$2 billion on imports of steel, cement, petrochemicals and fertilizers. These imports are required not because Iraq is inherently disadvantaged in making these products, but because it lacks production capacity and it lacks reliable fuel, feedstock, and power. As these production resources become available, Iraq should invest in developing sufficient capacity in these industrial products to satisfy domestic demand. This investment will improve the overall economics of the energy

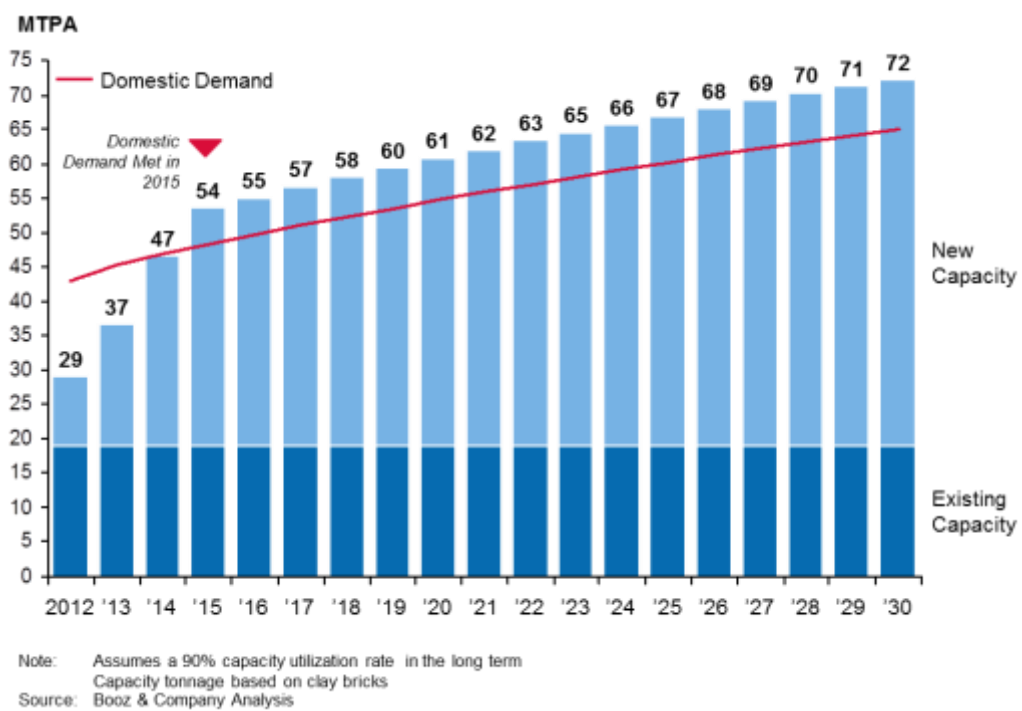
sector, contribute to economic diversification and employment, and strengthen Iraq’s energy security.

INES recommends capacity development at a pace that meets domestic demand for cement in 2014, bricks in 2015, and steel in 2021. For cement and for steel, most of this capacity growth will require new plant construction. Brick and cement plants should be located near demand centers and preferably near sources of raw materials, so as to minimize transport costs. They will need to have reliable allocations of fuel oil, and should be open to private sector participation. Fertile soil currently used as raw material for brick manufacturing should be gradually phased out with the concurrent introduction of alternative materials and new technology.

Steel capacity will require assured allocations of natural gas, and should ideally be located in industrial parks where the costs of basic infrastructure can be shared. Capacity should be designed for primary steel manufacture such as rounds, ingots, and slabs. Private sector participation should be encouraged, particularly in downstream steel industries such as rebar, wire, rods, rails, pipe, and tubing.

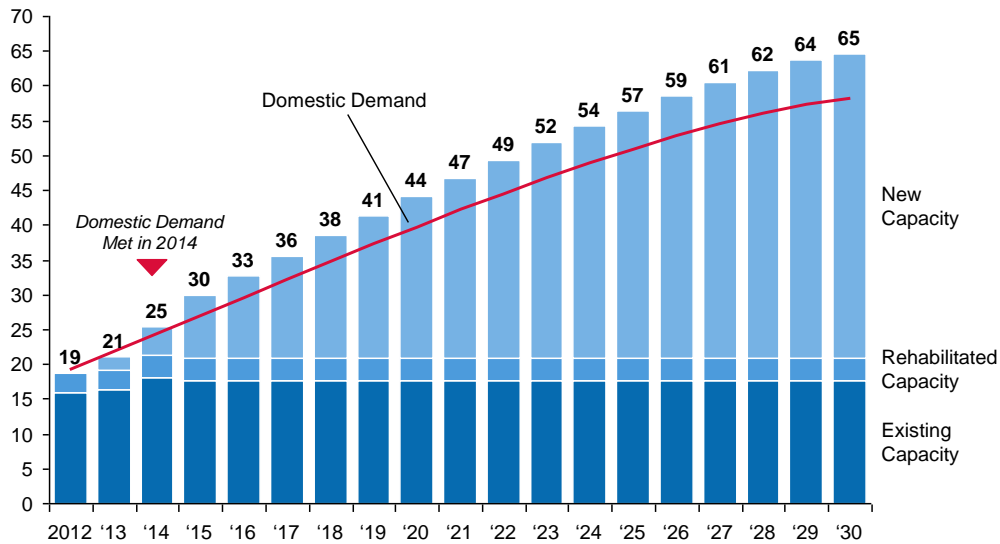
In all three of these construction-related industries, Iraqi production will have an inherent price advantage against imports due to low transportation costs and ample domestic fuel and power resources. It is expected that all three industries will substantially displace imports. The steel industry will need to import iron ore as a raw material, and therefore would be located most efficiently near Basra. Bricks and cement manufacture should be geographically spread, drawing on local raw materials and serving primarily local demand.

**Exhibit 5 - 22: Bricks Capacity Expansion**



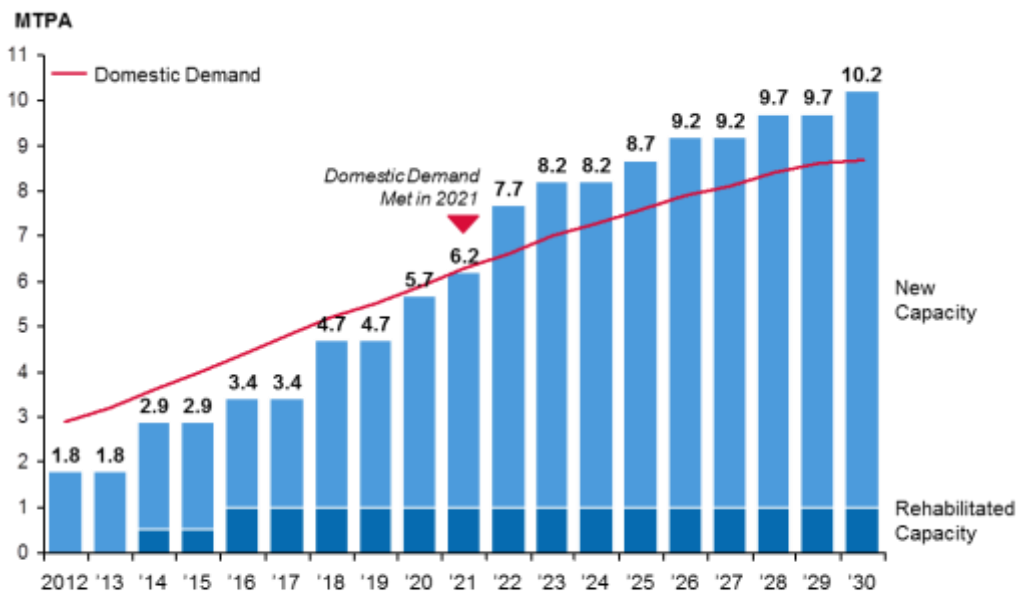


**Exhibit 5 - 23: Cement Capacity Expansion**



Note: Assumes capacity utilization of 80% in 2012 and of 90% from 2013 onwards  
 Source: Booz & Company Analysis

**Exhibit 5 - 24: Steel Capacity Expansion**



Note: Assumes a 90% capacity utilization rate in the long term  
 Source: Booz & Company analysis

All facilities should be built to world standards of fuel efficiency and environmental compatibility, with strict control of air pollution, liquid effluents, and water use. Improvements to current inefficient and environmentally stressful brick manufacturing processes should be required, including improved burning processes, plastering of interior kiln walls, insulation of the kiln top, and use of gravity chambers. Under MoIM guidance, brick manufacture also should begin switching from production of clay bricks to production of concrete and sand-lime bricks so as to reduce the industry's consumption of agricultural soil.

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In addition to satisfying domestic demand, Iraq should build export capacity in fertilizers, petrochemicals, and aluminum. In each of these industries Iraq's natural energy resources would support a strong competitive position in world markets.

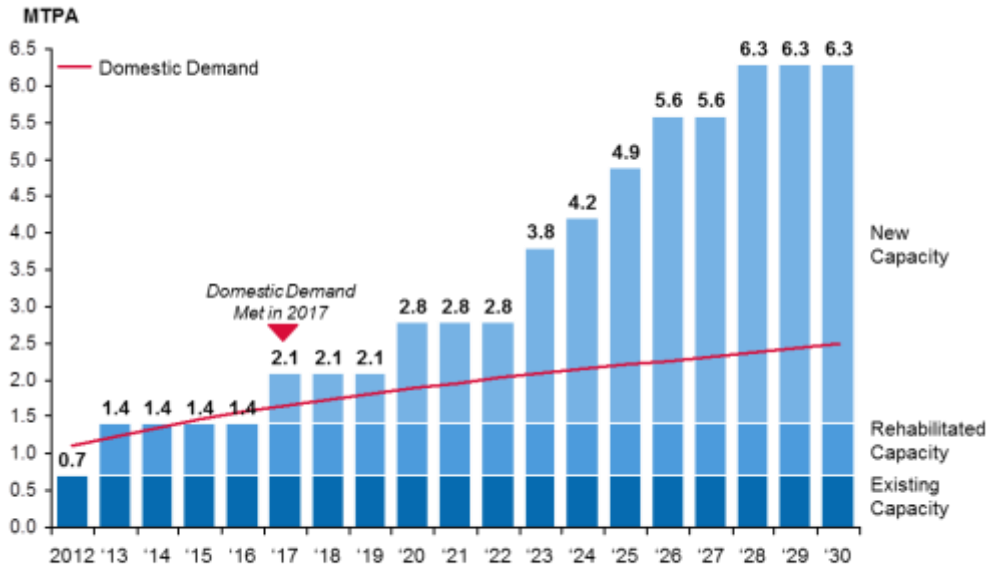
Fertilizer capacity is planned to satisfy domestic demand by 2017. In the short term, plants should be built near domestic demand centers. Once domestic demand is met, around 2017, new capacity should be built primarily to serve export markets and should be located with other export-oriented industries in an industrial park.

Petrochemical demand in Iraq is modest at present, but Iraq's abundant supplies of ethane-rich natural gas give it a potentially favorable position with respect to export markets, particularly in view of the shortage of ethane elsewhere in the region. World demand for petrochemicals is projected to grow at approximately 4 percent per year, and Iraq should be able to capture a substantial share of that growth. In addition to ethane-based petrochemicals, Iraq's gas supply will support propane-based and methanol petrochemicals as well. To take advantage of this export potential, world-scale petrochemical facilities should be located with other export-oriented industries in an industrial park. Until this park is developed, smaller petrochemical plants could be built elsewhere if warranted by local demand, but in the long term it will be more efficient to serve even local demand from large-scale facilities.

Aluminum provides an export opportunity based on Iraq's abundant gas supplies, which can support at relatively low cost the large power needs of aluminum smelters. Domestic demand today, however, is modest, and can be supplied through imports at relatively low cost. Moreover, the world price for aluminum is highly sensitive to changes in supply volume. For these reasons INES calls for aluminum capacity to be developed in the medium term, and in moderate 500 KTPA increments. Under this plan, domestic demand will be met in 2022, and thereafter the aluminum industry will serve primarily export markets, expanding as permitted by world market conditions. This industry, which imports alumina as well exporting aluminum, should be located close to import and export facilities along with other export-oriented industries in an industrial park.

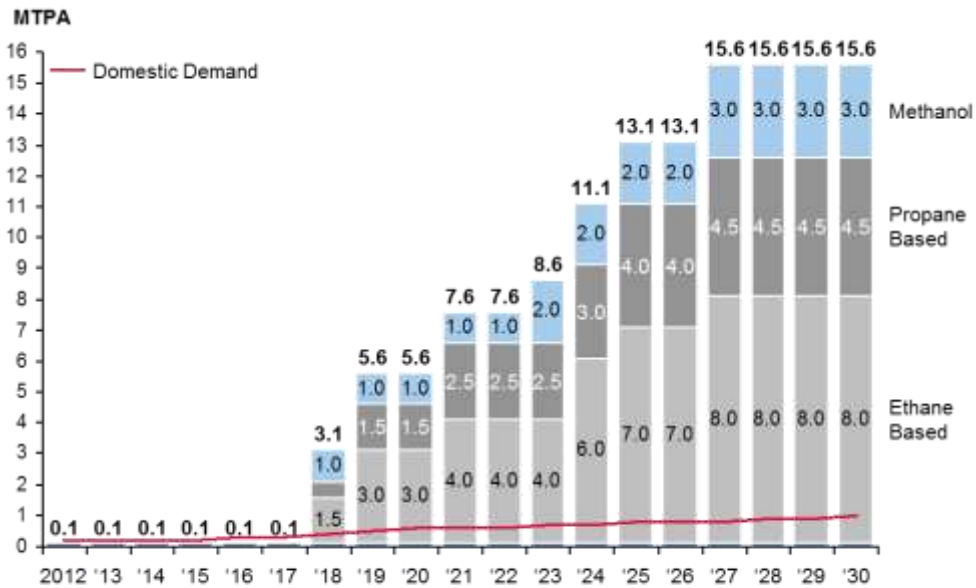
Because of Iraq's advantaged energy position, and because of strong export demand especially from Asia, each of these export industries is expected to provide strong financial returns. These returns, however, will depend on application of world-class plant design, scale, and processes. It will be important to attract strong private participation in these industries to provide capital, expertise, and economic discipline.

### Exhibit 5 - 25: Urea Capacity Expansion



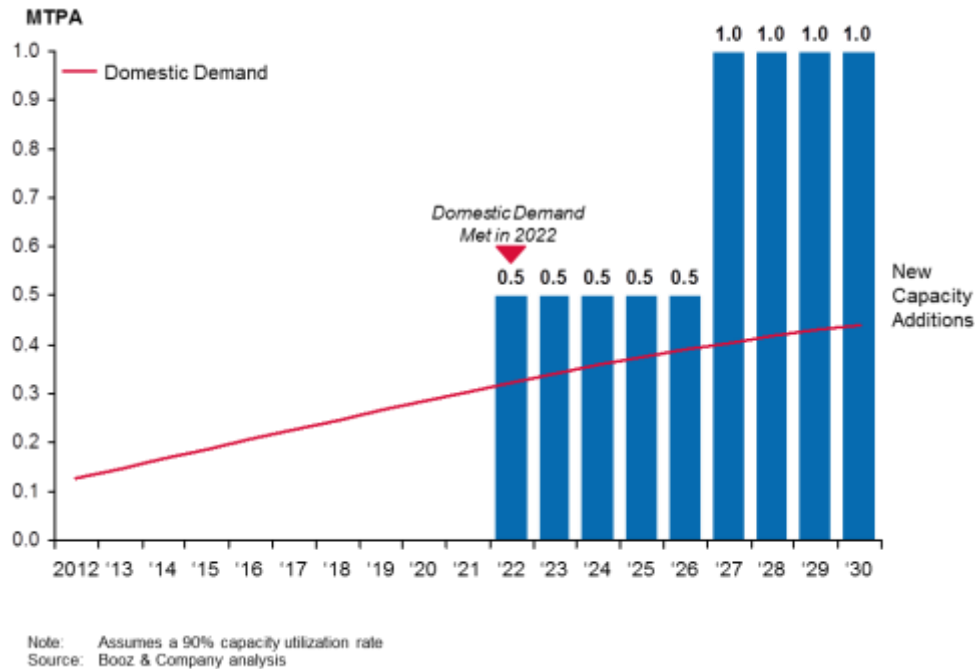
Note: Assumes a 90% capacity utilization rate in the long term  
 Source: Booz & Company analysis

### Exhibit 5 - 26: Petrochemical Capacity Expansion



Note: Assumes a 90% capacity utilization rate for capacity additions  
 Existing capacity of ~150 KTA is for ethylene-based petrochemicals  
 Source: Booz & Company analysis

## Exhibit 5 - 27: Aluminum Capacity Expansion



Each of these six primary energy-intensive industries has the potential of creating ancillary industries, both upstream in the form of suppliers and service providers, and downstream in the form of secondary value-added manufacture. To take advantage of this potential, Iraq will need to provide a strong framework of incentives and institutional support to attract investment and to develop local skills and local content. These issues are discussed in Chapter 6.

### 5.3. The INES Plan

The INES plan unfolds in three phases, each of which reflects a distinct set of priorities, and each of which lays the foundation for succeeding phases. Each phase has a set of strategic objectives and initiatives.

The first, short-term, phase is foundational. It focuses on building the infrastructure needed for the development of the energy sector and on securing the cash flow needed to fund that infrastructure. Because this phase depends on early monetization of Iraq's oil and gas resources, it is called the "Oil rush" phase. By the end of this phase, Iraq will be in a position to establish long-term oil and gas production targets. It will have an oil and gas infrastructure in place capable of handling that production, and it will have sufficient power generation capacity to meet domestic power needs reliably.

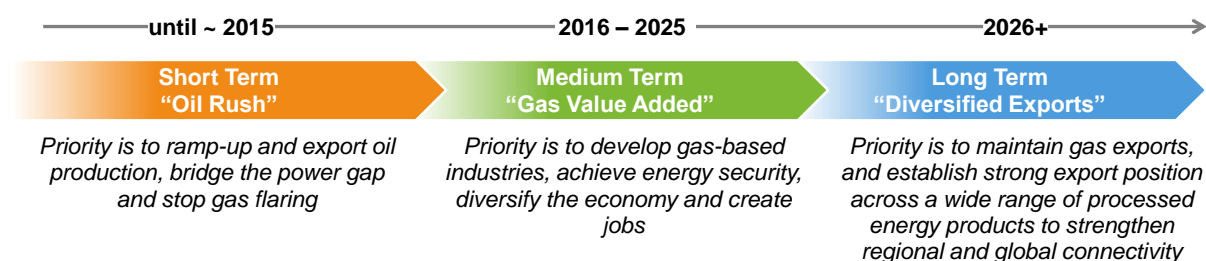
The second, medium term, phase is developmental. It focuses on creating downstream value from the hydrocarbon supply and infrastructure developed in the first phase. Because natural gas in particular will be deployed to support industrial growth and power efficiency, this phase is called the "Gas Value Added" phase. It spans a decade-long period from 2016 to 2025. During this period, oil production will be stabilized at levels appropriate to Iraq's reserves, and new non-associated gas reserves will be developed. Refinery capacity will be built to satisfy fully Iraq's domestic needs and to supply export markets opportunistically. Power capacity will expand with the steady addition of combined-cycle gas units, and the power system will become increasingly gas-fueled. Taking advantage of Iraq's abundant and

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ethane-rich natural gas, world-scale capacity will be developed in petrochemicals, fertilizers, and aluminum to serve global markets.

The third, long-term, phase is outward-looking. Building on the resources and capabilities developed during the preceding two phases, it focuses on using Iraq's energy-based economic strength to establish a significant, reliable, and sustainable position in regional and global markets. Because this phase will expand the scope and market reach of Iraq's energy exports, it is called the "Diversified Exports" phase. It begins in 2026 and carries through the remainder of the INES time span, to 2030 and beyond.

### Exhibit 5 - 28: The Phases of INES



#### Short Term - the "Oil Rush" phase (2012-2015)

The "Oil Rush" phase of INES will aim to accomplish seven primary objectives, each of which is necessary for subsequent development of the energy sector and the broader Iraqi economy.

- **Ramp up oil production.** Oil production should aim to achieve a minimum production level of 4.5 mmbpd by the end of 2014. This is lower of the range of production bracketed by the Medium and High oil production profiles. This target range provides strong early cash flow in order to fund immediate infrastructure requirements while preserving optionality with respect to long-term production targets. This objective requires the following initiatives:
  - *TSC oversight and support.* The MoO will need to monitor closely and facilitate actively the execution of upstream development plans. In particular it will need to focus on five critical fields (West Qurna 1 & 2, Rumaila, Zubair, and Majnoon) that constitute about 75% of incremental production. While facilitating production ramp-up, the MoO also will need to monitor and enforce TSC commitments to international petroleum industry best practices.
  - *Provision of water supply.* The MoO needs to fast-track the CSSF project. Additionally, either through CSSF expansion or through alternative means it needs to arrange water supply for fields not currently covered by the CSSF such as West Qurna 2 and Majnoon. Further, it needs to ensure that produced water from oil wells is treated and reused in ways appropriate to the specific reservoir formations involved.
  - *Development of longer-term production targets.* By 2014 the MoO will have received detailed FDP's and EDP's from the oil field operators. This information will need to be analyzed to understand reservoir potential, appropriate withdrawal rates, and future project economics. The MoO will need to integrate these findings with its commercialization strategy and its view of global market dynamics to determine

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policies and targets for long-term production. This is a formidable task of policy and analysis, and the MoO will need to develop the tools and information systems required to perform it. This need is addressed in Chapter 6.

- **Build a flexible and segregated crude oil evacuation system.** The oil evacuation system must be expanded to align with Iraq's increased oil production, crude segregation policies, and commercialization strategy. This objective requires the following initiatives:
  - *Development of segregation infrastructure.* Infrastructure needs to be developed to allow separate handling of light crude production (Basra Light and Kirkuk) and heavy crude production (North Heavy, Central Heavy, and South Heavy), including an evacuation route to the Arabian Gulf for South Heavy.
  - *Increases in evacuation capacity.* Southern evacuation capacity needs to be increased to 6.8 mmbpd through the addition of 4 SPMs. Northern evacuation capacity should be increased and diversified to a capacity of 1.6 mmbpd through rehabilitation of existing pipelines through Turkey and Syria. The North-South pipeline link needs to be rehabilitated to a capacity of 0.9 mmbpd. These expansions need to occur by 2014.
  - *Coordination of evacuation systems.* The field-level oil evacuation infrastructure under development by field operators needs to be coordinated with the pipeline infrastructure under development by the MoO. The MoO needs to plan these linkages and ensure their timely execution.
- **Launch refinery upgrades and distribution improvements.** Improvements to Iraq's system of producing and distributing refined products need to begin in this first phase. This objective requires the following initiatives:
  - *Refinery upgrades.* The Daura and Basra refineries, along with selected topping units such as Kask and Haditha should be upgraded, increasing refining capacity by 80 kbbpd. Tenders for new refineries should be issued.
  - *Improved investment incentives.* The MoO should perform a study to determine what program of assurances and incentives is required to attract private international investment in Iraqi refineries.
  - *Improved distribution capability.* The existing pipeline system for refined products needs to be expanded and metering and control systems need to be strengthened to improve flow management and accountability.
- **Eliminate gas flaring.** Elimination of gas flaring is a high INES priority. It will require the following initiatives:
  - *Development of adequate gas gathering and processing infrastructure.* The MoO needs to ensure timely establishment of gas gathering, compression, and processing facilities for Ahdab, Round 1 and 2, and self-operated fields. Particular focus should be placed on West Qurna 1 & 2, Majnoon, Rumaila and Zubair fields, since they constitute 70% of projected new associated gas production by 2014. The MoO needs to ensure that SGC operations are integrated rapidly into the BGC to expedite infrastructure development.



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- *Development of gas transportation and distribution infrastructure.* The MoO must build the transportation infrastructure needed to connect processing facilities with demand locations. Given the multiplicity of stakeholders and handover points in the pipeline system, strong coordination will be required to ensure that requirements regarding gas composition, volumes, delivery location, and schedule are met in a timely manner.
  - *Gas Master System design.* The complexity and size of the Iraqi gas system as volumes and product types grow, as new industrial users and generation plants come on line, and as entry and exit points proliferate, require a comprehensive plan of network design and control. The MoO should commission a technical study for the development of a nationwide Master Gas System covering gas movements from well-head to burner tip and establishing appropriate technical standards and regulations.
  - **Launch measures to manage future surplus gas.** The lead time required to manage the gas surplus that is expected to emerge in 2016 requires immediate short-term steps. This objective requires two initiatives:
    - *Development of export options.* Iraq should initiate discussions with potential export customers with the aim of securing Memorandums of Understanding and identifying pipeline and LNG terminal requirements.
    - *Identification and confirmation of non-associated gas reserves.* The MoO needs to pursue the development of Round 3 and Round 4 fields and conduct exploration activities to identify non-associated gas reserves that can support long-term export commitments and help to keep in balance Iraq's gas supply and demand. Iraq should continue to pursue additional bidding rounds to explore and develop non-associated gas prospects.
  - **Meet power demand.** Reliable power supply is a basic requirement for Iraq's future development. Expansion of generation capacity and improvement to the T&D system are urgently required. This objective will require the following initiatives:
    - *Successful completion of the existing capacity expansion program.* The MoE is currently executing an ambitious plan to build 40 new plants by 2016 with a combined installed capacity of 22 GW. To execute this plan successfully, the MoE needs to address three issues.<sup>57</sup> First, it needs to finalize pending EPC contracts. Second, it needs to monitor the advancement of on-going construction and commissioning works. Third, it needs to coordinate closely with the MoO to ensure that gas infrastructure is in place to serve these plants and that fuel agreements are stable and confirmed.
    - *Provision for management of new plants.* The MoE needs to ensure that sufficient O&M staff is assigned to the new plants as they come on line, or that contingency measures are available in case qualified MoE personnel cannot be made available. Those measures could include extending EPC contracts to cover one or two years of operation or outsourcing plant management to specialized O&M contractors.

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<sup>57</sup> As of February 2012, 9 GW of planned power capacity were not yet covered by signed EPC contracts, and 4 GW did not yet have secure or sufficient allocations of fuel.

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- *T&D alignment.* As new generation capacity becomes available, the MoE needs to expand, strengthen, and de-bottleneck the T&D network to handle increased power production.
  - *Accommodation of captive power generation.* Given that power shortages are likely to persist until 2016, captive power generation should be given considerable scope. Large residential or commercial complexes, industries operating in the construction or agricultural sectors, or light industries offering substantial job opportunities should be allowed to develop their own generation sources. As the supply of electricity improves, these small captive plants should be phased out or transformed into emergency or back-up generators.
  - *Initiation of renewable pilot projects.* The MoE should implement its current pilot project to generate off-grid renewable energy in selected isolated locations. The project will install 50 MW of capacity in 20 remote off-grid and 2 on-grid locations using hybrid solar and wind plants. The cost of this hybrid renewable solution (~23 US cents per kWh) is competitive with typical diesel units in these locations (25 US cents per kWh) due primarily to the high costs of transporting fuel oil to these isolated locations.
  - **Reduce reliance on imports of energy-intensive products.** With its inherent advantage in energy resources, Iraq should begin immediately to expand capacity in steel, cement, bricks, and urea. Domestic demand in each of these industries will grow rapidly as Iraq's construction and agricultural sectors expand. Fuel supplies should be guaranteed to these industries for manufacturing processes and for captive power generation as needed. This objective requires the following initiatives:
    - *Expansion of cement capacity.* The MoIM should encourage the private sector to build 12 MTPA of new and rehabilitated cement capacity by 2015 (including IFRK production). This capacity will be sufficient to meet domestic demand starting in 2014.
    - *Expansion of bricks capacity.* The MoIM should encourage the private sector to build 34 MTPA of new bricks capacity by 2015 (including IFRK production), sufficient to meet domestic demand in that year. Fertile soil currently used as raw material for brick manufacturing should be gradually phased out with the concurrent introduction of alternative materials and new technology. A shift in manufacture from clay bricks to concrete bricks and sand-lime bricks should therefore be encouraged to preserve agriculturally valuable soil resources.
    - *Expansion of steel capacity.* The MoIM should rehabilitate 0.5 MTPA of existing steel capacity by 2014 and encourage the private sector to develop 2.4 MTPA of new steel capacity by 2015. This capacity will not be sufficient yet to cover all domestic needs, leaving a deficit of approximately 1 MTPA to be supplied by imports until capacity catches up with demand in the next INES phase.
    - *Rehabilitation of existing urea capacity.* The MoIM should encourage rehabilitation of 1 MTPA of urea capacity by 2014, leaving approximately 0.5 MTPA of domestic demand to be filled through imports. This capacity, intended to serve domestic demand only, should be built near domestic demand centers as standalone plants or in small-scale regional clusters.

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- *Redesign of incentives for private investment.* The MoIM should commission a study to develop incentives for private investment in these domestic industries. In order to overcome the perceived risks of investing in Iraq, it may be advisable to offer a mix of fuel supply guarantees, infrastructure guarantees, and discounted access to land, as well as tailored financial incentives.
  - **Establish platforms for the development of export-related industries.** Iraq's potential export advantage in export industries such as petrochemicals, urea, and aluminum will be realized only after Iraq has established a reliable system of natural gas transport and delivery. In anticipation of that advantage, Iraq should use the first phase of INES to develop an infrastructure platform for export industries. This objective requires the following initiatives, both of which are discussed further in Chapter 6:
    - *Establishment of an industrial park.* The MoIM should develop a large industrial park in Basra, covering between 25 and 100 Km<sup>2</sup> of land, and providing modern infrastructure for supplies, services, and exports. While land parcels of this magnitude is preferred for capturing the full benefits of co-locating synergistic industries and developing an economic eco-system, in its absence, the MoIM should aim at maximizing the clustering of industries in different locations.
    - *Establishment of a holding company for strategic export industries.* The MoIM should establish a holding company to coordinate initiatives in selected strategic export industries and to develop joint ventures with private investors.

#### **Medium Term: the "Gas Value-Added" phase (2016-2025)**

Building on the foundation of infrastructure and supply developed in the short term, the "Gas Value-Added" phase of INES will diversify and expand the value potential of Iraq's energy resources. This phase aims to accomplish seven primary objectives.

- **Reach and sustain oil production targets consistent with long-term production policy.** By 2015 Iraq will have detailed information from its Round 1 and 2 oil fields as a consequence of the FDP's and EDP's submitted by TSC operators. It also will have improved information regarding potential oil and gas reserves based on continuing exploration work. Accordingly, by the end of Iraq will have set long-term production targets that reflect best practices in reservoir management and that align with global market demand and Iraq's revenue needs. During the medium term the MoO needs to develop upstream resources to meet those targets.<sup>58</sup> This objective will require two initiatives:
  - *Management of long-term production levels.* The MoO will need to increase 2015 production levels as needed to meet long-term production targets. If targets are set by Iraq at levels below existing TSC commitments, adjustments to those commitments will need to be negotiated on a field-by-field basis. If targets are confirmed at existing TSC levels, then TSC commitments will remain applicable, possibly with reallocation of field-by-field expectations.

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<sup>58</sup> As noted in Chapter 4, INES investment plans are based on the Medium production scenario that reaches a plateau production of approximately 9 mmbpd by 2020. If Iraq's reset long-term production targets in 2015 differ significantly from that figure, then INES investment projections for subsequent years will also need to be modified. This is one of the tasks of ongoing strategic management noted in Chapter 7.

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- *Enhancement of reserves.* The MoO will need to continue oil and gas exploration activity in order to accrue reserves and maintain a healthy resource base. Especially if Iraq decides to sustain production at or near the High production plateau for a period longer than seven years, it will need to locate new reserves and initiate plans for their development.
  - **Expand the crude oil evacuation system to accommodate growing production.** As oil production increases, the oil evacuation system will need to be expanded to handle the growth in production and to advance Iraq's commercialization strategy. This objective will require two initiatives:
    - *Expansion of the northern evacuation system.* Evacuation capacity on the northern system via Syria and Turkey will need to be increased from the 1.6 mmbpd developed in the short term to 3.8 mmbpd. It is currently recommended that this addition occur through rehabilitation of an existing pipeline through Turkey by 2016, with 0.9 mmbpd capacity, and construction of a new Syrian pipeline by 2017, with 1.25 mmbpd capacity.
    - *Expansion of the North-South pipeline link.* Concurrently, the capacity of the North-South link will need to increase from 0.9 mmbpd to around 3.2 mmbpd in order to transport Basra Light crude to the northern evacuation system. It is recommended that this addition occur through construction of a new North-South pipeline by 2017, with 2.25 mmbpd capacity, paralleling the existing North-South Strategic Pipeline that will be rehabilitated during the short term. Together with expansion of the northern evacuation system, this initiative will permit Iraq to use the most efficient routings for its balanced export strategy.
  - **Meet domestic demand for refined products.** Between 2015 and 2025 refinery capacity will need to increase from approximately 800 kbpd to more than 1,400 kbpd. This increase in domestic capacity will permit Iraq to cover domestic demand in all oil products by 2019 at international specifications. This objective will require two initiatives:
    - *Continued improvements to the refinery system.* Approximately 210 kbpd of existing capacity at inefficient topping units will be retired. New refineries will be built at Karbala (140 kbpd in 2016), Amara (150 kbpd in 2017), Kirkuk (150 kbpd in 2018), Nasiriya (300 kbpd in 2019), and Qayyarah (100 kbpd in 2019).
    - *Continued improvement to the refined product distribution infrastructure.* The increase in domestic oil products will require continued expansion and rehabilitation of the primary distribution pipeline network to reduce dependency on trucks. Storage capacity for white products should be enlarged to provide a 60 day inventory. Installation of metering and control station systems should be continued to monitor product flows and losses.
  - **Begin gas exports supported by development of non-associated gas reserves.** Due to the gas infrastructure built in the short term, gas flaring due to inadequate infrastructure will have ended by 2015. However, beginning in 2015 more gas will likely be produced and processed than Iraq can consume domestically, and that surplus will need to be exported. For reasons discussed in Section 5.2, export commitments in turn will require

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identification of new natural gas resources. Accomplishing the objective of exporting gas therefore will require the following initiatives:

- *Completion and implementation of export agreements initiated in the short term.* Iraq's gas surplus is likely to develop as early as 2016. By then Iraq will need to have at least one or two of the export options discussed in Section 5.2 ready for launch. Others will need to follow within the next two or three years.
- *Commencement of production from Round 4 gas fields.* The exploration and development of Round 4 non-associated gas fields including those from additional bidding rounds will begin in the short term. In the medium term capacity plans need to be developed in alignment with export commitments. By 2020 it is likely that actual production from these fields will need to commence. The timing and level of production will need to be flexible in order to balance gas surplus with export commitments
- *Accrual of additional non-associated gas reserves.* Beyond Round 4, Iraq should conduct further exploration to clarify its reserves of non-associated gas. Based on more comprehensive reserve estimates, Iraq can establish long-term development plans to sustain its export commitments and to provide flexibility in its overall gas portfolio.
- **Increase power system efficiency.** By 2016 Iraq will have enough power generation capacity to meet its domestic peak demand, with sufficient reserve to ensure reliability. During the medium term, peak demand is estimated to rise from 17 GW in 2016 to 27 GW by 2025. Serving this demand will require further expansion in generation capacity and further improvements to the T&D system. Both aims should be pursued in a way that enhances overall system efficiency. This objective requires the following initiatives:
  - *Addition of combined cycle gas turbines to the generation fleet.* Once gas resources are reliably available after 2015, the MoE should add only CCGT's to Iraq's fossil-fuel generation mix. These units are substantially more cost-effective than any other fossil-fuel technology, and Iraq has an abundance of the fuel they require. The MoE should maintain existing GT's and ST's. These units run efficiently on natural gas, but they are flexible in the fuel they use. So long as Iraq has otherwise stranded quantities of fuel oil or very heavy crude oil, it is cost-effective to continue consuming those fuels. Moreover, the fuel optionality of GT's and ST's will be valuable in the event that for some reason a temporary shortage of gas occurs
  - *Phase-out of inefficient capacity.* As CCGT capacity is added, it should displace the least efficient existing sources of supply. Imports will have been phased out by the end of the short term. Thereafter diesel generators and ST and GT units existing prior to 2012 should be progressively retired, eliminating the least efficient units first. By the end of 2025, virtually all units existing today should be retired
  - *Development of on-grid solar and wind capacity.* Iraq has substantial long-term potential in renewable generation, especially solar-based. It is expected that the total capacity of renewable energy will reach 1.2 GW by 2025, mainly comprising CSP, PV and wind solutions. Early in the medium term the MoE should develop a detailed solar and wind atlas to identify areas with high potential for renewable installations. A regulatory framework to incentivize investments in renewable energy, discussed further in Chapter 6, also will need to be developed



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- *Assessment of hydropower potential.* Iraq has relied extensively on hydropower in the past, but the country's water balance today is too precarious to provide a reliable supply of electricity from dams. However, the long-term potential - particularly in the IFRK - has not been comprehensively assessed. Because hydropower is an inexpensive potential source of base-load power, and because it can support a broader program of water management, Iraq should perform a technical, economic, and environmental evaluation of hydropower's potential. In parallel, discussions and agreements on water rights with upstream countries will be required.
  - *Improvement to the T&D system.* The T&D system needs to expand to match the growth of the electrical system. Technical losses should be reduced to acceptable levels and a smart grid program should be initiated to monitor grid performance and enhance peak load management. The location of future gas-fueled generation units should optimize the construction of gas pipelines and transmission lines in order to create a stable transmission system with contingent capabilities.
  - *Introduction of demand-management capabilities.* Once reliable power supply is provided, tariffs should gradually increase to cover at least the fuel and O&M costs of generation and possibly asset depreciation. As tariffs begin to align with costs, customers will likely become responsive to demand-side management measures such as green building codes, load control programs, district cooling in high density areas, gas kitchens, and solar water heaters.
  - *Formulation of a policy for regional interconnection.* Once Iraq has acquired self-sufficiency in power, it should develop a long-term strategy for international power exchange, either as a net exporter or as part of a cooperative regional grid for reserve sharing and load balancing. Iraq's location gives it a strategic position for potential wheeling of power from the Middle East to Europe. This location could have value in a possible future environment where the Middle East's solar potential is developed to a point where it can provide substantial carbon-free power for export.
  - **Meet domestic demand in all linked industries.** By the end of the short term, Iraq will be self-sufficient in only cement and bricks and will be continuing to import large quantities of steel, urea, and petrochemicals. One of the aims of the medium term is to become self-sufficient in all these energy-intensive products. This objective requires the following initiatives:
    - *Continued construction of cement and brick capacity.* The MoIM should continue to encourage the construction of cement and bricks capacity near demand centers in line with domestic demand. Between 2016 and 2025, brick capacity will need to grow from 54 MTPA to 67 MTPA. Cement capacity will need to grow from 30 MTPA to 57 MTPA.
    - *Continued construction of new steel capacity.* At the end of the short term, Iraq will have domestic steel production capacity of 2.9 MTPA and will be importing approximately 1 MTPA. During the medium term the MoIM should oversee construction of an additional 5.8 MTPA of capacity, possibly through joint ventures with international investors. Under the INES investment plan, domestic demand will be met by 2021.
    - *Construction of aluminum capacity.* In order to meet domestic demand for aluminum, the MoIM should construct 0.5 MTPA of capacity to come on line by 2022. This



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capacity could likely be developed through a joint venture. Because aluminum may in the long term have export potential that would justify capacity expansion, it would be appropriate to locate this initial capacity in an industrial park with other export-oriented industries.

- **Develop large-scale export capacity in petrochemicals and urea.** With the availability of abundant gas supply after 2015, the stage will be set for large-scale development of urea and petrochemicals capacity. This capacity will be aimed not only at satisfying domestic demand but also establishing a significant export position. Both industries should be assured reliable supplies of natural gas to serve as feedstock and to support captive power generation. The government-owned strategic industries holding company established in the short term should structure joint ventures involving private capital, and the industrial park in Basra initiated during the short term should provide the facilities and synergies needed for world-class operations. This objective requires the following initiatives:
  - *Expansion of urea capacity.* By 2017 urea capacity should be brought to a level that satisfies domestic demand through the addition of 0.7 MTPA of new capacity. Starting in 2020, new capacity should be added to serve export markets, reaching a total urea capacity of 4.9 MTPA by 2025.
  - *Development of petrochemicals capacity.* Petrochemicals production will start to come on line in 2018, with the construction of 3.1 MTPA capacity. This production will satisfy domestic demand but will primarily serve the export market. Subsequent development should bring petrochemicals capacity to 13.1 MTPA by 2025, consisting of ethane-based capacity (around 7 MTPA), propane-based (4 MTPA), and methanol capacity (2 MTPA).

### **Long Term: The “Diversified Export” Phase (2026-2030+)**

The third phase of INES is a steady state that extends to 2030 and beyond. During this period Iraq will continue to export crude oil and dry gas at levels set during the medium term, and will extend the export positions it has established in gas-based industries, refined products, and power. The principal focus of this phase is to strengthen further the economic integration of Iraq into regional and global economies. It aims to accomplish four primary objectives:

- **Export refined products.** The MoO should consider adding an export-oriented refinery to add value to its crude oil and to diversify its energy-related export offerings. The refinery should handle at least 300 kbpd in order to benefit from scale economies, and it should have a complex configuration capable of processing heavy crude and yielding higher middle distillates in line with international demand. The advisability of adding this capacity will depend on prevailing global market dynamics and refinery margins.
- **Sustain gas supply to meet domestic and export commitments.** The MoO should continue development and exploration of non-associated gas fields and pursue new gas export opportunities as permitted by long-term gas reserves.
- **Export power.** Based on the international interconnection strategy developed during the medium term, Iraq should consider exporting power to the region and beyond and building power plants specifically for that purpose. These export plans would be a

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means of adding value to natural gas, and their value will depend on the margin differential between exporting electricity and exporting gas.

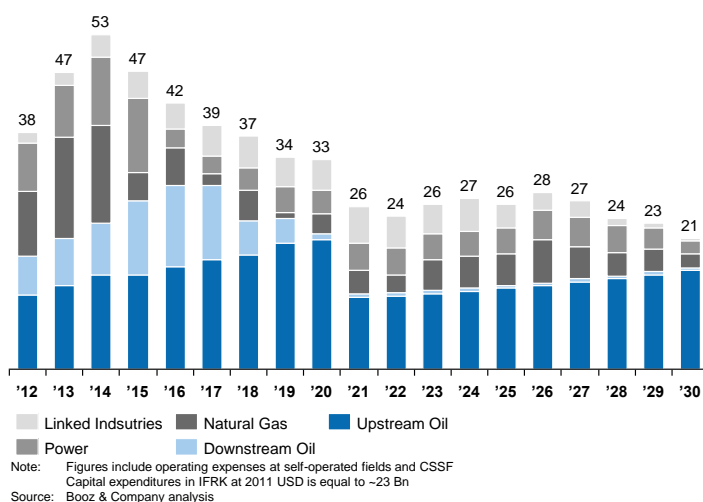
- **Continue improving the efficiency of the power system.** Depending on the results of feasibility studies conducted during the medium-term, Iraq should consider expanding its reliance on renewable generation beyond the 4 percent currently established for 2030 (8 percent if the IFRK and its hydropower production is included). It also should consider further tariff increases to make the electricity sector self-funding and to support continued initiatives in demand-side management.
- **Expand export-oriented gas-based industries.** Iraq will expand its position in export-oriented industries by increasing capacity and capturing increased value from downstream petrochemical activities. It is assumed that capacity in these industries will continue to grow after 2030 as permitted by global market conditions and domestic gas supply. This objective requires the following initiatives:
  - *Expansion of urea capacity.* The MoIM should increase urea capacity from its 2025 level of 4.9 MTPA to 6.2 MTPA by 2030.
  - *Expansion of petrochemicals capacity.* The MoIM should increase petrochemicals capacity from its 2025 level of 13.1 MTPA to 15.6 MTPA by 2030. It also should encourage private investment in downstream petrochemicals processes in order to capture value from higher-margin engineered plastics.
  - *Expansion of aluminum capacity.* Assuming favorable international markets, the MoIM should continue to build capacity in aluminum, expanding from the 2025 capacity level of 0.5 MTPA to 1.0 MTPA in 2030.

### **INES Expenditure requirements 2012 - 2030**

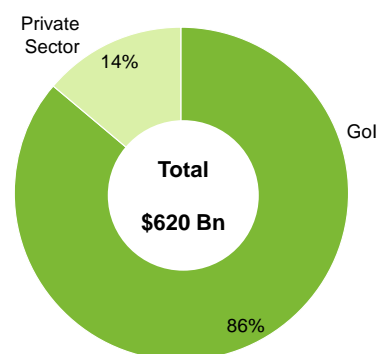
The development program recommended by INES will require capital expenditures of approximately \$620 billion (in constant 2011 dollars) between 2012 and 2030, including all contracted payments to TSC operators. Of this total figure, it is assumed that about 15 percent will be available from private investments, primarily in refineries and linked industries, leaving \$530 billion to be funded by the Government of Iraq.

## Exhibit 5 – 29: I INES Expenditures 2012-2030

**Capital Expenditures and Payments to TSC Participants**  
USD Bn (in real term 2011)



**Breakdown of Cumulative Expenditures**  
USD Bn (in real term 2011), 2012 – 2030



Approximately 60 percent of projected INES expenditures by the Government of Iraq will go toward the production and evacuation of crude oil, and much of that amount will consist of reimbursements to the MoO's TSC operators. 15 percent of expenditures will go toward the production and handling of natural gas, and another 15 percent toward the renovation and expansion of the national power system.<sup>59</sup>

**Exhibit 5 – 30: Projected Ministry of Oil Expenditures on INES**  
USD Billion (2011\$)

	2012-15	2016-20	2021-25	2026-30	Total
Oil TSCs Petroleum Costs	49.0	79.4	53.4	56.2	<b>238.0</b>
Oil TSCs Remuneration Fees	2.9	10.0	11.2	10.0	<b>34.1</b>
MoO Self-Operated Fields	3.7	1.4	1.0	1.0	<b>7.1</b>
Common Seawater Supply Facility	4.3	5.1	0	0	<b>9.4</b>
Refineries	4.5	6.6	1.5	1.5	<b>14.1</b>
Oil Products Domestic Distribution	0.5	0.4	0	0	<b>0.9</b>
Oil Evacuation Infrastructure	20.0	14.0	0.5	0	<b>34.5</b>
<b>Total MoO Oil Investments</b>	<b>84.9</b>	<b>116.9</b>	<b>67.6</b>	<b>68.7</b>	<b>338.1</b>
Gas TSC Development Costs (Round 3)	3.0	3.1	0	0	<b>6.1</b>
Gas TSC Remuneration Fees (Round 3)	0.1	1.8	2.0	2.0	<b>5.9</b>
Additional Gas Field Development	0	5.2	15.1	16.6	<b>36.9</b>
Basra Gas Company	12.0	0.3	0	0	<b>12.3</b>
Non-BGC Gas Processing Facilities	7.9	1.7	3.2	1.5	<b>14.3</b>
Domestic Gas Pipelines	2.8	0.3	0.5	0.2	<b>3.8</b>
Export Gas Pipelines	0	2.7	0	0	<b>2.7</b>
<b>Total MoO Gas Investments</b>	<b>25.8</b>	<b>15.1</b>	<b>20.8</b>	<b>20.3</b>	<b>82.0</b>
<b>Total MoO Investments</b>	<b>110.7</b>	<b>132.0</b>	<b>88.4</b>	<b>89.0</b>	<b>420.1</b>

<sup>59</sup> Please see Appendix G for year-by-year breakdowns of planned expenditures.

**Exhibit 5-31: Projected Ministry of Electricity Expenditures on INES**  
USD Billion (2011\$)

	2012-15	2016-20	2021-25	2026-30	Total
Generation	25.5	9.8	10.3	5.3	<b>45.8</b>
IPPs	0	0.9	1.0	1.2	<b>3.1</b>
Transmission	8.4	3.5	4.5	7.0	<b>23.4</b>
Distribution	4.3	1.5	1.5	2.5	<b>9.8</b>
<b>Total MoE Investments</b>	<b>35.2</b>	<b>15.3</b>	<b>17.3</b>	<b>16.4</b>	<b>84.2</b>

**Exhibit 5-32: Projected Ministry of Industry and Minerals INES Expenditures**  
USD Billion (2011\$)

	2012-15	2016-20	2021-25	2026-30	Total
Steel	0.5	1.7	1.2	0.6	<b>4.0</b>
Urea	0.3	0.7	1.3	0.3	<b>2.6</b>
Petrochemicals	1.7	6.4	6.6	0.8	<b>15.5</b>
Aluminum	0	0.6	1.2	0.6	<b>2.4</b>
Basra Industrial Park Infrastructure	0.4	1.0	0.7	1.2	<b>3.3</b>
<b>Total MoIM Investments</b>	<b>2.9</b>	<b>10.4</b>	<b>11.0</b>	<b>3.5</b>	<b>27.8</b>

#### **5.4. INES Results**

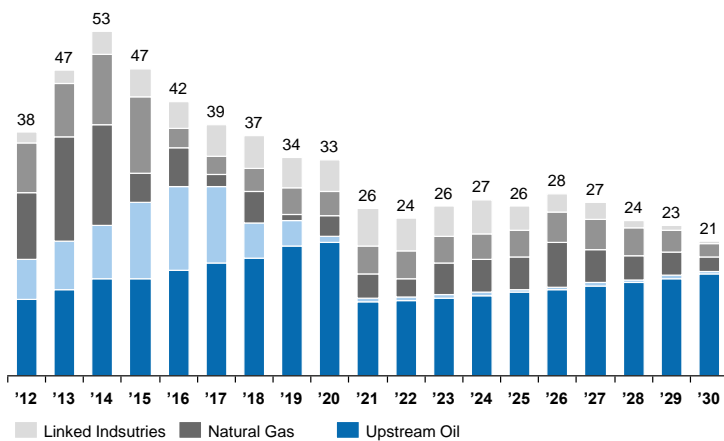
The Integrated Energy Model used in the formulation of INES projects the impact of the INES plan on the five strategic evaluation metrics discussed in Chapter 4. The results presented here are premised on two base-case assumptions: plateau production at the Medium oil production plateau level of 9 mbpd and an average Brent benchmark price of \$110 per bbl, in constant 2011 dollars.

- **Government value creation.** The INES initiative outlined in the preceding section, as noted, will require government expenditures of approximately \$530 billion (in constant 2011 dollars) between 2012 and 2030. This figure includes capital and operating expenditures, and will be supplemented with approximately \$90 billion in private investment, for total projected expenditures of \$620 billion.

### Exhibit 5 - 33: INES Projected Expenditures

#### Capital Expenditures and Payments to TSC Participants

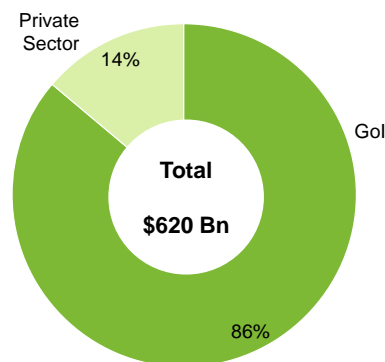
USD Bn (in real term 2011)



Note: Figures include operating expenses at self-operated fields and CSSF  
Capital expenditures in IFRK at 2011 USD is equal to ~23 Bn  
Source: Booz & Company analysis

#### Breakdown of Cumulative Expenditures

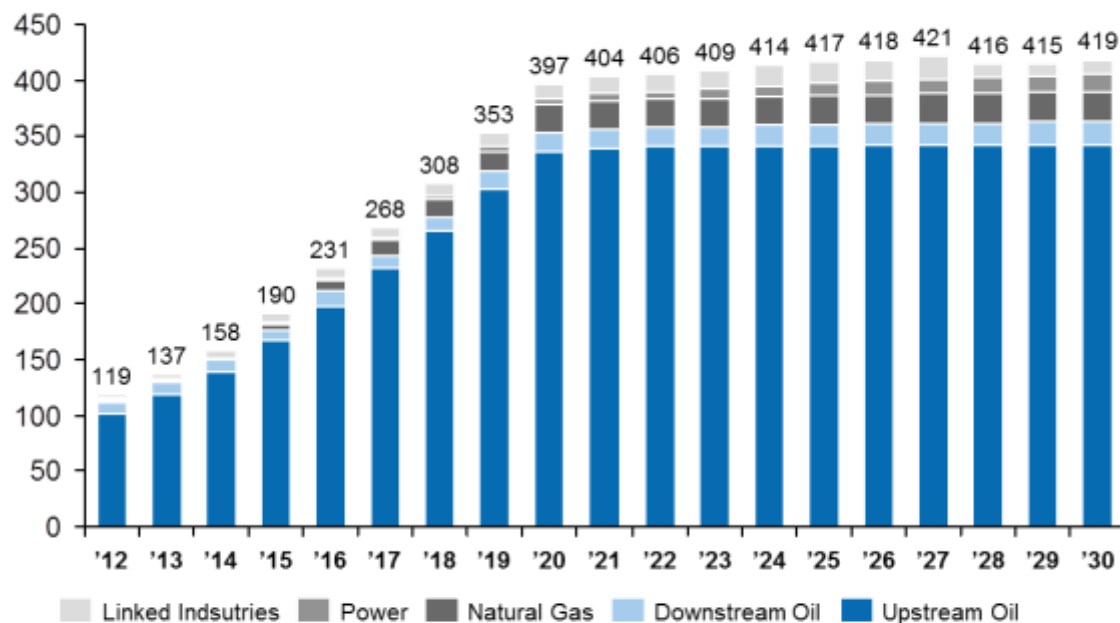
USD Bn (in real term 2011), 2012 – 2030



The revenue generated by these expenditures over the same period is expected to amount to approximately \$6 trillion. Of this amount, almost 85 percent is attributable to oil exports.<sup>60</sup>

### Exhibit 5 - 34: INES Projected Government Revenues

2011 USD Bn

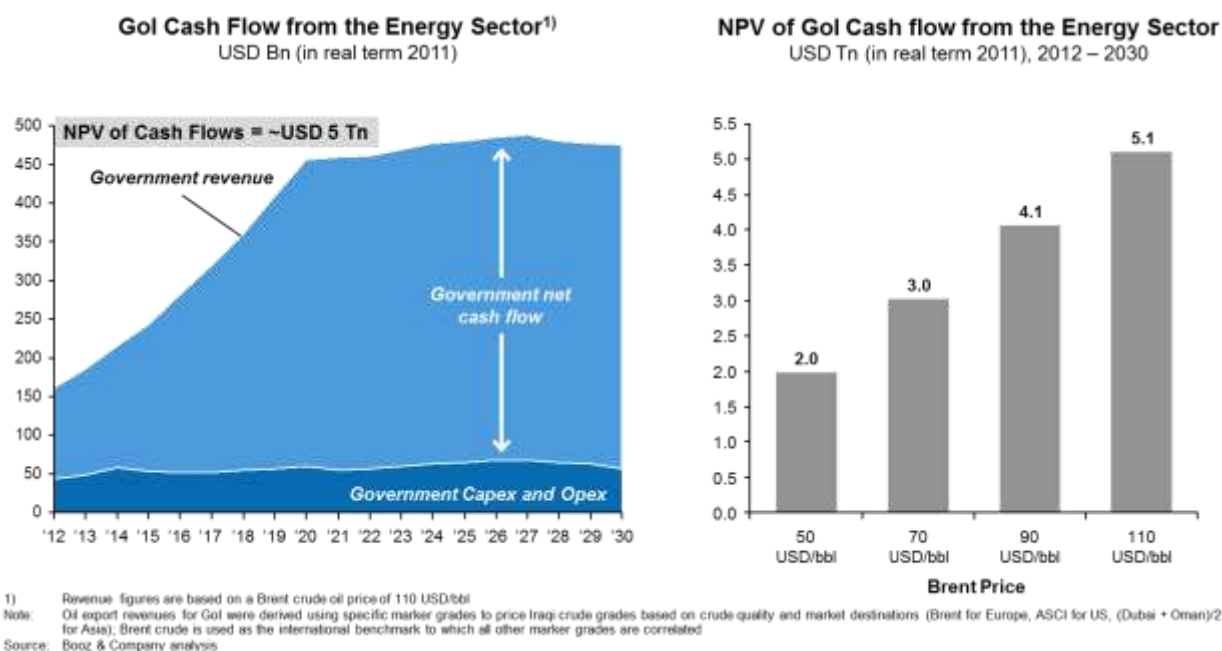


Notes: Iraqi oil prices are based on a Brent crude price of 110 USD/bbl and factor in price differentials for quality and shipping  
Upstream oil includes domestic and export sales of crude oil – with export sales making up the majority of sales  
Source: Booz & Company analysis

<sup>60</sup> The specific price of Iraqi oil is calculated from Brent, adjusting for price differentials at assumed points of delivery and crude characteristics. Transportation costs associated with different routes and markets are deducted from those prices in order to arrive at a per-barrel revenue figure. The revenue per barrel is multiplied by projected volumes to arrive at an overall oil revenue projection.

The cash flow implied by these cost and revenue projections is highly positive from the outset. At the base-case price assumption of \$110 per bbl, the net present value of cash flow over the span of INES is \$5 trillion. NPV rises or falls by roughly \$1 trillion as average oil price rises or falls by \$20.

### Exhibit 5 – 35: INES Net Value Creation



- Economic diversification.** In order to estimate the impact of INES initiatives on the economy as a whole, it is assumed that a portion of oil revenue (10 percent in years of fiscal deficit, 20 percent in years of fiscal surplus) will be invested each year in the non-energy economy. It is assumed that these investment will be deployed with reasonable efficiency and with economic multiplier effects typical of government investments in emerging economies.<sup>61</sup> Under these assumptions, Iraqi GDP is projected to grow at a compound annual rate of 7 percent between 2012 and 2030.

Oil revenues will be the primary engine of Iraqi economic growth over the next two decades. Oil revenue growth will precede non-oil growth, and with expected production ramp-up it will occur more rapidly in the early years than non-oil growth.

INES measures economic diversification as a ratio consisting of a numerator (non-oil and gas GDP)<sup>62</sup> and a denominator (overall GDP). The dynamic just described will increase the denominator (which includes oil revenue) faster than it increases the numerator. Consequently the diversity ratio actually will fall in the short term from its current level,

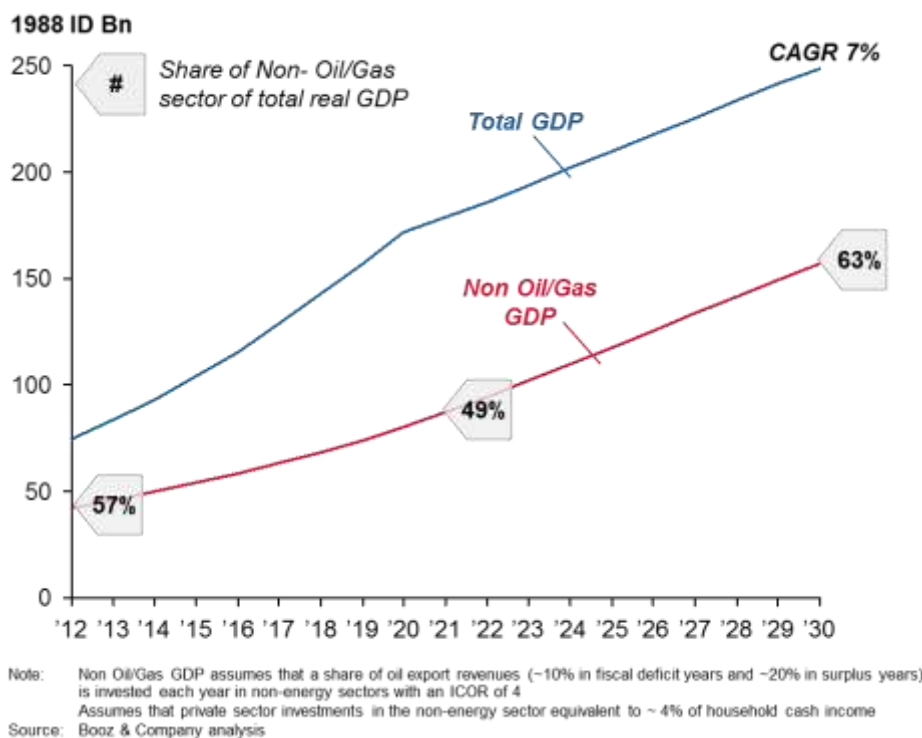
<sup>61</sup> The multiplier effect on economic growth from public investment depends on the type of investment and socio-economic factors specific to individual countries. INES applies an ICOR (Incremental Capital Output Ratio) of 4, which is generally regarded as a reasonable benchmark expectation for public investment in emerging economies. It implies that four dollars of public investment will generate a recurring one-dollar increment in annual GDP.

<sup>62</sup> “Non-oil and gas GDP” contains all GDP except that attributed directly to upstream oil and gas activities.



and this effect will be increasingly pronounced at higher oil production levels. This drop in the diversification ratio will occur even though the non-oil sector in fact is growing rapidly. After an initial drop, the diversity ratio will gradually improve as oil production levels off and as the non-oil economy continues to expand.

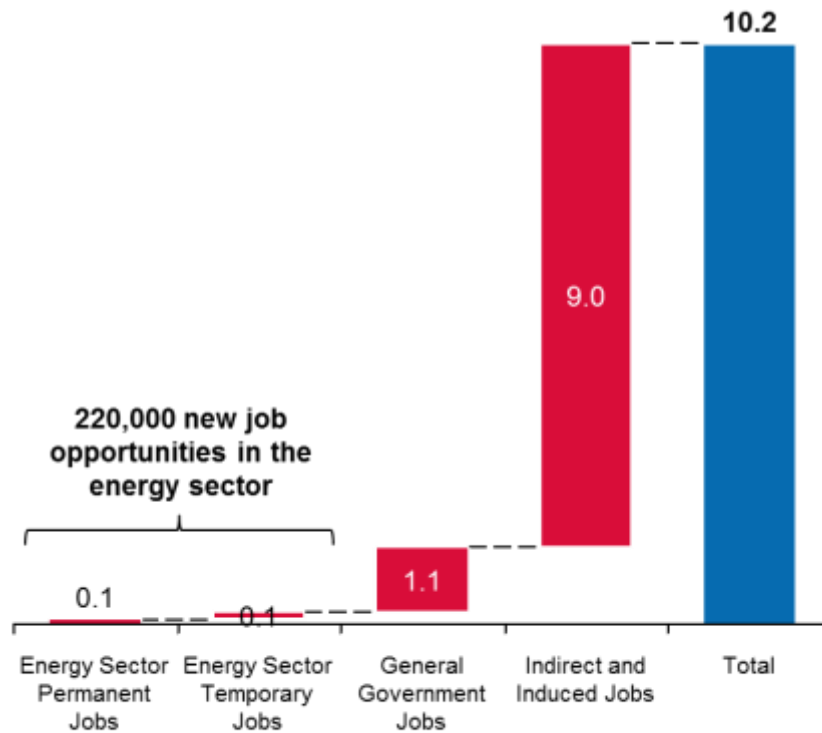
**Exhibit 5 - 36: Iraqi Economic Growth and Diversification**



- Employment growth.** Production in the energy sector is capital-intensive. The initiatives prescribed in the INES will create jobs directly, but at modest level (~220,000) in relation to the amount of capital invested. The far greater impact of the energy sector on job growth will be indirect. By providing funds for investment in economic development, and by providing the fuel and power needed for commercial and industrial development, the energy sector will support job growth in all economic sectors. As indicated in Exhibit 5- 6, this indirect effect on employment will be 30 to 40 times as great as the direct effect.

A significant number of new jobs also will be needed in the public sector, to manage the large flow of public investment and to serve the needs of an expanding economy. Because the Iraqi public sector is widely regarded as being overstaffed at present, some portion of these new public-sector jobs may involve a redeployment of current positions rather than a net addition to public employment.

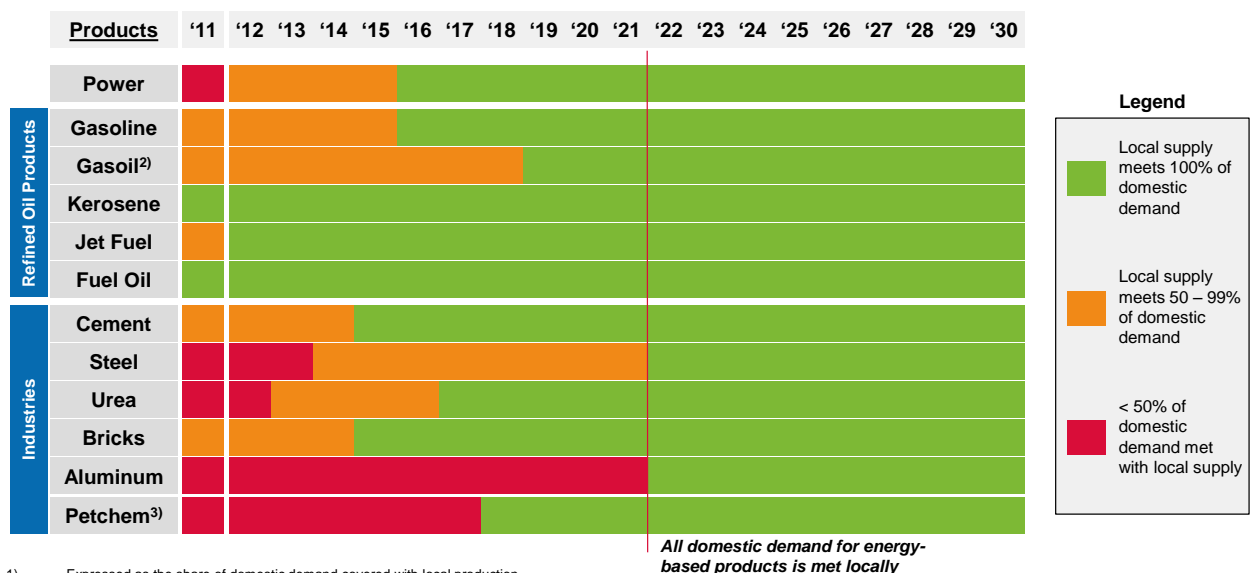
**Exhibit 5 - 37: Cumulative New Job Opportunities from INES**  
(Millions of New Jobs, 2030 vs. 2012)



Source: Booz & Company analysis

- **Energy security.** The INES capacity plan will cover all of Iraq's domestic demand for energy-related products by 2022. Importantly, power demand will be fully covered by the end of 2015, as will demand for cement and bricks - - commodities critical to Iraq's reconstruction.

**Exhibit 5 - 38: Portion of Domestic Demand Met by Domestic Production Capacity**



1) Expressed as the share of domestic demand covered with local production  
 2) According to the MoO plan, which only covers the 2012-2019 period, there will be a shortage on gasoil in 2025. We assume that by then the MoO will add new capacity to cover the shortage  
 3) Includes propane and ethane-based petrochemicals  
 Source: Booz & Company analysis

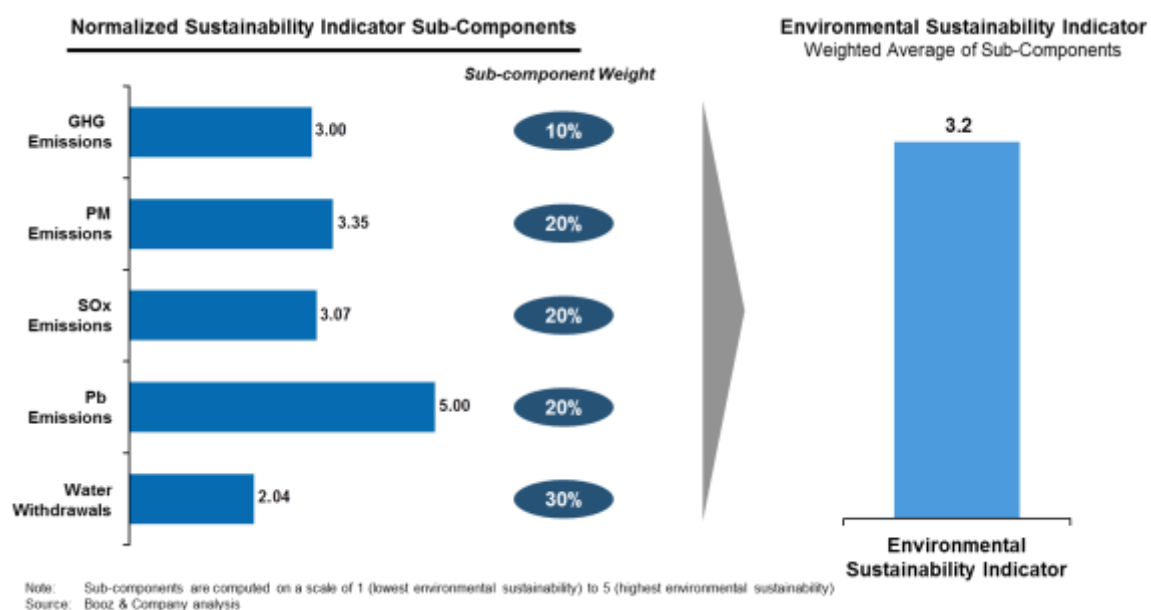
- **Environmental sustainability.** INES has both positive and negative impacts on the environment. By displacing inefficient power plants, by improving the quality of transportation fuels, by eliminating gas flaring, and by establishing a comprehensive water-resource infrastructure for use in oil production, it addresses directly some of today's most glaring environmental challenges.

On the other hand, INES is expected to spur rapid growth in the overall national economy, which will create new stress on the natural environment and create new potential for water, air, and land pollution. These negative effects can be contained through the systematic application of appropriate production technologies, use of remediation technologies, and environmentally sensitive site selection. None of these corrective elements, however, is self-executing. They will require investment and careful regulation, monitoring, and enforcement. The expense of that effort will be substantial, but the resources to fund the effort will be available. While INES adds to Iraq's environmental challenges it also provides the means to meet them.

The environmental impact of INES plans is calculated on the basis of regional benchmarks for the level of emissions associated with the specific production activities and technologies proposed. These levels reflect standards of environmental remediation that are typical in the region. To the extent that Iraq surpasses regional standards of environmental practice, its performance will be better than indicated by the sustainability index rating shown here.

For purposes of developing this index, five areas of environmental impact were examined: emissions of greenhouse gases, emissions of particulate matter, emissions of sulfuric oxide, emissions of lead, and volumes of fresh water withdrawals. Each impact area was assigned a relative weight, and changes in each area have been calculated and normalized on a scale from best strategies (5) to worst strategies (1). Applying this composite metric, the INES sustainability score is a relatively positive 3.2.<sup>63</sup>

**Exhibit 5 - 39 Composite Environmental Impact of INES**

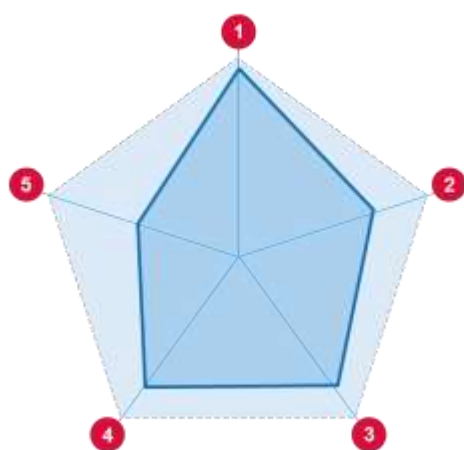


<sup>63</sup> Please see Appendix F for details of the environmental impact calculation.

In summary, INES substantially achieves its strategic objectives. By the end of INES, Iraq has virtually 100 percent energy security. It will have received sufficient funds from energy development (particularly from oil export) to support a broad program of national social and economic development. Its economy will be more diverse than it is today, and becoming increasingly diverse. Nearly 10 million new jobs will be available, bringing the economy to full employment.

Environmental conditions will be greatly improved from today due to improved power availability, fuel quality, and gas management. The full environmental benefits of INES will depend on a well-funded, systematic national program of environmental improvement and protection, and the national wealth created by INES will make such a program feasible.

**Exhibit 5 - 40: Summary of INES across Strategic Objectives**



Source: Booz & Company analysis

	<i>Strategic Objective</i>	<i>Metric Value</i>
1	<b>Energy Security</b> Average of annual share of domestic energy demand met through domestic supply for 2011-2030	93%
2	<b>NPV of government's cash flow (from the energy sector)</b>	-\$5 Tn
3	<b>Diversification</b> Average share of non-oil & gas sector in Iraq's total real GDP for 2011 – 2030	54%
4	<b>Employment Creation</b> Direct, Indirect and induced jobs created between 2011 and 2030	220 k direct job 9 Mn indirect and induced jobs
5	<b>Environmental Sustainability</b> Indicator capturing stress imposed by energy sector on air and water on a scale from 0 (for worst) to 5 (for best)	3.2

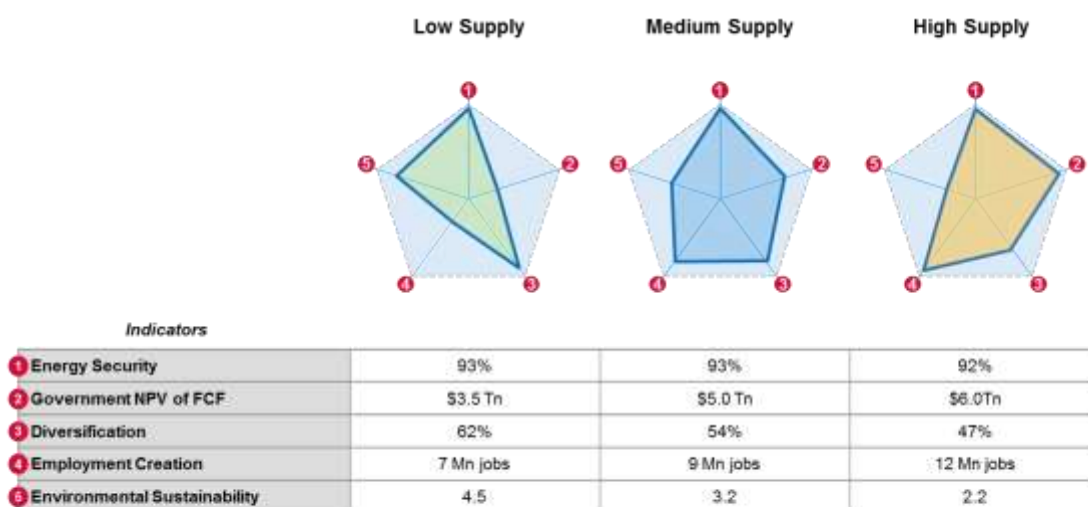
### 5.5. Sensitivities and Risk

The outcomes of INES described in the previous section are sensitive to oil price and production levels. INES projections for oil cash flow assume oil production at the Medium production level and a Brent price of \$110 per bbl. Because this cash flow strongly affects the other dimensions of evaluation, these are important variables. Exhibit 5-40 indicates the sensitivity of these evaluation dimensions to different oil production profiles.

- Energy security remains high under any of the production scenarios.
- Government NPV varies directly with oil production levels, reflecting the dominant role played by oil exports in overall energy cash flow.
- Economic diversification is higher on average at lower production levels, since diversification measures the ratio of non-oil and gas revenue to total revenue.
- Employment generation varies directly with government NPV and is therefore less favorable at lower production levels.

- Environmental sustainability is higher at lower production levels because increased economic production increases the elements of environmental stress. Potentially offsetting this effect, however, is the greater level of resources available to the government under higher production levels that can be used for environmental remediation and regulatory enforcement.

**Exhibit 5 - 41: Production Impact on INES Outcomes**



Source: Booz & Company analysis

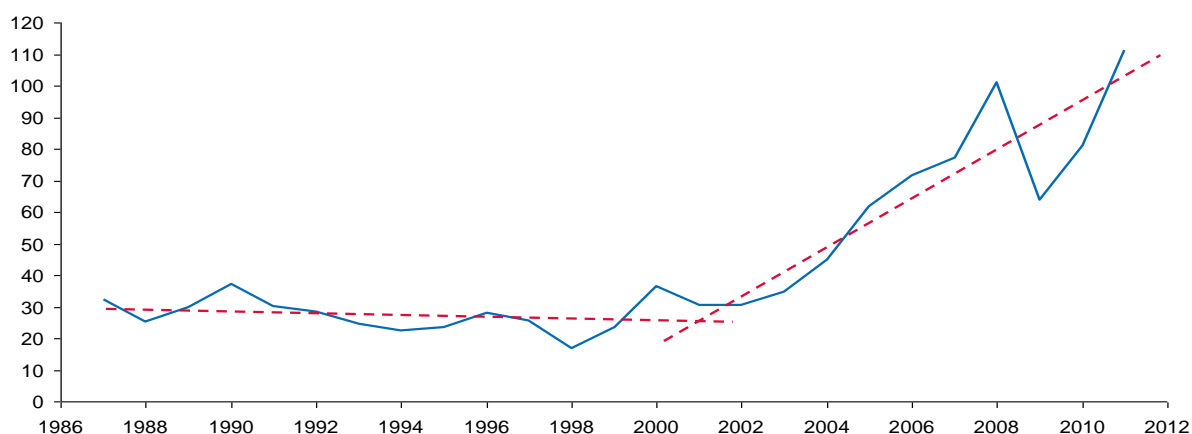
The impact of price variations on INES would be similar. If the average Brent oil price will diminish in a directly linear way. As indicated above in Exhibit 5-34, for each \$20 per bbl decline in oil price, the NPV of government cash flow from the energy sector would fall by roughly \$ 1 trillion. Economic diversification would be higher, and employment creation would be lower, while energy security and environmental sustainability would be unaffected. An average price higher than \$110 would have the opposite set of effects.

Crude oil prices are volatile and notoriously difficult to predict. By the standards set over the past quarter-century, \$110 per bbl is high. However, the strong entry of China and India into world oil markets around 2000 appears to have created an inflection point in oil price trend lines. At present the \$110 per bbl assumption (in 2011 dollars) has roughly equal probabilities of being higher or lower than actual price.<sup>64</sup>

<sup>64</sup> The International Energy Agency's 2011 World Energy Outlook posits three long-term global demand scenarios: "Current Policies," "New Policies," and "450." The scenarios reflect different levels of public policy assertiveness in managing global emissions and energy efficiency. Between 2015 and 2030 the average projected price for "IEA crude imports" (in 2010 dollars) is \$121 for Current Policies, \$111 for New Policies, and \$97 for 450. The "IEA Crude Imports" benchmark is about \$2 below the Brent benchmark used in INES.

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**Exhibit 5 - 42: 25 Years of Brent Crude Price**  
2011 USD, yearly averages



Although INES outcomes are sensitive to oil price and production assumptions, INES recommendations for infrastructure investment and capacity development are not sensitive to those factors. The basic policy choices reflected in INES are appropriate under a broad range of price and production assumptions. This resilience is attributable to three circumstances:

- The logical sequence of infrastructure development. Industrial capacity cannot economically be developed until fuel and feedstock infrastructure is in place. The power sector cannot use combined-cycle gas technology until reliable gas supply is available. Oil and gas production cannot be increased significantly until evacuation infrastructure is available for oil and until gathering and processing infrastructure is available for gas. In these and other ways, the sequence in which Iraq's energy infrastructure must be developed is determined by basic logistics rather than by production or price levels.
- The need for self-sustaining economics. Developing the energy sector will be expensive, and Iraq's ability to borrow funds is limited. The energy sector needs to raise itself by its bootstraps, generating cash flow from the beginning to pay for investments later on. Iraq needs to produce and export oil to generate its initial cash flow. With that cash it can invest in gas infrastructure and power development. With adequate gas infrastructure and power capacity, it will be able to create additional wealth. Economics as well as logistics underlie the INES sequence of development.
- The stability of hydrocarbon allocation priorities. The allocation priorities described in chapter 4 are based on the international market value of hydrocarbon products in relation to each other. The prescribed sequence is sensitive to the available quantity of these products only if volumes fall to a level where scale economies in their application are no longer available. None of the production scenarios considered would have this effect. The prescribed sequence is sensitive to oil price only if the *relationship* among product prices changes significantly. So long as historic correlations of hydrocarbon product prices to crude oil benchmark prices persist, then the absolute price of crude oil does not affect the priority of allocation.

INES recommendations are therefore robust across a relatively wide range of potential economic variables. In this sense, INES itself is a low-risk strategy. However, successful



execution of INES is subject to numerous risks. INES calls for infrastructure build-up at a pace well beyond anything that Iraq has managed before now. Iraq must overcome logistics bottlenecks, resource constraints, and institutional limitations to coordinate and manage multiple major initiatives. Iraq also must design and plan a long-term structure for sector governance capable of achieving the long-term INES vision.

### Exhibit 5 - 43: Overview of INES Short-Term Execution Risks



These execution risks need to be addressed through the institutional dimension of INES, discussed below in Chapter 6.

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## **6. Institutional Reform**

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### **6.1. Overview**

INES comprises both economic and institutional recommendations. Chapter 5 describes the INES infrastructure and production plans and an integrated investment program for achieving them. The current chapter describes the institutional reforms needed to implement this program.

The institutional challenges of Iraq's energy sector fall into a short-term and a medium- to long-term time frame. In the short term, the energy sector's institutions need to deploy all currently available resources and attention to the achievement of specific, urgent tasks - - the objectives set forth in the short-term "Oil Rush" phase of INES. Once the foundation has been established for sustained energy-sector growth, the institutional agenda will shift. In the medium and long terms the focus needs to be on developing durable governance frameworks that support efficiency, accountability, integrity, and professional role differentiation.

### **6.2. Short-Term Institutional Reform**

During INES's short-term phase, Iraq's energy institutions need to focus on a challenging array of immediate objectives. To initiate a program of major structural rearrangement during this period would be counterproductive. Several more modest institutional initiatives will be needed, however, in order to ensure appropriate attention to critical priorities.

Three ministries will have primary responsibility for implementing INES: the Ministry of Oil, the Ministry of Electricity, and the Ministry of Industry and Minerals. It is recommended that within each of the Ministries one or more temporary task forces be established. Each task force would be responsible for ensuring that its Ministry deploys the necessary resources and effort to accomplish on schedule the INES investment agenda.

It is also recommended that within each Ministry an institutional reforms committee be established. Its mission would be two-fold: first, to develop for implementation in the short term a program to strengthen institutional competencies, and second, to design for implementation in the medium term an institutional framework appropriate to the Ministry's evolving long-term mission.

Each of these groups should be chaired by a Minister or Deputy Minister. Each should comprise 6 to 7 senior officials of its Ministry, supported by external advisors as needed. Each should have the authority to make decisions on behalf of its Ministry and should be held accountable for accomplishing a specific set of tasks pursuant to the INES schedule. The specific mission of each group will reflect its Ministry's role in implementing INES.

#### **The Ministry of Oil**

INES recommends that the Ministry of Oil establish two task forces, one for development of oil resources and one for development of gas resources, plus a single institutional reform committee covering both oil and gas.

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**Oil Task Force.** The Oil Task Force will be responsible for monitoring and overseeing the execution of short-term INES objectives in oil, both upstream and downstream. It will conduct the following primary activities:

- **Expedite and monitor field works.** The MoO has to oversee 12 technical service contracts, ensuring through reviews and approvals that investments are appropriate and that best practices for reservoir management are observed. While review needs to be careful and professional, it also needs to be efficient, and approval authority needs to be delegated to personnel who are knowledgeable of the circumstances and able to render decisions rapidly. Unnecessary bureaucratic delay cannot be allowed to add to the already substantial technical challenges of bringing the Iraqi oil fields into rapid development.
- **Facilitate logistics and administration.** Production ramp-up will require coordinated logistics support to mobilize EPC contractors, service providers, work crews, and rigs. Impediments to the efficient processing of import approvals, visas, and technical support will need to be identified and eliminated. This effort is too extensive to be accomplished through ad hoc interventions; it will require process review and continual monitoring of process outcomes.
- **Monitor execution of water injection infrastructure.** The Common Seawater Supply Facility has not yet attained the Front End Engineering and Design (FEED) stage, and even as planned it is not sufficient to serve the water requirements of all the fields. The planning and execution of this facility, involving all members of the TSC consortium, needs to be actively monitored by the MoO and remedial actions need to be taken in case of further delays
- **Monitor execution of field evacuation infrastructure.** The MoO needs to ensure that TSC plans are modified to provide separation and segregation of heavy oil grades at the oil field, in line with the INES commercialization strategy.
- **Ensure timely development of the oil evacuation system.** Oil production plans require substantial expansion of both southern export capacity through the construction of single-point mooring stations and northern export capacity through rehabilitation of northern evacuation pipelines. These plans also require revival of a North-South pipeline link. These evacuation projects require right-of-way arrangements with regional governments that must be secured within the coming months in order to avoid construction delays, and active implementation of construction plans.
- **Ensure development of interlink from field to main depots.** Responsibility for the movement of oil from field depots (for which field operators are responsible) to the main depots on primary evacuation routes (for which the MoO is responsible) is not clearly assigned. Responsibility for this movement must be clarified, and the MoO needs to ensure that the plans for each stage of oil movement and transfer are aligned.

**Gas Task Force.** The Gas Task Force will have parallel responsibilities pertaining to gas. It will be responsible for monitoring and overseeing the execution of short-term INES objectives in gas, both upstream and midstream. It will conduct the following primary activities:

- **Monitor execution of gas gathering and processing infrastructure.** The MoO needs to ensure that the gas gathering and processing infrastructure needed at Ahdab, Round 1,

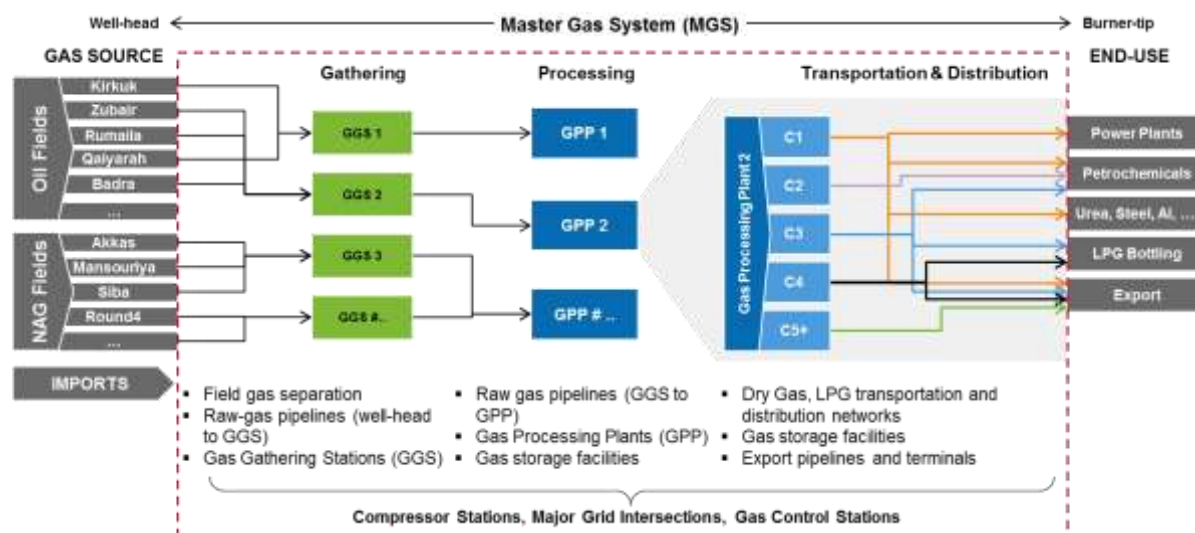
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and Round 3 fields is developed on schedule, and that field operators' plans for gathering, compressing, and transporting well-head gas are aligned with plans for mid-stream gas processing facilities. The MoO needs to facilitate the integration of SGC into BGC and support the BGC's infrastructure development program.

- **Monitor execution of transportation infrastructure.** Field operators are expected to build gas gathering and processing infrastructure capable of handling an additional 4 bscfd of raw gas at ten new processing plants. The MoO needs to ensure that handovers are coordinated and that transportation infrastructure is aligned. With each passing month, greater amounts of raw gas are being produced at Iraqi oil fields. Until a comprehensive infrastructure is in place to gather, process, and transport that gas, it will be flared - at heavy economic and environmental cost.
- **Align gas infrastructure with user requirements.** User expectations of gas volumes, delivery points, and timing need to be confirmed as early as possible. The current joint MoO - MoE committee handling this interface is an important part of this process, but at present it lacks the ability to commit to and enforce agreed volumes.
- **Commission a design for a Master Gas System.** The MoO faces a major design challenge in linking the multiple sources of gas production with processing facilities, transport lines, and off-take points. Injection and withdrawal rates from supply and demand nodes will vary widely, gas flows will shift as the regional balance of supply and demand evolves, and load patterns will follow daily and seasonal demand. Processing facilities, compressor stations, storage locations, and system controls will need to be located and integrated to optimize system performance. The complexity of this design challenge will increase over time as the volume of associated gas increases, as non-associated gas emerges from new fields, as new power plants and industrial sites come on line, and as gas export opportunities arise.

The MoO should engage a technical engineering advisor to design a comprehensive Master Gas System (MGS) that builds on existing plans, integrates them into a technically and logistically coherent system, and provides for future expansion. The scope of the MGS should encompass the movement and treatment of gas from well-head to burner-tip. It should not only specify system design but also provide recommendations for standards and regulations for the construction, operation, and maintenance of system components.

Exhibit 6 - 1: Scope of Master Gas System



**MoO Institutional Reforms Committee.** The Institutional Reforms Committee will be responsible for developing a program of short-term and long-term institutional reform for both the oil and gas subsectors. It will conduct the following primary activities:

- **Define and oversee the MoO’s capability agenda.** The MoO needs a development plan for enhancing and deepening its human resources. It needs to assess the gap between existing skill levels and those needed to accomplish the INES vision, including such critical capabilities as oil and gas policies and planning, regulatory design, pricing, contracts and partnership management, project management, HSE, and petroleum reserve management. Once identified, these gaps should be addressed through a broad program of human development measures funded by donors, international organizations, and the private sector. This program should be implemented as early as possible, and pursued throughout the INES period.
- **Establish a Petroleum Reserve Management System.** Iraq’s current understanding of its oil and gas resources is inadequate to a nation that aims to become one of the world’s leading providers of hydrocarbon products. Over the next two to three years, the volume of information available to Iraq will explode, as data comes in from exploration and production activities at current oil fields and from seismic studies and exploratory drilling in as-yet unexplored blocks. Converting this data into actionable insight, and then into long-term plans, will require systematic gathering, tracking, analysis, and evaluation. In particular, it will require:
  - Definitions and standards. The MoO should adopt the Society of Petroleum Engineers (SPE) standards and definitions for its internal resource management and reporting. The standards should be cascaded to all participants in the and should form the basis for future reserves and resources evaluation and reporting, including ERPs and FDPs. The MoO should start with a pilot focusing on the super-giant fields.
  - Reporting and processes. Reserves and resources should be reported annually and audited on a regular 3 – 5 years schedule. Information, probabilistic assessments, and commercial evaluations should be submitted at the level of individual development projects within each field.



- Database and software. With consistent and detailed reporting, state-of-the art industry data software can be deployed to store, manage, and analyze Iraq’s resource data.

These elements together can provide comprehensive, consistent, and current reserve information. On the basis of this data the MoO can be in a position to make informed decisions in 2014 and 2015 regarding long-term production targets.

- **Develop plans for restructuring the MoO.** A major responsibility of the Committee will be the development of a long-term restructuring plan for the MoO, to be implemented after the short term. Recommendations for this restructuring are discussed below in Section 6.3. Planning for this restructuring should begin in the short term.
- **Commission studies to improve investment incentives and product pricing.** The MoO should review and revise the incentives currently provided to refinery investors, and it should define policies for foreign participation in the refined-products retail sector. Admitting international gasoline retailers into the Iraq market, with pricing margins that permit investment in facilities and service quality, would have a transformative impact on the retail sector. The benefits would be felt immediately by the consumer and would strengthen public support for Iraq’s broader program of energy development to world standards.

Concurrently, the MoO should define long-term wholesale and retail pricing policies for domestic oil and gas products. Currently, all retail products prices (gasoil, gasoline, Kerosene and LPG) cover their production costs but are significantly below international prices. Attracting international investment will likely require a closer alignment of domestic and international prices.

**Exhibit 6 - 2: 2011 Domestic Petroleum Product Prices**

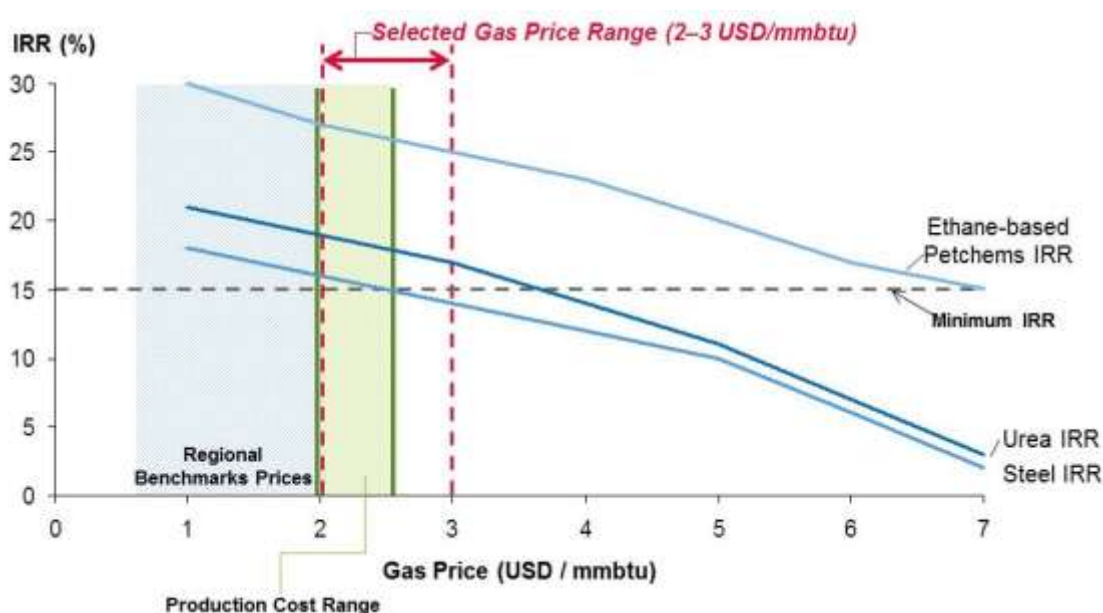
Category	Petroleum Product	End User	Current Price (2011)	Covers Production Costs? <sup>(1)</sup>	Lower than International Prices?
Retail	Gasoil	Commercial / Retail	46 \$/bbl (400 ID/Liter)	Yes	Yes
	Gasoline		60 \$/bbl (450 ID/Liter)		
	Kerosene		20 \$/bbl (150 ID/Liter)		
	LPG		214 \$/ton (~3,000 ID /12 kg cylinder)		
Wholesale	Crude Oil	Government Refineries	2.3 \$/bbl	No	Yes
		Private Sector Refineries	Discount as defined in Law 64/2007	Yes	Yes
	Fuel Oil	Power, Linked Industries	20 \$/bbl (150 ID/Liter)	Yes	Yes
	Dry Gas	Power, Linked Industries	1.04\$/mmbtu	No	Yes
	LPG	Linked Industries	N/A	-	-

<sup>1)</sup> Production costs include operating expenses, depreciation of assets and return on capital  
Source: Booz & Company analysis



Some of these pricing reforms can wait until the medium term for implementation, but, a policy needs to be implemented in the short term regarding prices charged to industry for wholesale gas. Industry investment plans will need to be made over the next three years, and they will depend heavily on gas price expectations. INES recommends \$2.00 to \$3.00 per mmbtu as the appropriate price range. This figure satisfies three criteria: (1) it covers the actual incurred cost of producing and delivering gas, including operating expense, depreciation of assets, and return on capital; (2) it conforms with regional gas price levels; and (3) it provides a viable return for industrial investors. The actual weighted cost of associated gas received from both associated and non-associated fields ranges from \$1.80 to \$2.40 per mmbtu. Regional benchmarks range between \$0.80 and \$1.00 per mmbtu but are expected to rise in light of growing shortages and more expensive sour gas developments taking place in some regional countries. A \$2 to \$3 per mmbtu would provide investors with at least 15% return on their capital.

**Exhibit 6 - 3: Price Selection for Gas Sales to Linked Industries**



### The Ministry of Electricity

The power subsector faces the immense challenge of transforming today's decrepit and defective electricity system into one capable of supporting a rapidly growing economy. Managing this transformation will require not only capital resources but strong management and institutional support.

As with the oil and gas sector, the immediate tasks facing the power sector are too urgent to allow for major restructuring of industry institutions in the short term. However, the existing institutional structure does need special mechanism to help focus its efforts and circumvent bureaucratic impediments.

INES recommends that the MoE establish a Power Task Force to oversee the actions needed to meet demand and a Loss Reduction Committee to develop and pursue a plan for reducing technical and commercial losses. INES also recommends the establishment of an Institutional Reforms Committee to address the power subsector's immediate and long-term institutional needs.

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**Power Task Force.** The immediate need in power is to meet demand. Plans are being implemented to accomplish this task by the end of 2016 through the construction of 22 GW of new generation capacity. To assure success in this vital effort, the Power Task Force needs to ensure focused institutional support. It will conduct the following primary activities:

- **Expedite contracting and confirm fuel allocation.** The MoE needs to expedite and conclude pending EPC contracts, strengthen the transmission system to handle the increased generation, and closely coordinate with the MoO to ensure that fuel agreements are clear, reliable, and backed by appropriate contingencies in case gas is temporarily unavailable or insufficient.
- **Ensure timely construction works.** The Power Task Force should monitor closely the advancement of construction works, facilitate the requirements of EPC contractors for visas and permitting, resolve logistical bottlenecks, and coordinate with the MoO to ensure that fuel pipeline infrastructure is in place
- **Ensure transmission alignment.** As new plants are brought on line, transmission need to be in place capable of connecting to the plants and handling the increase in power loads.
- **Ensure seamless handover of plants to O&M operators.** The MoE needs to ensure that managerial and technical resources are in place to operate and maintain the new plants once they are commissioned. The number of qualified staff required for this purpose is estimated to be between 4,000 and 6,000. While the MoE will be able to staff many of its new generation plants, it also should consider extending existing EPC contracts in some instances to cover a transitional period of operations and maintenance. Alternately, it could tender operations and maintenance of some plants to service companies. The MoE should begin now to develop a handover plan that incorporates a workable mix of these options.

**Loss Reduction Committee.** As power travels from the power plant to the paying customer, it suffers significant attrition. Twenty percent of power dispatched by generators is lost through technical deficiencies in the transmission and distribution systems, and reaches no one. An additional 23 percent is lost to theft via illegal connections to the grid, and fails to reach system customers. Another 26 percent reaches customers who are billed but don't pay (a category that includes several government agencies). Less than one-third of dispatched power is actually paid for by the customer. The Loss Reduction Committee will be responsible for developing and pursuing a comprehensive plan to reduce value leakage in the power system. It will conduct the following primary activities:

- **Collect and analyze loss data.** The MoE needs to understand the sources and locations of its technical losses, identify root causes, and assign priorities.
- **Upgrade network infrastructure.** The MoE needs to repair or replace defective meters and install meters where they do not exist today. In doing so, it should move meters outside of residences to facilitate meter reads and to discourage tampering. It needs to increase the capacity of distribution stations, transformers, and other equipment, and needs to rationalize and reinforce its network of distribution lines.
- **Enlist legal and public support.** The MoE needs to propose laws and regulations that incentivize payment of bills, penalize theft, and allow for disconnection of non-paying customers. It needs to launch also a public awareness campaign reinforcing these laws and stressing the safety hazards of power theft.

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- **Strengthen billing and collection processes.** The MoE needs to update its customer account database, incentivize meter readers to cover all meters, provide customers with easy alternatives for paying bills, install a comprehensive billing and customer service system, and develop consistent processes for collection follow-up and enforcement.
  - **Consider engaging private-sector participation in distribution.** The complexity of Iraq's distribution network challenges, both technical and commercial, will likely require the engagement of international expertise, systems, and processes. The MoE should consider tendering out distribution service contracts for upgrading, operating, and maintaining the distribution network and for handling collections and billing. Separate contracts could be negotiated for each of the seven existing distribution directorates. Contractual frameworks could be designed on lines similar to the technical service contracts used in oil field development: asset investments and operating costs would be reimbursed, with additional remuneration tied to the achievement of specific performance indicators.

**MoE Institutional Reforms Committee.** The rapid build-up of power capacity in the short term will strain the capabilities of the Mo E. Over the past four years, MoE investments have averaged \$3.4 billion per year; over the next four years, the planned average investment will be almost double that amount - \$6.7 billion. Thereafter the MoE will be managing a system with twice the capacity of today's system, and it will be expected to meet the demanding power requirements of a rapidly expanding economy. To meet this managerial challenge, the MoE needs urgently to build its internal capabilities and to secure external assistance. The Institutional Reforms Committee will be responsible for developing a program of capability enhancement within the MoE and for proposing plans for the long-term structural reform of Iraq's power sector. It will conduct the following primary activities:

- **Drive the capability agenda.** The Committee needs to recruit, hire, and train skilled personnel. It also should collaborate with national universities to provide a structured combination of classroom and on-the-job technical and managerial training. Six capability areas should be given immediate priority: strategy and planning (for sector structure design, system planning, fuel optimization), regulations (economic and technical, conventional and renewable), environmental assessment, contracting, and project management.
- **Plan for the restructuring of the MoE.** A major responsibility of the Committee will be the development of a long-term restructuring plan for the MoE, to be implemented in the INES medium term. Recommendations for this restructuring are discussed below in Section 6.3. Planning for this restructuring should begin in the short term.
- **Initiate a program for phased introduction of IPP investment.** Iraq would benefit from both the capital and the expertise that independent power projects (IPP's) provide. With no existing track record of IPP development in Iraq, however, initial IPP's are likely to be costly. They will expect a long project development period, which adds substantially to investment cost, and they will likely perceive Iraq as a high-risk environment and require capital returns commensurate with that risk.<sup>65</sup> It is recommended that rather than

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<sup>65</sup> An IPP developer typically undertakes to build a plant and to supply its output to a power buyer pursuant to a guaranteed power purchase agreement. The price of power sold by the IPP must be sufficient to provide an economic return on the IPP investment. Under such an arrangement, an IPP developer has a guaranteed market and a guaranteed price, and therefore bears negligible market risk, but the developer does bear construction risk. The major elements of that risk are delay and unanticipated costs. The more uncertain the developer's schedule expectations - whether due to

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pursuing multiple IPP's now, when required returns might reach as high as 30 percent, Iraq should phase in an IPP program, starting with a single project over the next two to three years. Once one project has been successfully developed, risk perceptions will improve. At the same time, the experience gained by the MoE in tendering and negotiating an IPP contract will enable it to expedite future projects.<sup>66</sup>

In developing a pilot project, the MoE will need to address and resolve several issues that currently impede IPP investment. For example, it will need to find ways of assuring any IPP that long-term purchase contracts will be honored - possibly through explicit sovereign guarantees. It will need to be able to provide enforceable assurances of fuel supply. It will need to facilitate the processes by which IPP investors are able to invest and repatriate funds, deploy employees, and manage logistics. These conditions will take time to achieve, but once achieved they will open the door to active IPP participation.

### **The Ministry of Industry and Minerals**

Unlike the oil and gas subsector and the power subsector, the linked industries subsector under INES does not face an immediate need to implement major capital investments. Some energy-intensive industries that can be developed in the near term, such as cement and bricks, will be funded exclusively by the private sector. Large scale, export-oriented petrochemical and fertilizer developments, on the other hand, will require lead time for the establishment of infrastructure, gas supply, and institutional enablers.

During the short term, the MoIM should lay the institutional foundation for this capacity expansion. This foundation will consist of several elements: an institutional vehicle for launching and facilitating strategic industries, a system of one or more industrial parks, a program for developing local content, a program for building commercial development capabilities, and the design of a durable institutional structure for the Ministry of Industry and Minerals.

INES recommends that the MoIM establish a Linked Industries Task Force and an Institutional Reforms Committee to address these needs.

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logistical concerns, contract difficulties, security threats, or regulatory caprice - the higher the construction risk. The higher the construction risk, the higher the power price the developer will require.

<sup>66</sup> It should be expected that any initial IPP pilot project will appear expensive relative to government-financed EPC contracts. Once this first project is in place, however, the cost of subsequent projects should decline progressively. Moreover, cost comparisons between IPP proposals and standard government-managed EPC projects are often misleading. IPP cash flow begins only when power flow begins. The longer capital is tied up without a revenue stream, the lower the return to the investor. Similarly, in IPP operations any unplanned shutdowns, or process inefficiencies, or staffing redundancies lower return. IPP's therefore have strong incentives for speed and efficiency in both construction and operations. By contrast, government power projects in all countries tend to proceed with a lower level of urgency and without the same focus on efficiency. Resources may be diverted, budgets may change, programs may be delayed for any number of reasons. All these contingencies carry hidden costs that are difficult to identify in analytic cost comparisons. For the government, the apparent cost of an IPP, though possibly higher than the EPC alternative, is certain. The apparent cost of an EPC project is not certain, and frequently ends up far higher than expected.

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**Linked Industries Task Force.** The Linked Industries Task Force will develop during the short term the enabling entities required for large-scale industrial development. It will conduct two primary activities.

- **Establish an Iraq Strategic Industries Company.** Several linked industries are strategically important to achievement of the INES vision: petrochemicals, fertilizers, steel, and aluminum. Each of these industries has the potential to achieve substantial scale and to compete in world markets based on Iraq's abundance of natural gas fuel and feedstock. Each can add significant economic value to Iraq's production of hydrocarbon products and generate attractive business margins. Each provides opportunities to attract international investment, build domestic skills and jobs, and diversify the Iraqi economy.<sup>67</sup>

INES recommends that these industries be sponsored and coordinated by a single government-owned holding company, an Iraq Strategic Industries Company (ISIC). It is expected that ISIC will enter into multiple JVs to leverage the capital, technology, and managerial and commercial expertise of global industrial players.<sup>68</sup> A centralized corporate holding entity of this kind will offer three primary advantages over a more decentralized structure. First, it will ensure that planning for these industries leverages the linkages and synergies that exist among them. Second, it will reduce business risk to the private sector and JV partners, since fuel allocation and guarantees of feedstock, land, and export facilities will be handled by a single government-backed entity. Third, it will allow for strategic design of investment incentives, and will permit development of consistent local content rules to promote job creation and domestic capabilities in secondary manufacturing and services. In the long term, once these industries have been established successfully through the ISIC's joint-venture affiliates, the MoIM may decide to permit the establishment of wholly privately owned companies that are not affiliates of the ISIC.

Ownership of ISIC would be held by the Government of Iraq, although the government would have the option of sharing ownership with regional governments, public investment institutions such as retirement funds, or Iraqi citizens via a partial share offering. ISIC would operate under the direction of a board of directors comprising representatives of government ministries, senior managers of ISIC itself, and independent industry experts.

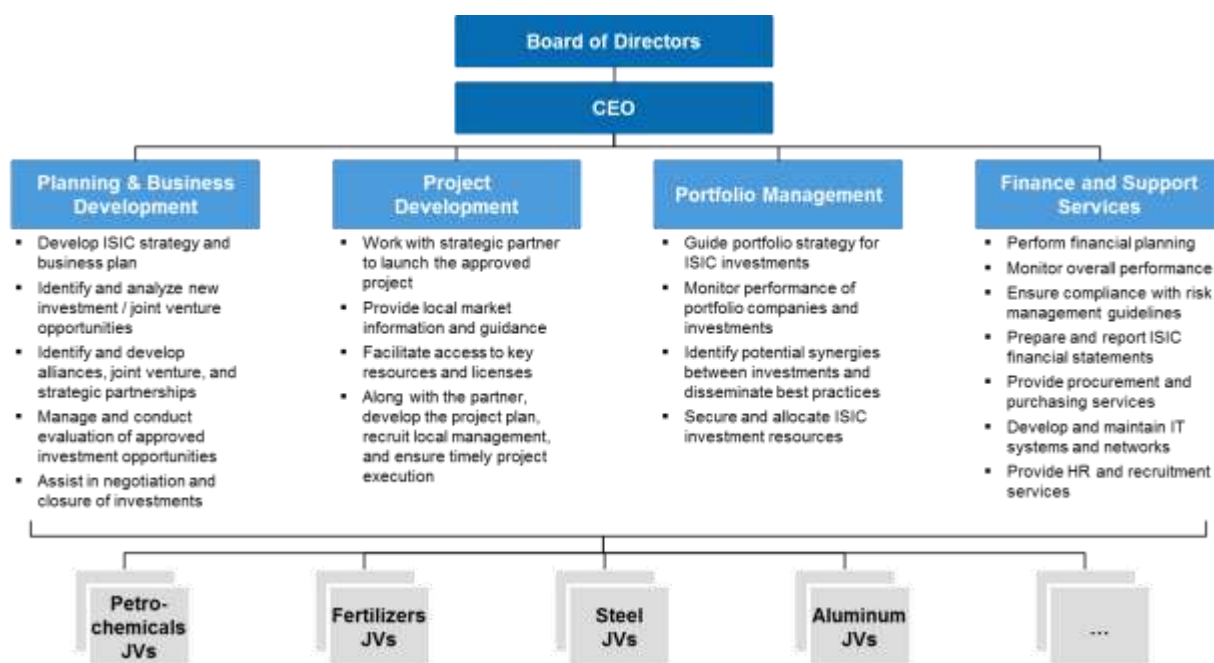
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<sup>67</sup> Two other linked industries - cement and bricks - are important to Iraq's economic development, but serve primarily domestic markets and can be developed on a smaller scale near demand centers and raw material supplies, at the initiative of private developers. They do not need the same degree of focused government planning and oversight as the strategic industries described here.

<sup>68</sup> Successful examples of similar holding-company approaches to planned industrial development can be seen in Saudi Arabia's SABIC and Malaysia's PETRONAS.



## Exhibit 6 - 4: Potential Structure of the Iraq Strategic Industries Company



- **Establish an Industrial Park Authority.** In parallel with the commercial planning and project development conducted by the ISIC, it will be necessary also to support strategic industries with physical facilities that offer access to fuel and feedstock supply, export routes, industrial infrastructure, and support services. In order to provide these services efficiently and at world-class quality standards, it is recommended that the Government of Iraq establish an Industrial Park Authority (IPA) to develop a common industrial park.

This park will be designed according to a master plan. Land allocation will accommodate primary strategic industries initially and then will expand to accommodate capacity growth in those industries and the addition of downstream industries. It will provide community areas and common facilities such as hospitals, schools, and recreational spaces, as well as basic community services like police and fire protection, sanitation, and maintenance. Importantly it will provide an efficient modern infrastructure to handle flows of fuel and feedstock, provide reliable power, and facilitate shipment and export.

The IPA should concentrate its efforts initially on the development of a single park, most likely near Basra where the proximity of gas fields and export facilities provides strong natural advantages. Once a single park is established, it may be worthwhile later to develop additional parks – albeit on a smaller scale – at other locations in order to promote regional economic growth diversity.

Developing such a park is a substantial and long-term undertaking, and should be conducted under the direction of a dedicated authority, funded and owned by the Government of Iraq. Private participation in IPA infrastructure investment could be permitted subject to the IPA's overall development plan.



## Exhibit 6 - 5: Potential Structure and Functions of the Industrial Park Authority



The Linked Industries Task Force would be responsible for overseeing the steps needed to set up and launch the ISIC and the IPA: designing the organizations, defining their roles and objectives, securing necessary approvals, and hiring the leadership and initial staff. Pending the establishment of these entities, the Task Force would be responsible for initiating joint-venture negotiations with potential investors, securing fuel and feedstock allocations, and designing incentive packages so that the initial wave of INES capacity additions can be accomplished on schedule.

**MoIM Institutional Reforms Committee.** The Institutional Reforms Committee will address the MoIM's long-term needs for structural reform, capability development, and promotion of local content. In doing so it will need to draw on international advice and expertise, and will require sufficient financial resources for that purpose. The Committee will be tasked to accomplish three primary purposes:

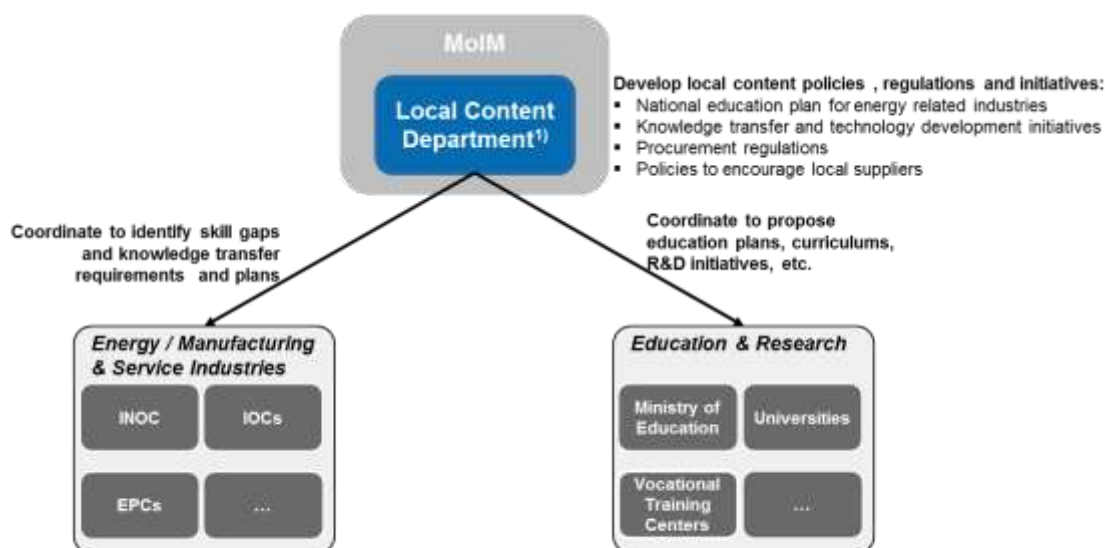
- **Strengthen the Ministry's and SOE skills.** As industries gain access to power, fuel, feedstock, and land, Iraq's potential for industrial production will grow rapidly. The MoIM will need enhanced capabilities in policy-making and planning, industry regulation, and industrial promotion and incentives. The SOE's under the Ministry will require skills in marketing, contracts and partnership management, and HSE regulation and compliance. Acquiring these skills will require training and development of existing staff, recruitment of qualified additional staff, and targeted engagement of external expertise. The Institutional Reforms Committee will have the responsibility of developing a program of hiring, training, and management development to support these needs.
- **Develop a program for encouraging local content.** One of the chief purposes of developing strategic industries is to provide Iraqis with employment opportunities in skilled trades and to strengthen domestic technical and managerial capabilities. In order to accelerate this process, the Institutional Reforms Committee should develop programs in three areas:
  - Use of local labor force and firms. The Committee should ensure that the ISIC incorporates roles for local providers in its industrial planning and in its joint-venture negotiations. Numerous mechanisms are available and should be part of the MoIM

planning portfolio. These mechanisms include breaking EPC contracts into smaller packages to provide opportunities for small-scale local suppliers, assisting local suppliers financially by facilitating bank loans or by providing advance payments, and providing bonus points in bid tenders for local ownership or for use of local suppliers as sub-contractors. Which mechanisms are appropriate, and to what degree, will evolve as domestic capabilities increase.

- Knowledge transfer and training. As part of the comprehensive economic packages negotiated with international investors, international companies should be required to provide technical and managerial training and employment to Iraqis. Similarly, international companies should be expected to participate in joint R&D initiatives and to license or transfer selected technology patents.
- Collaboration with other Iraqi institutions to pursue a long-term strategy of skills development. The MoIM should conduct a comprehensive skills assessment comparing the skills that will be needed to support Iraq’s industrial activities over the next ten years against the skills currently available within Iraq to meet that demand. Based on that assessment, it should collaborate with Iraqi universities to develop appropriate educational offerings and to recruit qualified university graduates.

In order to pursue this policy, INES recommends that the Institutional Reforms Committee oversee the establishment of a dedicated department within the MoIM to develop and coordinate local-content initiatives across the energy sector, and to enlist support from a broad array of public institutions.

**Exhibit 6 - 6: Department to Promote Local Content and Capabilities**



1) Could be duplicated in other ministries (e.g., MoO) and/or in INOC once it is established  
Source: Booz & Company analysis

- **Develop a plan for restructuring the MoIM.** The Institutional Reforms Committee should develop long-term plans to restructure the MoIM and to corporatize and privatize the MoIM’s State Owned Enterprises. It also should propose laws and regulations to facilitate development of Iraq’s industrial capacity. These changes, discussed more fully in Section 6.3, will be implemented for the most part after 2015, but planning for them should begin in the short term.

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### 6.3. *Medium to Long Term Institutional Reform*

For the foreseeable future, hydrocarbon resources and their energy derivatives will dominate Iraq's economy. Iraq's national wealth accordingly will depend to a considerable extent on the efficiency with which the energy sector is developed. It will depend also on how well Iraq can protect the professionalism, transparency, and integrity of its energy sector management. A framework of energy governance is needed that insulates the sector from short-term political pressure and allows sector managers to focus on the economic performance of the business.

From analysis of institutional benchmarks in other countries, and from discussions with PMAC and other Iraqi stakeholders, several principles of institutional design appear paramount.

- **Distinguish and separate discrete governance functions.** Policy-making, regulation, and operations have distinct aims and standards, and they should be conducted by distinct institutions. Policy makers should set directions and expectations that reflect national aspirations and serve the broad public interest. Regulators should convert those policies into specific standards that are consistently and fairly applied. Operational managers should manage economic resources in a way that accomplishes established policy objectives and conforms to the regulatory standards prescribed. Separating these functions allows each to focus on its particular tasks and contributes to sector transparency and accountability.
- **Corporatize and commercialize operations.** Once policy-setting and regulatory oversight is assigned to distinct governance institutions, the task of operations management becomes primarily economic: to optimize value created from resources employed. A corporate structure is well suited to this purpose. Corporatization establishes an economic entity whose performance is judged by value creation, not by either revenue or cost alone. It thereby provides flexibility in responding to shifts in economic circumstance or technology, and encourages the adoption of up-to-date commercial practices and systems.

Corporatization provides a board of directors that oversees operations from an independent and expert perspective. It provides a legal framework in which policies regarding budget management, human resources, and procurement can be tailored to the needs of the particular corporate mission. Finally, it permits, though it does not require,<sup>69</sup> participation by private investors, thereby expanding the capital resources available to the enterprise and introducing international expectations of transparency and performance.

- **Align governance authority with the national political structure.** Under a federal system like Iraq's it is appropriate to share responsibility for sector governance between

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<sup>69</sup> Corporatization does not necessarily imply privatization. A corporation can be entirely government-owned, while still enjoying most of the benefits enumerated. In the case of Iraq's hydrocarbon sector, the Constitutional requirement that resource ownership remain with the people of Iraq would seem to require that any corporation with ownership of oil and gas assets would be entirely government-owned. INES assumes that all oil and gas production, pipeline, and evacuation assets (with the possible exception of those in the IFRK, where ownership issues have not yet been resolved) will continue to be owned by the Government of Iraq. Other energy-related assets, however, are not constrained in this way, and various approaches to private ownership within a corporate framework should be explored.

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national and regional authorities. Those portions of the energy sector that are national in scope and that require centralized decision-making should be under the governance of the national government. Those that are primarily regional in scope and impact may appropriately be placed under the primary jurisdiction of regional authorities. Mechanisms should be developed that encourage regional-federal collaboration by providing for central coordination of regional efforts and regional input to national decisions.

- **Establish separations among the distinct businesses within operations.** Economic efficiency and transparency are encouraged when separate businesses are provided discrete economic metrics and management organizations. This unbundling of operations may evolve, starting with unbundling of accounts, to unbundling of legal structures, and eventually to unbundling of ownership and control. Even modest unbundling provides insight into the economic dynamics of the energy sector, and provides flexibility for further unbundling as desired to accommodate private investment and ultimately competition.
- **Encourage international investment.** Participation by international investors provides not only a source of capital to the energy sector but also a source of investment discipline. In Iraq it would introduce international standards of financial accountability and transparency, serve as a reality check on the economic viability of investments, and provide a path for the introduction of world-class technology and expertise.

Iraq is currently regarded as a relatively high-risk environment for investment, due to lingering security concerns, an untested legal structure, and the absence of a recent track record of investment success. For the next several years, Iraq may need to offer special incentives to compensate for this set of perceived risks. These incentives may include discounted access to land and facilities, guaranteed supply of resources at negotiated rates, guaranteed off-take of products at market prices, unconstrained repatriation of profits, and various tax and duty rebates.

The purpose of incentive packages is to correct for specific risks associated with otherwise viable projects and to foster a climate of investment security and contractual dependability. Incentives should not be used to prop up fundamentally uneconomic initiatives. The economics of projects should be transparent, and incentives should be structured to address the particular concerns investors have with respect to particular categories of projects. As international investments begin to show success, incentives can be redesigned to reflect the improved investment climate and the diminished perception of risk.

- **Rationalize pricing.** Many of the maladies associated with petroleum-dominated economies arise from the economic distortion introduced by non-economic pricing. Because petroleum resources are locally abundant, governments typically assign prices that have little relation to world market prices. Consequently, resource decisions are made - both in the public and private spheres - without benefit of market-based price signals. Under these circumstances, the domestic economy is incentivized to use petroleum resources wastefully, and the development of a diverse and economically balanced economy often is impaired.

Where these distortions already have taken hold, however, behavior patterns may be entrenched. Under those circumstances abrupt reform of subsidies can cause short-term hardship and social stress disproportionate to the desired gain in economic efficiency.

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For this reason, although Iraq's economy operates today with significantly underpriced hydrocarbon products, the correction of that distortion needs to be addressed as an incremental and long-term undertaking. It should be phased in only as economic conditions improve, and as the benefits of a more transparent pricing system become publicly accepted.

The energy sector's long-term institutional requirements, then, are to develop durable, transparent, and professional structures of governance, to encourage economic management of resources through corporatization and international investment, and to introduce on a prudent schedule a market-based system of pricing. In each of the primary energy Ministries INES recommends that the institutional reforms committee established in the short term be tasked with designing medium-term plans that satisfy these requirements. Subject to the deliberations and decisions made by these committees, INES recommends the following reforms.

### **The Ministry of Oil**

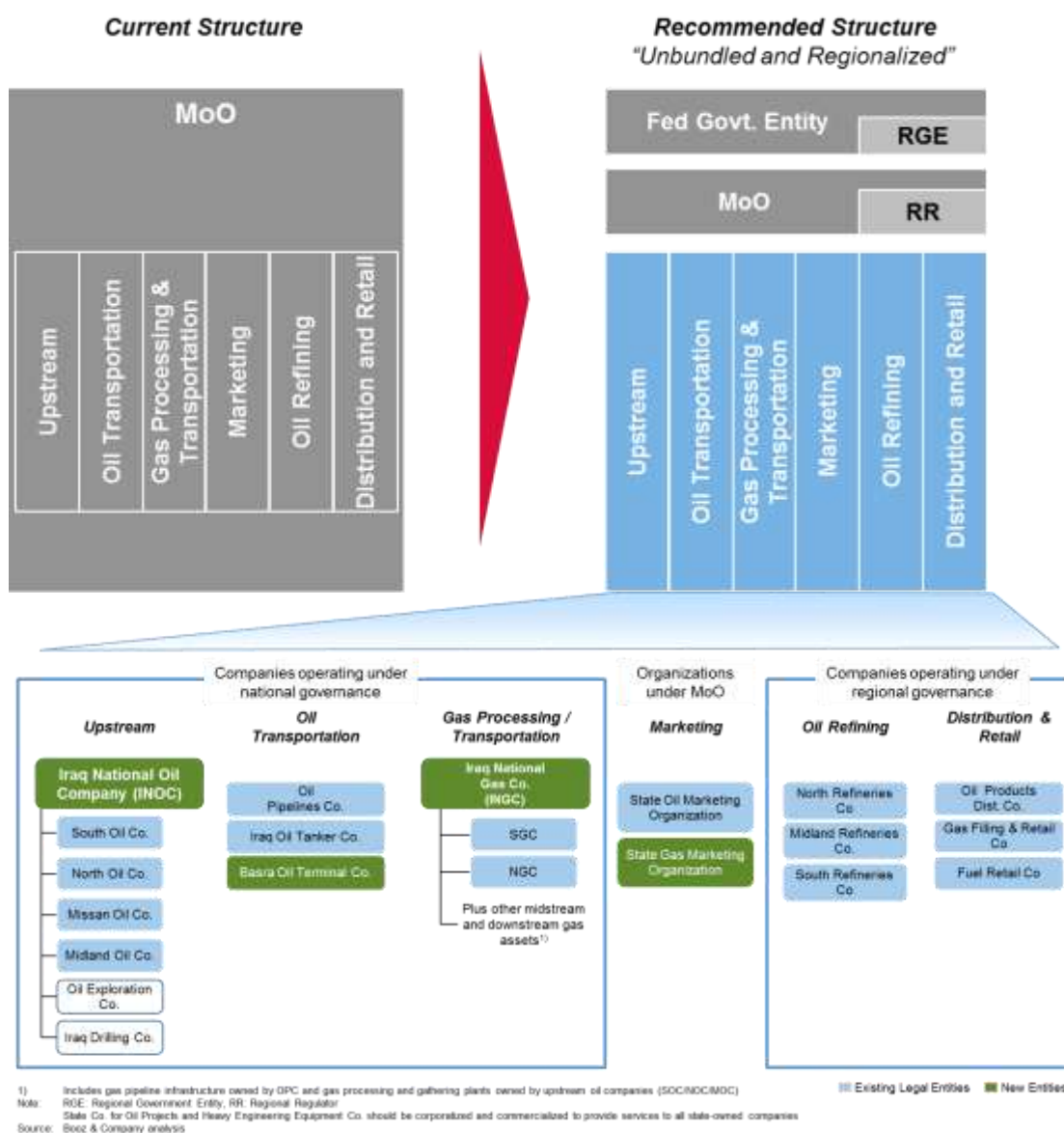
The long-term governance structure recommended by INES for the oil and gas subsector aims to accomplish five primary objectives.

- **Separate policy-making and regulatory oversight from operations.** Separate institutions are assigned responsibility for policy-making, regulation, and operations. Under the recommended structure, hydrocarbon policy would be set by a federal government entity separate from the MoO. The MoO would have primarily regulatory responsibility, as well as responsibility for marketing both oil and gas. Operations would be managed by separate operating corporations owned by the MoO but led by independent boards of directors and executive staff.
- **Share responsibilities between federal and regional authorities.** Federal policy entities would define production policies and strategy, set wholesale oil and gas prices, and market oil and gas exports. Regional policy entities would define regional strategies for refining, distribution, and retail, and would set retail prices within their jurisdictions. Regulatory responsibilities would be assigned in a parallel fashion, with the MoO given regulatory authority over matters of national policy and regional regulators given regulatory authority over matters of regional policy. The scope of selected operating companies could be aligned with this regional structure, so that refineries and distribution and retail companies would fall under the primary jurisdiction of regional policy-makers and regulators.
- **Unbundle operations.** The operating entities would be unbundled into discrete units. The marketing organization would remain as part of the MoO, and would have responsibility only for revenue optimization. Other entities would operate as profit-and-loss enterprises in corporate form, using transfer prices established by policy and regulation. Separate holding companies would be established to oversee oil operations and gas operations.
- **Establish a distinct operations unit to manage downstream gas operations.** The complex operation of Iraq's downstream gas system justifies the establishment of a single operating company with downstream gas responsibilities, capable of focusing exclusively on gas-related issues. Downstream oil operations, by contrast, are already separated into



distinct spheres of activity with clear hand-off points, and can be managed efficiently through separate companies.

**Exhibit 6 - 7: Recommended Evolution of Oil & Gas Governance Framework**



- Install an Integrated Control Center.** Iraq's vast increases in oil and gas production, its growing domestic requirements for gas and refined products, and its growing export markets will create a highly complex system of product flows. The MoO will need to develop a centralized means of monitoring and controlling this system from well-head to export points and delivery points. An integrated control system will be critical for operational transparency, accurate reporting, loss management, coordinated planning, and rapid response to system bottlenecks or interruptions. The MoO should commission a study for the design of such a system, covering oil, oil products, and natural gas, and including a central control center. It should aim toward installing this system by 2017 or 2018. Because this center will manage nation-wide flows and multiple products, it should be located organizationally within the INOC, under the control of a joint committee representing all operating companies.



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## **The Ministry of Electricity**

The same broad principles of sector organization that apply to the oil and gas sector apply to the power sector. To the extent possible, policy, regulatory, and operational functions should be separated, operations should be corporatized and unbundled, and governance responsibilities should align with the country's federalism practices.

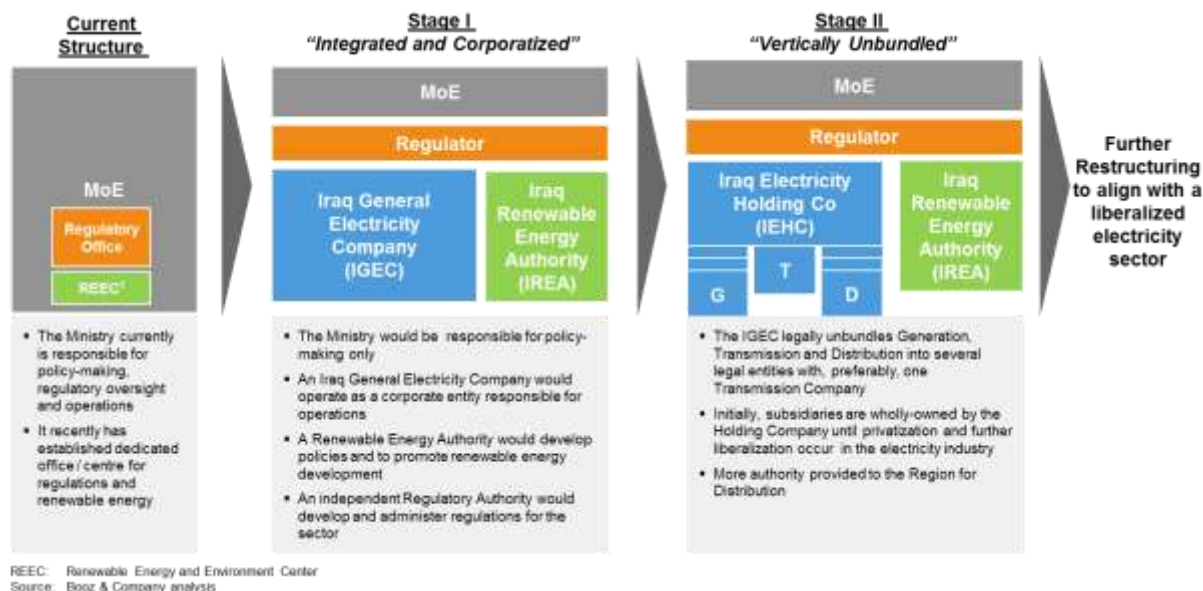
Power sector structures vary throughout the world, but appear to follow, on different timetables, a consistent pattern of evolution. Beginning often from a single integrated governmental department comprising all aspects of power management, the power sector moves into a "corporatization" stage in which vertically integrated operations (generation, transmission, and distribution) are managed through a government-owned corporation. In this stage, the sector typically begins to accommodate private sector participation through independent power production contracts supported by firm off-take agreements. To support this commercial opening, the sector establishes a regulator with authority to license and regulate these commercial arrangements.

The next stage in this evolution allows for carefully defined competition in wholesale generation, under which large consumers may strike bilateral contracts with independent power producers. At this stage, generation is likely to be unbundled from transmission in order to establish a fair competitive playing field for potential competitors, and the regulator assumes a more assertive role in defining and enforcing the terms of competition. The final stage, which only a handful of electricity sectors have reached as yet, allows full competition in generation, subject to market rules designed to preserve system integrity and reliability.

During the period covered by INES, it is unlikely that Iraq will choose to embrace full competition in power markets. However, it can benefit from adopting in stages a structure that allows the introduction of private participation and makes the economics and regulation of the sector transparent.

Following the INES short term phase, during which all efforts should be focused on infrastructure strengthening, the power sector should establish four distinct entities: the MoE with policy-making authority, a regulator, an Iraq General Electricity Company (IGEC), and an Iraq Renewable Energy Authority (IREA). Once this structural framework is established, the next stage would be to unbundle the IGEC into separate generation, transmission, and distribution companies. If desired, distribution could be managed by several regional companies, which could fall under the policy and regulatory jurisdiction of regional authorities.

## Exhibit 6 - 8: Potential Structural Evolution of the Iraq Power Sector

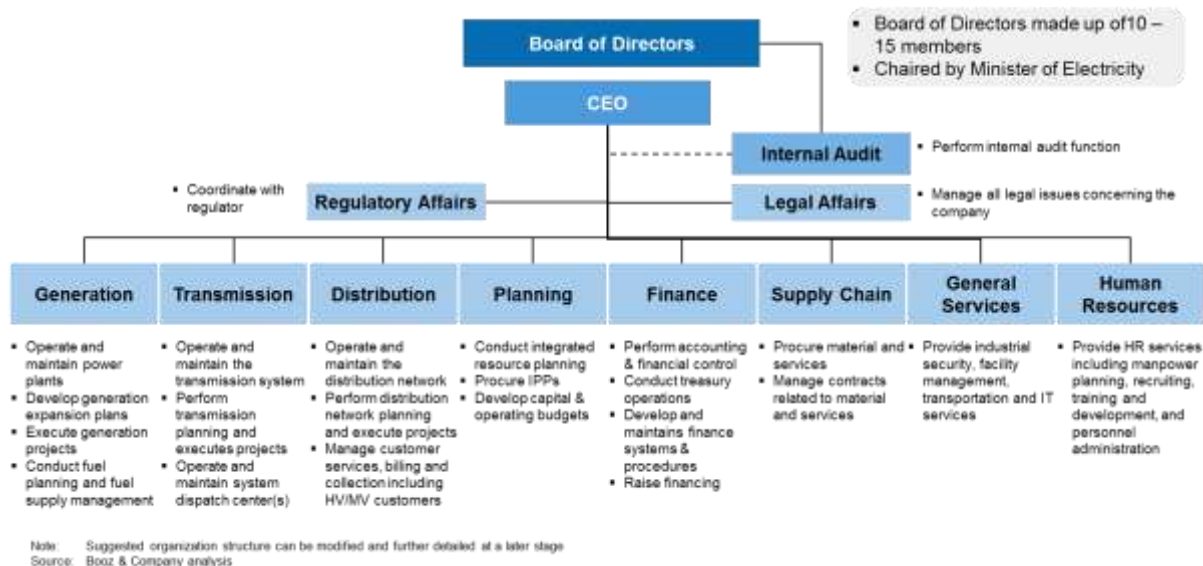


Within this framework the Ministry of Electricity would be responsible for formulating sector policies and strategies covering such areas as privatization, competition, tariff principles, renewables, and demand-side management.

The Regulator would be responsible for establishing regulations detailing the implications of the MoE's policy guidance. It would set tariffs pursuant to MoE pricing principles, promulgate technical codes and standards, detail customer rights and obligations, issue licenses, and monitor sector compliance and performance.

The IGEC would develop, maintain, and operate the assets of the power subsector, and serve the subsector's customers. It would be owned by the government, but would be governed by a board of directors and function as a corporation. Its high-level organization would encompass economically discrete business units and critical corporate support functions.

## Exhibit 6 - 9: Potential IGEC Organization



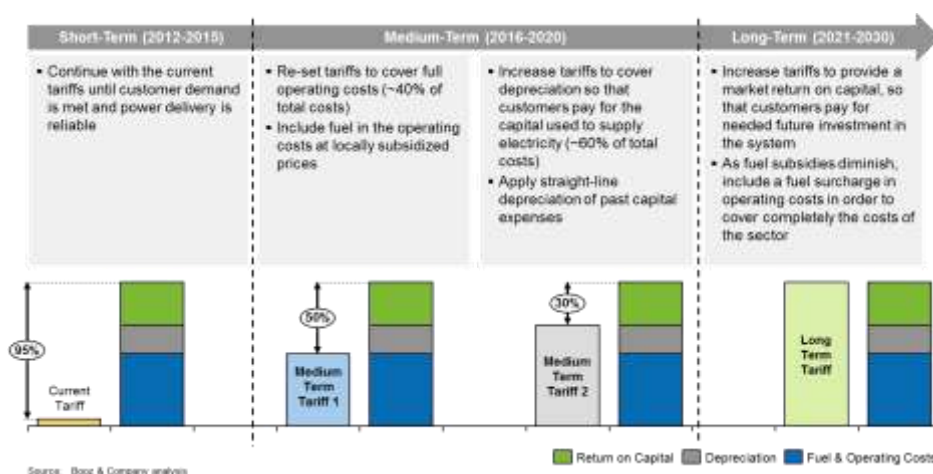
The IREA would be responsible for implementing national policy regarding renewable power. It would operate separately from the IGEC in order to focus on the development and promotion of renewable power, but once a renewable power source was established it would feed into the IGEC power grid. IREA would conduct feasibility studies and economic analyses, commission and oversee projects, recommend economic incentives and feed-in tariffs as required to meet national renewable policy objectives, and promote technical knowledge regarding renewables through research, publications, and conferences.

Along with pursuing this structural reform, the MoE's Institutional Reforms Committee should take steps to rationalize the economics of the Iraqi power industry. In common with other subsectors the MoE should seek to attract international investment and bring pricing more closely in line with costs. It should pursue in particular two objectives:

- **Explore opportunities for distribution concessions.** During the medium to long term it is recommended that Iraq consider establishing concessions to provide distribution services within defined franchise territories. Under this arrangement, an international company would acquire, develop, maintain, and operate distribution assets within its franchise. Its tariffs would be set, and its performance monitored, by the regulator (federal or regional) responsible for that territory. Until Iraq's power system is established on a more stable basis than today, this approach to privatization is not likely to be feasible, but in the medium to long-term it would represent a logical and potentially advantageous evolution from the distribution service contracts described in Section 6.2.
- **Rationalize pricing and manage power demand.** Electricity tariffs in Iraq today cover a small fraction of production cost - even when they are collected. Demand management, meanwhile, is inadvertent, consisting of shortages and deprivation. With such vast disconnects between cost and price, and between supply and demand, there is no basis for economic consumption choices or rational conservation.

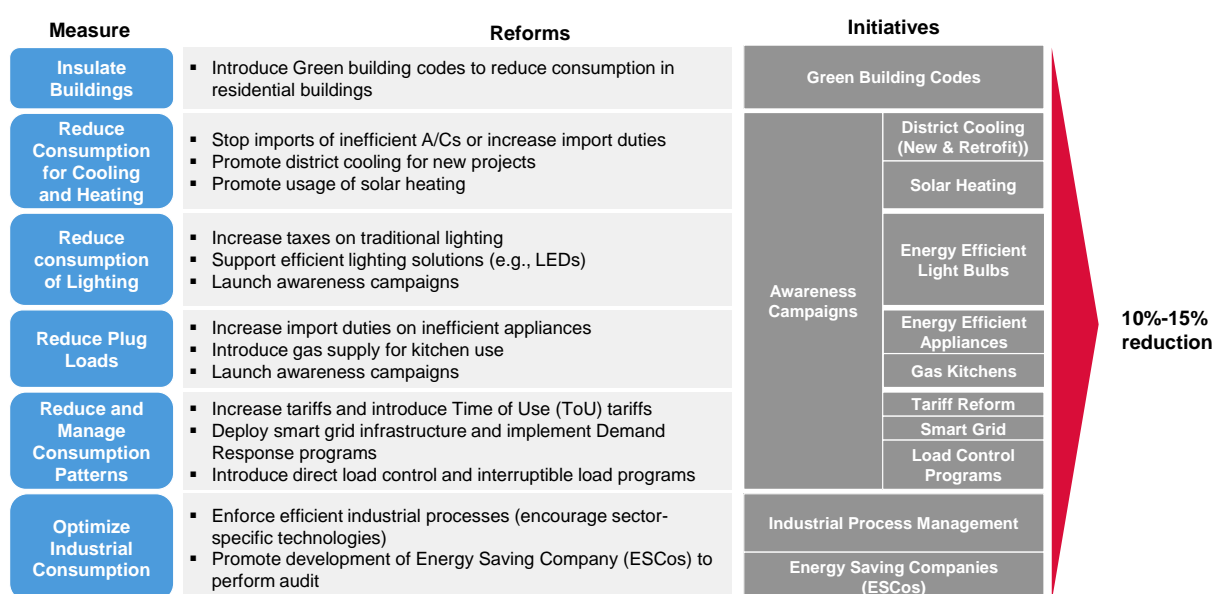
Iraq needs to close the gap between price and cost, but before it can do that it needs to close the gap between supply and demand. To raise prices while power supply is chronically unreliable would be socially and politically untenable. For this reason, INES recommends a phased approach to tariff correction, holding current tariff levels steady until power demand is met at the end of 2015, then increasing tariffs gradually to cover an increasing share of total cost.

**Exhibit 6 - 10: Stages in Alignment of Electricity Tariffs and Costs**



As tariffs increase, and as prices come closer to reflecting the costs of production, it will be feasible to introduce measures to slow the growth of power demand. Green building codes requiring such features as insulation, efficient lighting and appliances, solar panels, and district cooling can be introduced as government directives. Economic incentives such as time-of-day pricing and dissemination of energy-efficiency information will be increasingly effective as tariffs rise. In the aggregate these measures could likely reduce long-term power consumption by 10 to 15 percent. INES projections of power consumption levels by 2030 assume that a comprehensive program of demand management will be in place by then.

**Exhibit 6 - 11: Potential Programs in Demand-Side Management**

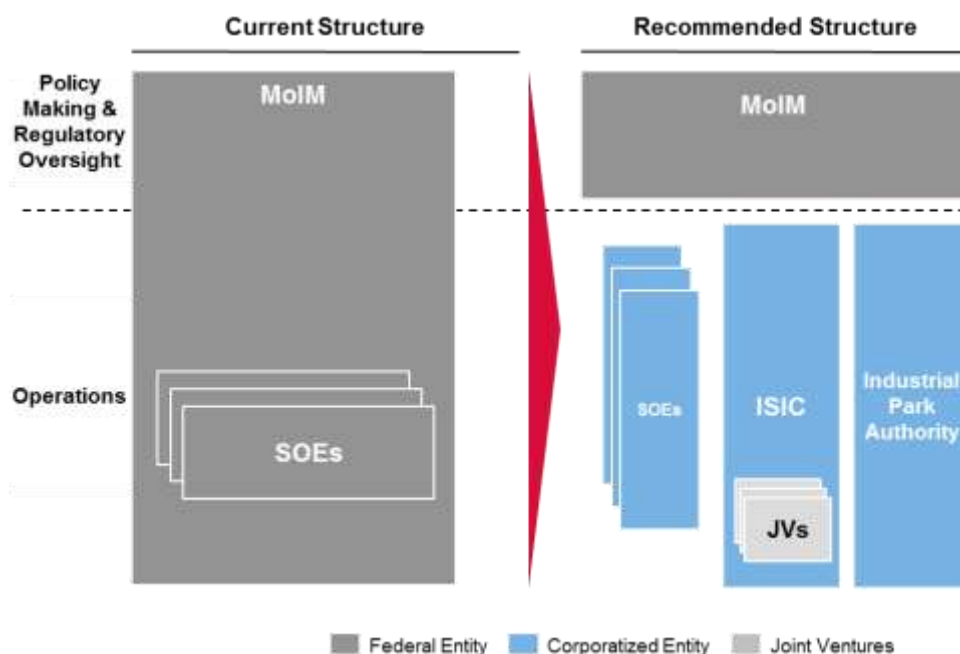


**The Ministry of Industry and Minerals.**

The development of a strong industrial sector will require the same kind of institutional separation and role clarification that has been discussed with respect to the oil and gas and the power subsectors. It is recommended that all energy-intensive state-owned enterprises (SOE’s) within the MoIM be corporatized with independent boards of directors.

As discussed in Section 6.2, ISIC should be established to develop strategic industries, and an Industrial Park Authority should be established to provide critical industrial infrastructure. These steps should be accomplished in the short term. Both these entities would be part of the MoIM and would support the capacity build-up targeted after 2015.

**Exhibit 6 - 11: Long-Term Framework for Industrial Governance**



#### **6.4. Institutional Reforms Outside the Energy Sector**

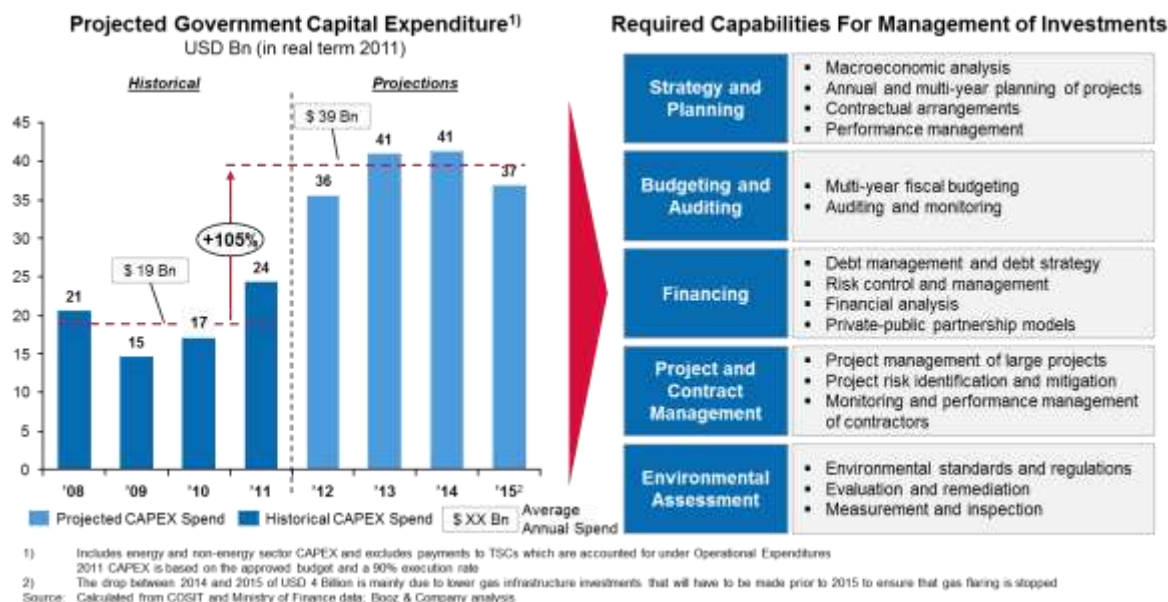
The benefits of INES to the overall Iraqi economy and society depend on a critical assumption: that the cash flow generated by the energy sector will be deployed prudently to support broad, balanced, sustainable economic growth. How to make that assumption a reality is beyond the scope of INES, but four areas are likely to require particular attention.

**Use of funds.** INES assumes that 20 percent of oil export revenues to the Government of Iraq (10 percent in years of fiscal deficit) will be invested each year in projects supporting national economic development. It also assumes that this investment will be directed toward strengthening Iraq’s productive capacity through improvements primarily in infrastructure and education. Based on these two assumptions, the energy sector is expected to support a sustained annual rate of GDP growth of 7 percent.

Managing this flow of internal investment will require capacity building across the government comparable to that proposed by INES for the energy sector. Iraq will need a balanced development strategy that avoids economic bottlenecks. It will need vigilant fiscal and monetary management to ensure that inflation remains at an acceptable level. It also will need discipline in allocating funds, auditing their expenditure, and monitoring their results.



## Exhibit 6 - 12: A Need for Enhanced Public Sector Capabilities

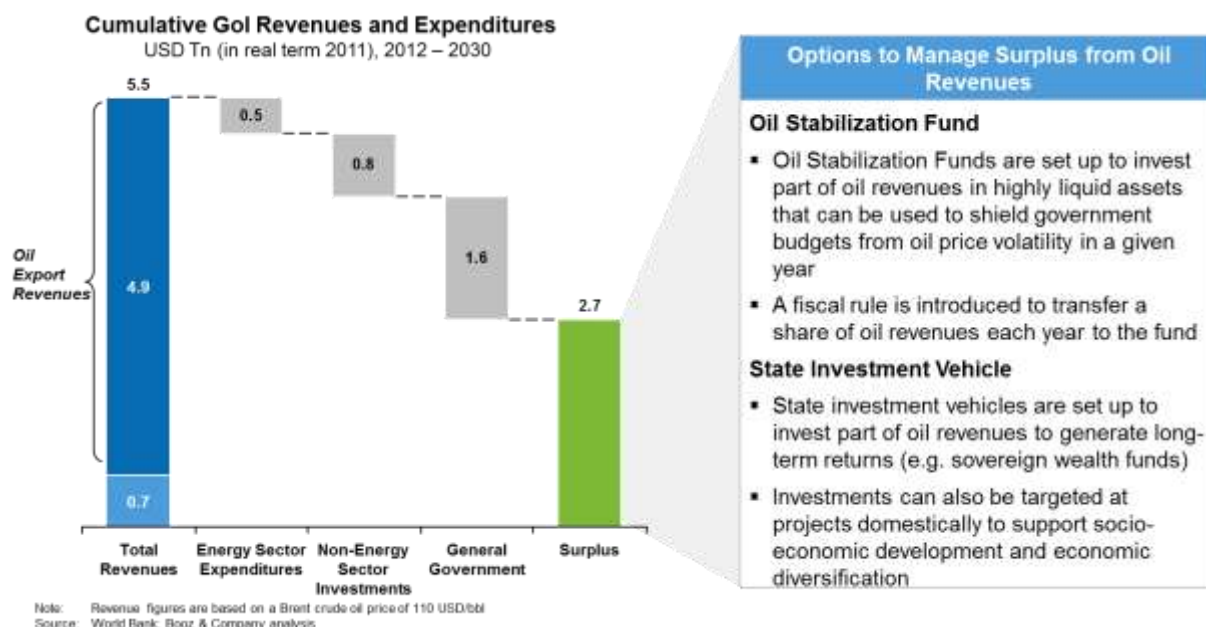


Even these assumed levels of development investment represent only a small portion of the projected cash flow from the energy sector. If the entirety of that cash flow were channeled into Iraq's domestic economy, it would flood it with cash. It would cause severe inflation, encourage wasteful spending, undermine the balanced growth of domestic industry, and present strong temptations for mishandling of funds.

In order to avoid these disruptions, and to keep the economy on a sustainable growth path through a steady but manageable investment program, it will be advisable to sequester some portion of energy-sector revenue into a separate fund. Money could be deposited into that fund during years of higher energy revenue, and drawn from it as needed during years of lower energy revenue. By serving as a default repository of funds, it would discourage indiscriminate and inflationary expenditure. Over the time span covered by INES, such a stabilization fund, properly managed, would likely grow to the point where it would represent in itself a substantial resource for ongoing creation of national wealth.



## Exhibit 6 - 13: Management of Surplus Revenue



**Environmental protection.** The environmental stress caused by rapid development of Iraq’s energy sector needs to be counterbalanced by specific plans for environmental remediation and a strong regulatory authority. As noted in Chapter 3, Iraq has comprehensive standards for environmental sustainability, but it lacks effective monitoring and enforcement capabilities. Actions are needed in three areas:

- **Revise enforcement and inspection procedures.** In the short term, detailed inspection procedures need to be defined, and a graduated schedule of penalties for regulatory violations, proportionate to the severity of the violation, needs to be authorized. In the medium term, these procedures and penalties should be implemented in all sectors of the economy.
- **Develop monitoring capabilities.** Monitoring procedures and measurement tools need to be developed, and a national data base of environmental indicators needs to be assembled and continually updated.
- **Strengthen inter-Ministerial coordination.** Specialized environmental units should be established at the MoO, MoE, and MoIM to develop targeted environmental programs in each energy subsector, and to consult with the Ministry of Environment as it sets and enforces regulatory policy.

**Institutional integrity.** Because energy will be the dominant economic sector in Iraq for the foreseeable future, it is vital that it be seen to observe the highest standards of technical and managerial professionalism. The sector needs to be insulated as much as possible from politics and partisanship, and to act disinterestedly for the benefit of all Iraqis.

The institutional frameworks discussed earlier in this chapter are designed to provide this professionalism. By separating policy, regulatory, and operating functions, by corporatizing resource management, by introducing international investment partners, and by continually strengthening internal capabilities, these frameworks can contribute to a culture of commercial discipline and integrity.

That culture needs to be respected and reinforced by other organs of government that will interact with the energy sector. The agendas and the processes followed by Iraq’s public planning, funding, auditing, law enforcement, and human resource agencies should align with the mission of the energy sector and collaborate in continually strengthening the sector’s competencies, performance, and transparency.

**Stable investment climate.** The development of a professional, world-class energy sector will require investment and commitment from world-class international partners. Iraq offers an array of potentially attractive investment opportunities in the energy sector. To realize that investment potential, Iraq also must offer a commercial system that inspires confidence. Investors need to be assured that Iraq provides durable institutions of governance, rational regulation, respect for contracts, and disinterested adjudication of claims.

**Skills development.** The human resource requirements of the energy sector have been noted. All Iraqi institutions are facing similar challenges. Much of Iraq’s professional talent has left the country. Experienced managers and experts are at a stage of their lives and careers where retirement is attractive. Iraq’s educational system has been unable to supply newly trained professionals in the numbers needed. Iraq needs to pursue a broad and sustained program of skills development, involving education policy, industrial planning, government employment rules, and foreign investor requirements. Exhibit 6-14 indicates the types of initiatives that should be considered for this purpose, and the time frame in which those initiatives could be expected to produce results.

**Exhibit 6 - 14: Measures for Building Human Capital**

<b>Attract talented Iraqis</b>	<ul style="list-style-type: none"> <li>• Iraq could attract talented Iraqis living abroad by offering better financial incentives and improving lifestyle issues. In addition, talented Iraqis residing in Iraq, can be attracted into ministries and SOEs by offering them better financial incentives</li> </ul>	Short-Term
<b>Attract foreign Expats</b>	<ul style="list-style-type: none"> <li>• Iraq could attract foreign expats with proper experience to selected ministry or SOEs positions, to ensure proper execution of projects, leverage their know-how, and increase knowledge transfer</li> </ul>	Short-Term
<b>Expand contracting with international consulting firms</b>	<ul style="list-style-type: none"> <li>• Iraq could hire experienced international consultants (legal, technical, strategy development, etc.) to aid in achieving the desired objectives and increase Iraqi capabilities through knowledge transfer</li> </ul>	Short-Term
<b>Increase retirement age</b>	<ul style="list-style-type: none"> <li>• Iraq could increase the retirement age of key senior and non-senior personnel that are close to the retirement age, to leverage their know-how and ensure proper execution of on-going projects</li> </ul>	Short-Term
<b>Set-up vocational training centers</b>	<ul style="list-style-type: none"> <li>• Iraq could improve the quality and capacity of it's available vocational training centers by allocating more human and financial resources and improving and modernizing the materials currently used. More training centers could be established if deemed necessary</li> </ul>	Short-Term
<b>Continue encouraging private sector participation</b>	<ul style="list-style-type: none"> <li>• Iraq should continue encouraging private sector participation, but include local content and knowledge transfer requirements to improve Iraqis capabilities</li> </ul>	Medium-Term
<b>Sponsor Iraqi students for training / education abroad</b>	<ul style="list-style-type: none"> <li>• Iraq should sponsor and provide scholarships for education abroad to over-achieving students, to bring back to Iraq global best practices and international experience</li> <li>• Sponsors and scholarship should not be limited to engineering practices, but include disciplines where Iraq lacks capabilities (legal matters, accounting, marketing, etc.)</li> </ul>	Medium-Term
<b>Improve domestic education</b>	<ul style="list-style-type: none"> <li>• Iraq could improve the education system by updating and aligning university curricula to the country's requirements, therefore reducing the skills supply/demand gap</li> </ul>	Long-Term

Source: Booz & Company analysis

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## 7. Path Forward

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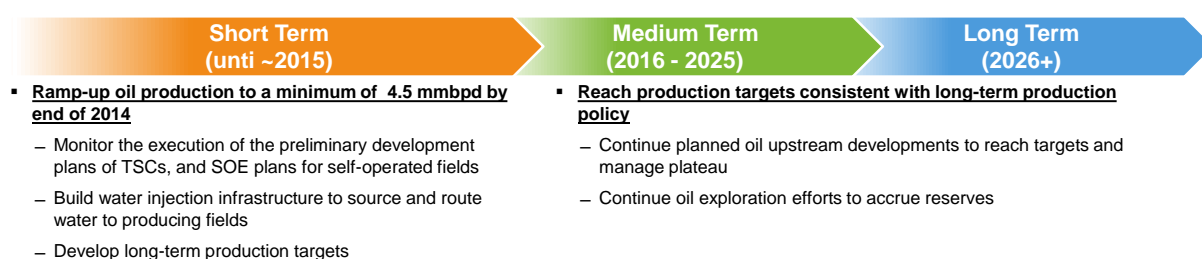
### 7.1. INES Roadmap

The INES establishes an infrastructure plan and an institutional reform plan for each of the primary energy subsectors. Those plans unfold in three phases over the next 18 years.

**Upstream oil.** The upstream oil plan in the short term calls for rapid field development and production ramp-up in accordance with the terms of the technical service contracts. Its focus is to ensure that the infrastructure required to support this ramp up is built – specifically, the infrastructure needed for injection water supply and for crude evacuation. During this period the Petroleum Reserve Management System (PRMS) will be implemented to enable the proper collection and analysis of data generated during this ramp-up. In 2015, based on improved reservoir data, production economics, and world market conditions, the medium- to long-term production targets will be set.

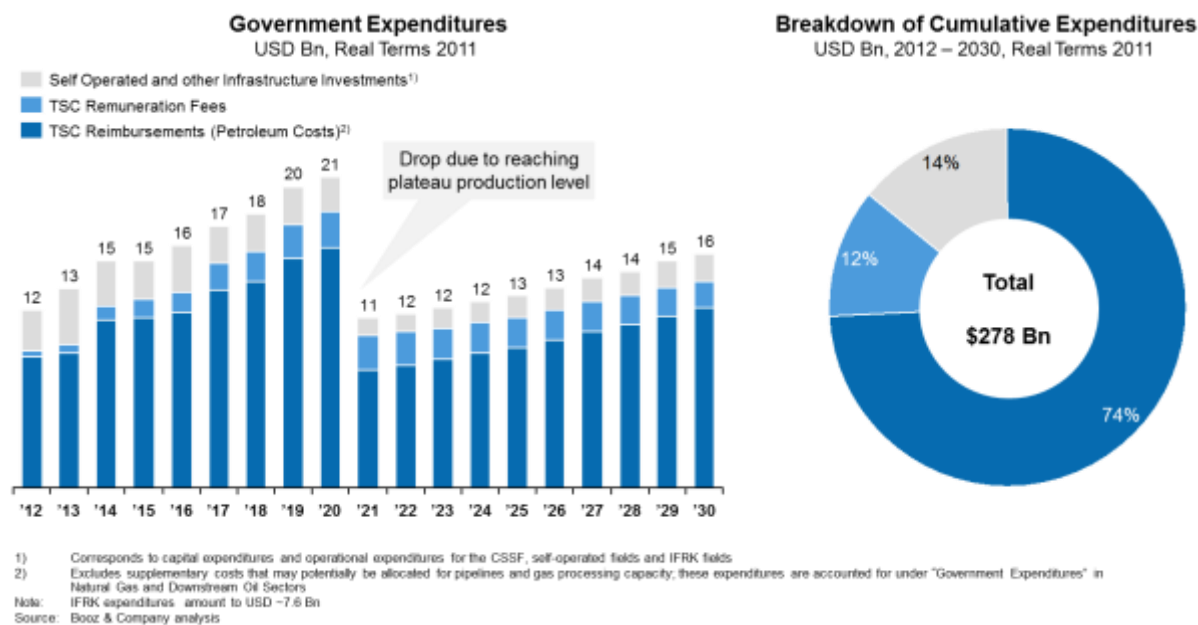
In the medium to long term, the upstream sector will continue field development and manage production to achieve the new targets set in the short term. Production targets will be periodically revised as appropriate in light of evolving resource knowledge and market conditions. Focus also will shift to managing production and accruing additional reserves through exploration in order to maintain a healthy and sustainable reserve replacement ratio.

#### Exhibit 7 - 1: Summary of Upstream Oil Strategic Objectives and Initiatives



The estimated cost to Iraq of implementing this plan, in constant 2011 dollars, is \$275 billion. These costs include approved capital expenditures by the Technical Service Contractors, remuneration fees to those contractors based on production levels, and direct MoO expenditures on self-operated fields and on the Common Seawater Supply Facility.

## Exhibit 7 - 2: Upstream Oil Expenditures



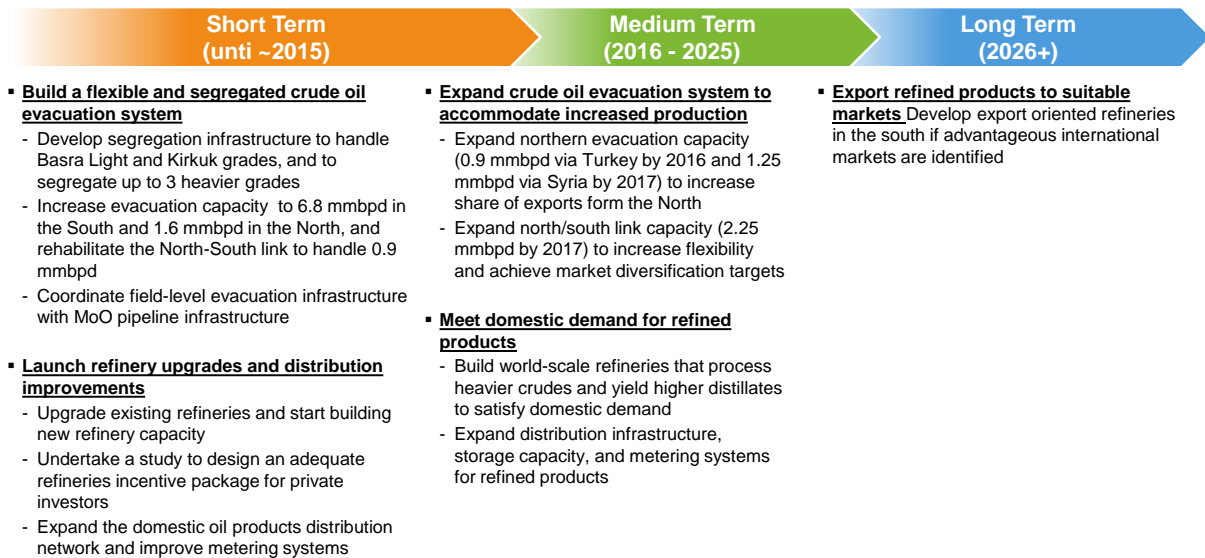
**Downstream oil.** The downstream oil plan calls for segregating new heavy oil production in the South, Center and North into new heavy grades, while maintaining the current light grades of “Kirkuk” and “Basra Light.” Evacuation infrastructure will be built to support a diversified marketing strategy that distributes Iraqi crude equally between Asian and western (American and European) markets.

During the short term, the southern evacuation system will be expanded to 6.8 mmbpd through the addition of pipelines and 4 SPMs. Of this, 2 mmbpd will be dedicated to evacuating heavier production (“South Heavy”) from southern fields. The North-South pipeline link will be rehabilitated to a capacity of 0.9 mmbpd to transport Basra Light grade from south to north. The northern evacuation system to the Mediterranean will be expanded to a capacity of 1.6 mmbpd through rehabilitation of an existing pipeline through Syria. During subsequent phases the infrastructure will be expanded to align with growing production, and an Integrated Control Center will be established capably of managing both crude oil and gas flows throughout the pipeline system.

Refining capacity will be increased and improved, beginning in the short term with upgrades and expansions of existing refineries, and progressing in the medium term to construction of new refineries. In the long term, after domestic demand for refined products is fully met, export-oriented refineries will be considered.

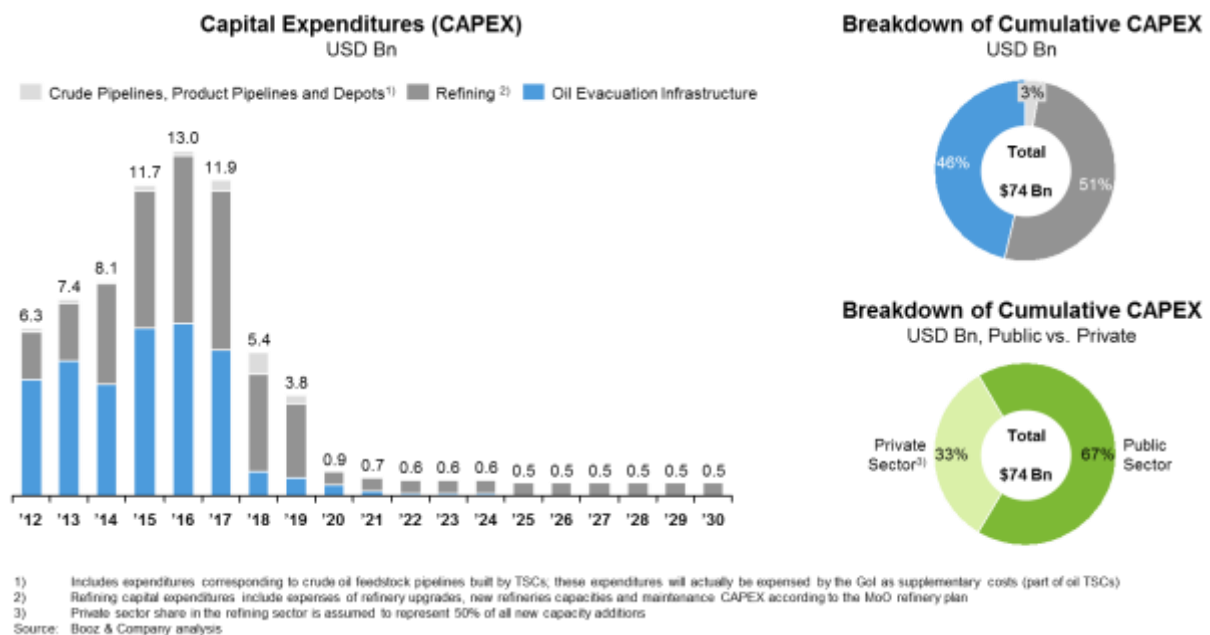
Beginning in the short term, Iraq’s refined-product storage and distribution system will be upgraded and expanded, with metering systems to permit control and measurement of product flows.

## Exhibit 7 - 3: Summary of Downstream Oil Strategic Objectives and Initiatives



The estimated cost to Iraq of implementing this plan, in constant 2011 dollars, is \$74 billion. That cost falls into three categories: investment in oil evacuation infrastructure, investment in refineries, and investment in the infrastructure needed to supply refineries with crude feedstock and to distribute refined products to customer off-take points. Approximately one-third of this total investment is expected to come from the private sector through joint ventures in refinery rehabilitation and construction.

## Exhibit 7 - 4: Downstream Oil Expenditures



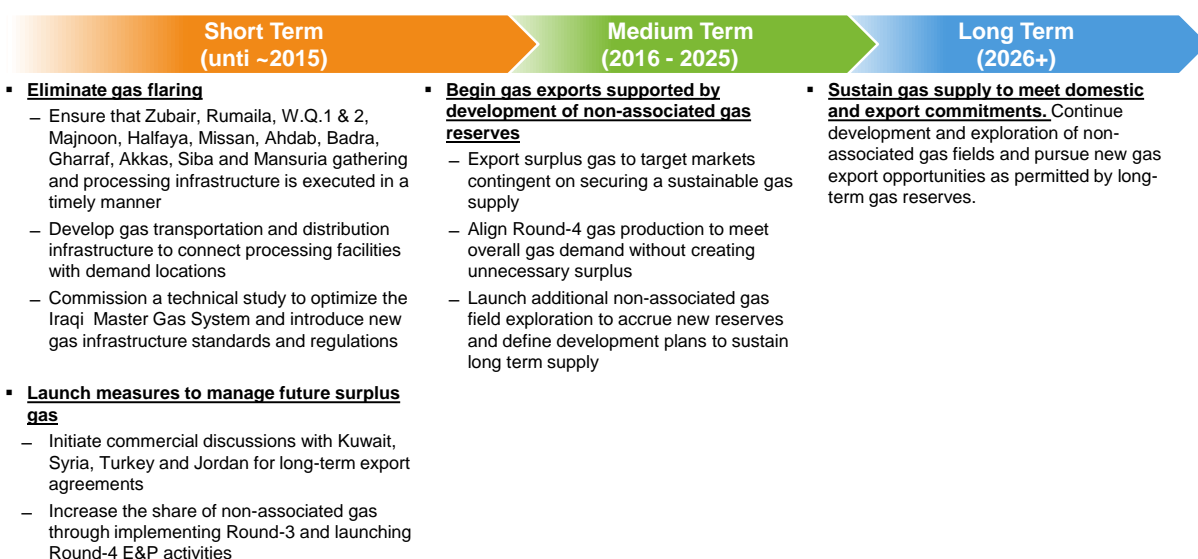
**Natural gas.** The natural gas plan calls for development of the gathering, processing, and transportation infrastructure needed to eliminate flaring of Iraq's associated gas, to be completed during the short term. During this early period a technical study will be launched for the design of the Master Gas System in order to optimize the development of the gas

infrastructure from well-head to burner-tip, and to define the standards and regulations required to administer the natural gas sector.

In light of an anticipated future surplus of gas supply, gas export options will need to be developed during the short term, and reserves of non-associated gas will need to be explored and assessed.

In subsequent phases gas exports will be implemented. Non-associated gas resources will be developed as needed in order to support domestic and exports commitments as well as to delink gas supply gradually from oil production.

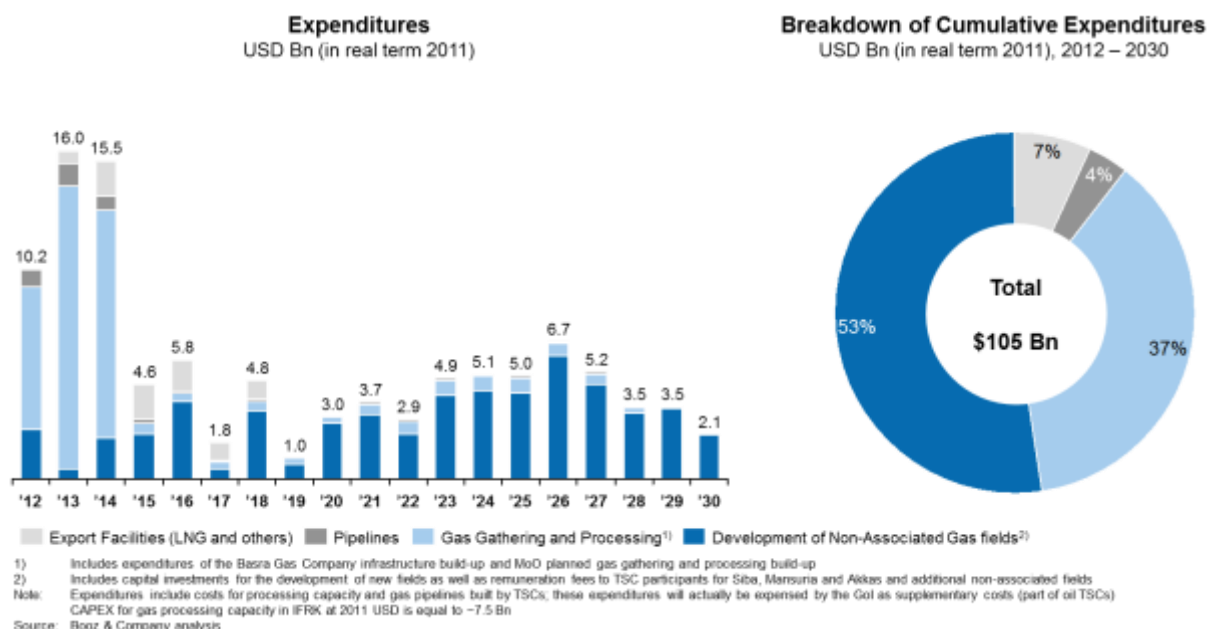
### Exhibit 7 - 5: Summary of Natural Gas Strategic Objectives and Initiatives



The estimated cost to Iraq of implementing this plan, in constant 2011 dollars, is \$105 billion. That cost falls into four categories: non-associated gas development, gathering and processing infrastructure, transportation infrastructure, and export pipelines and LNG terminals.



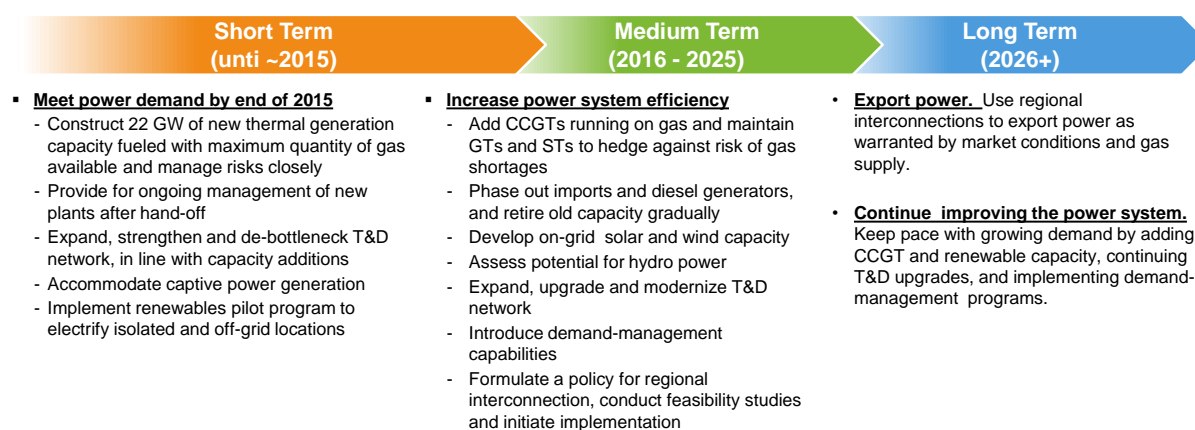
## Exhibit 7 - 6: Natural Gas Expenditures



**Power.** The short term priority for the power subsector is to meet domestic electricity demand by 2015, by adding 22 GW of generation capacity and by expanding and upgrading the T&D network. Renewable projects in several isolated off-grid locations will be implemented.

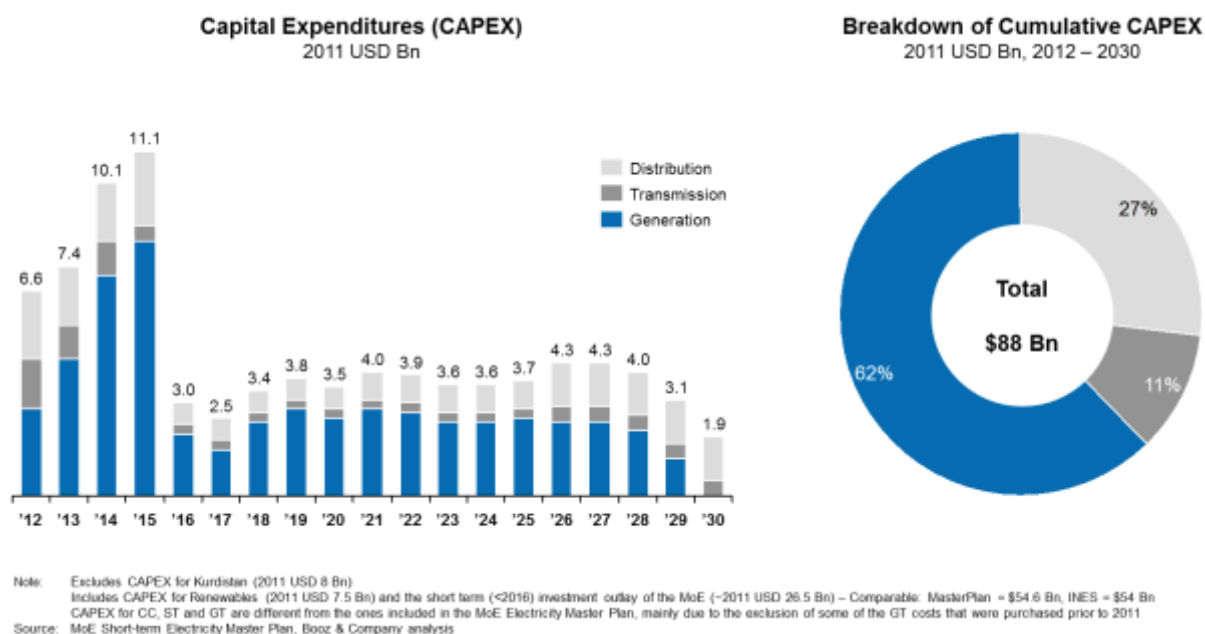
In subsequent phases capacity will grow to meet peak demand, including a 15 percent reserve margin. Capacity additions will consist primarily of CCGT units. GT and ST units will continue to operate as a hedge against potential disruptions to gas supply, but by the end of the long term the fleet as a whole will be fueled almost entirely by natural gas. On-grid renewable capacity will be built and imports will be phased out. The T&D infrastructure will be expanded and aligned to capacity additions in generation, and interconnections to neighboring regions will be explored for possible electricity exports.

### Exhibit 7 - 7: Summary of Power Strategic Objectives and Initiatives



The estimated cost to Iraq of implementing this plan, in constant 2011 dollars, is \$88 billion, divided among generation, transmission and distribution.

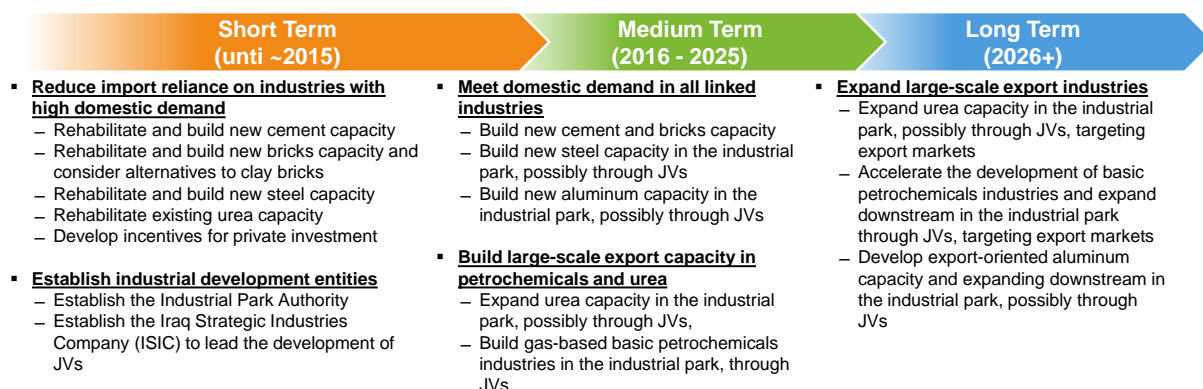
## Exhibit 7 - 8: Power Expenditures



**Linked Industries.** During the short term, existing capacity in cement, bricks, steel, and urea will be rehabilitated and additional new capacity will be built, in order to support Iraq's rising needs in construction and agriculture and to reduce reliance on imports. During this phase existing petrochemicals plants also will be rehabilitated. The foundation for strong export position in selected strategic industries, particularly urea and petrochemicals, will be laid through establishment of a government holding company and through development of an industrial park under an Industrial Park Authority.

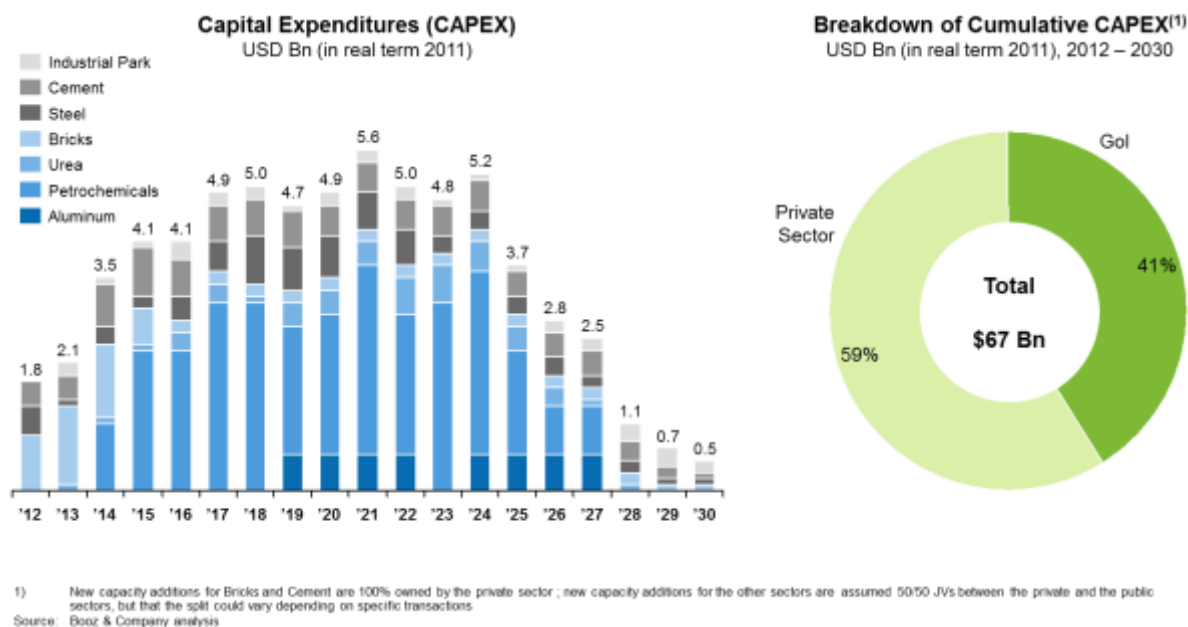
In Phase Two, the focus of linked industries shifts to the development of large-scale export capacity in petrochemicals and urea. Capacity in steel, cement, and bricks is also expanded and aluminum capacity is built. Capacity in these products will be sufficient to cover all domestic demand. In the long term, petrochemical and urea export capacity will be further expanded, and aluminum export capacity will be developed.

### Exhibit 7 - 9: Summary of Linked Industries Strategic Objectives and Initiatives



The estimated cost to Iraq of implementing this plan, in constant 2011 dollars, is \$67 billion. Roughly two-thirds of this amount is expected to come from the private sector through joint ventures.

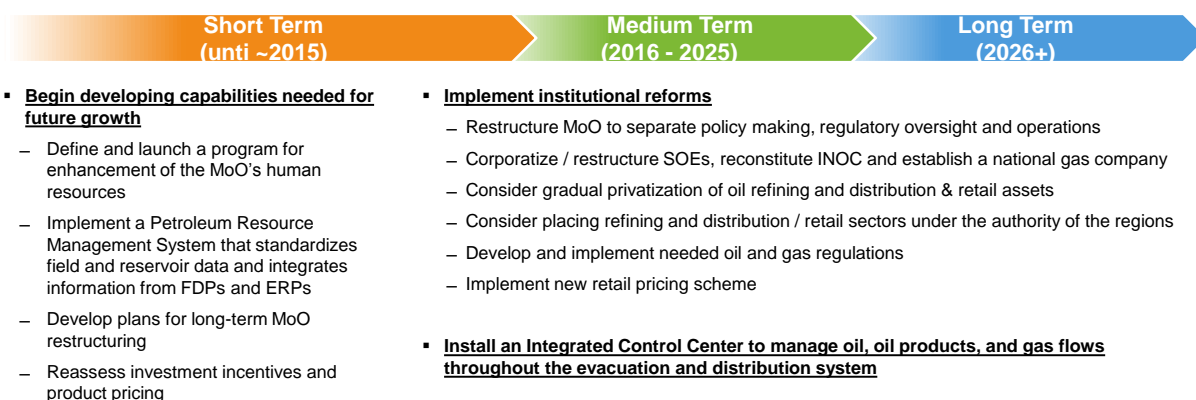
## Exhibit 7 - 10: Linked Industries Expenditures



**Institutional reforms.** The INES institutional reforms discussed in Chapter 7 will be pursued in parallel with the INES infrastructure development plan. Common to all subsectors is the need for greater technical and managerial capabilities. In addition, the governance structure of each subsector needs to evolve toward greater transparency, accountability, and commercial focus.

In the oil and gas subsector, the short-term focus is on developing institutional capabilities and on developing a detailed institutional reform plan for implementation in the medium term. The reform plan will involve the separation of policy making, regulations and operations, the balance of governance roles between Federal Iraq and the Governorates, the corporatization and reorganization of operating entities, and the reform of retail and wholesale pricing for oil and gas products. Also in the medium term, the MoO will establish a centralized control system for oil, oil products, and gas.

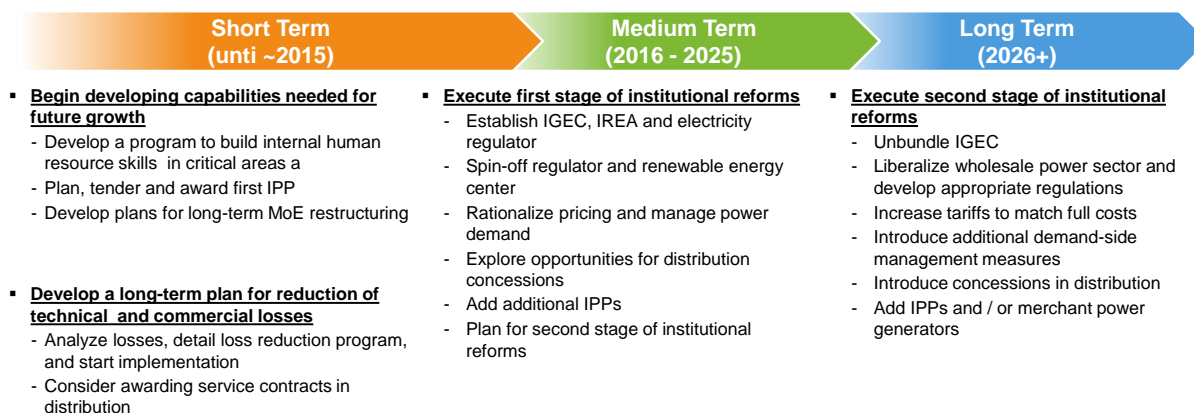
## Exhibit 7 - 11: Summary of Oil & Gas Institutional Objectives and Initiatives



In the power subsector, the -agenda is to implement a loss reduction program to remedy the current high level of technical and commercial losses, to initiate the outsourcing of service contracts in distribution, to launch a pilot IPP project, and to develop an institutional reform plan.

The institutional reform plans will be implemented during the medium term, and will involve the establishment of IGEC, IREA and an electricity regulator. Distribution responsibilities in the may be devolved to regional authorities. Tariffs will be increased gradually. In the long term, the sector’s overall structure may evolve to a point where it is feasible to consider introducing market competition.

### Exhibit 7 - 12: Summary of Power Institutional Objectives and Initiatives



In linked industries, during the short term the MoIM will establish an Iraq Strategic Industries Company (ISIC) and an Industrial Park Authority, both of which are needed to facilitate the large scale development of strategic export industries such as petrochemicals and urea fertilizers. The MoIM will design the incentive packages required to attract investors, and it will establish a local-content office to encourage knowledge transfer and development of Iraqi capabilities. Additionally during the short term, the Ministry will develop a restructuring plan for the MoIM that provides for corporatization and partial privatization of existing SOE’s. That restructuring plan will be implemented during the medium term.

### Exhibit 7 - 13: Summary of Linked Industries Institutional Objectives and Initiatives



**Exhibit 7 - 14: Key Performance Indicator (volumes and capacity)**

Key Performance Indicators	2015	2020	2025	2030
Oil Production (mmbpd)	4.5*	9.3	9.3	9.3
Oil Export Capacity (mmbpd)	8.4	10.6	10.6	10.6
- from South	6.8	6.8	6.8	6.8
- from North	1.6	3.8	3.8	3.8
- North - South Link	0.9	3.0	3.0	3.0
Gas flaring	-	-	-	-
Raw Gas Production (bscfd)	4.3	7.6	7.6	7.6
- Associated (bscfd)	3.6	6.2	6.4	6.4
- Non-associated (bscfd)	0.7	1.4	1.4	1.4
Domestically Marketed Gas (bscfd)	2.9	3.6	5.1	6.7
- Sales Gas (bscfd)	2.6	3.1	4.2	5.6
- Ethane (bscfd)	0.1	0.3	0.6	0.7
- C3 + C4 / LPG (bscfd)	0.2	0.2	0.3	0.4
Available Power Capacity (GW) - excl. IFRK	22	27	34	42
- Share of natural gas	70%	71%	80%	83%
Available Refinery capacity (mmbpd)	0.8	1.4	1.4	1.4
Bricks (MTPA)	54	61	67	72
Cement (MTPA)	30	44	57	65
Steel (MTPA)	2.9	5.9	8.9	10.2
Aluminum (MTPA)	-	-	0.5	1.0
Urea (MTPA)	1.4	2.8	5.0	6.2
Petrochemicals (MTPA)	minimal	5.6	13.1	15.6

Note\*: minimum target by 2014

**Key Performance Indicators.** Exhibit 7-14 provides an overview of key performance indicators (KPI'S) establishing capacity targets for each stage of the plan. Progress in implementing the INES can be tracked by reference to these indicators.

## **7.2. INES Governance**

INES establishes an ambitious set of objectives, many of which are scheduled for achievement immediately, during the short term. The expansion of oil production, the installation of gas infrastructure, and the elimination of power shortages, are all urgent short-term priorities that cannot be delayed without great cost to the economy, the environment, and to the well-being of the Iraqi people.

Once these short-term objectives are accomplished, a strong foundation will be laid for long-term development. The energy sector at that point will have momentum for accomplishing the significant objectives that lie beyond 2015.

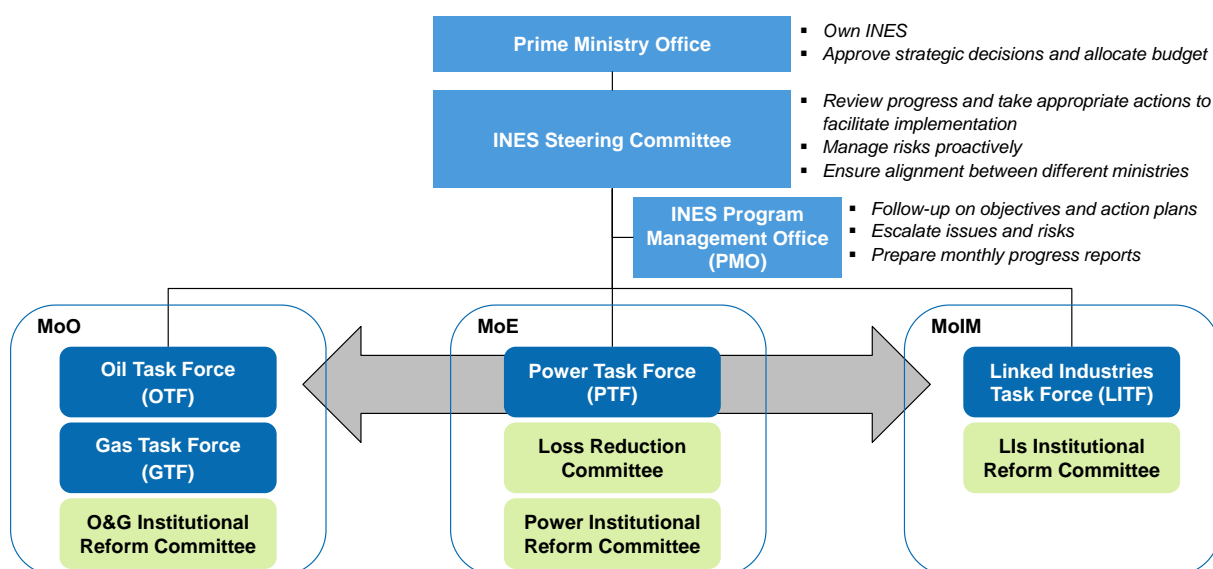
The short term is the point of critical risk. Objectives are front-loaded into this period, but institutions have little running room to build the capabilities needed.

Chapter 6 describes the special task forces and committees needed to provide institutional focus during this period. An oversight framework also is needed at the highest levels of government to ensure that the right economic and managerial resources are applied to the INES tasks, and that appropriate coordination occurs among Ministries

INES should be owned by the Executive Branch of the Government through the Prime Minister’s office that will approve strategic decisions and allocate budgets. The Legislative Branch represented by the Council of Representatives and its dedicated committees will monitor the implementation of INES and support the Government in its responsibilities.

INES recommends that Iraq establish an INES Steering Committee responsible for the Implementation of INES. The Steering Committee will be chaired by the Deputy Prime Minister for Energy Affairs or the Chairman of the PMAC. It will comprise senior representatives such as deputy ministers from the Ministries of Oil, Electricity, Industry and Minerals, Environment, Planning, and Finance. The responsibility of the Steering Committee will be to keep INES implementation on track and to provide a forum where high-level decisions can be reached quickly.

**Exhibit 7 - 15: INES Governance Structure**



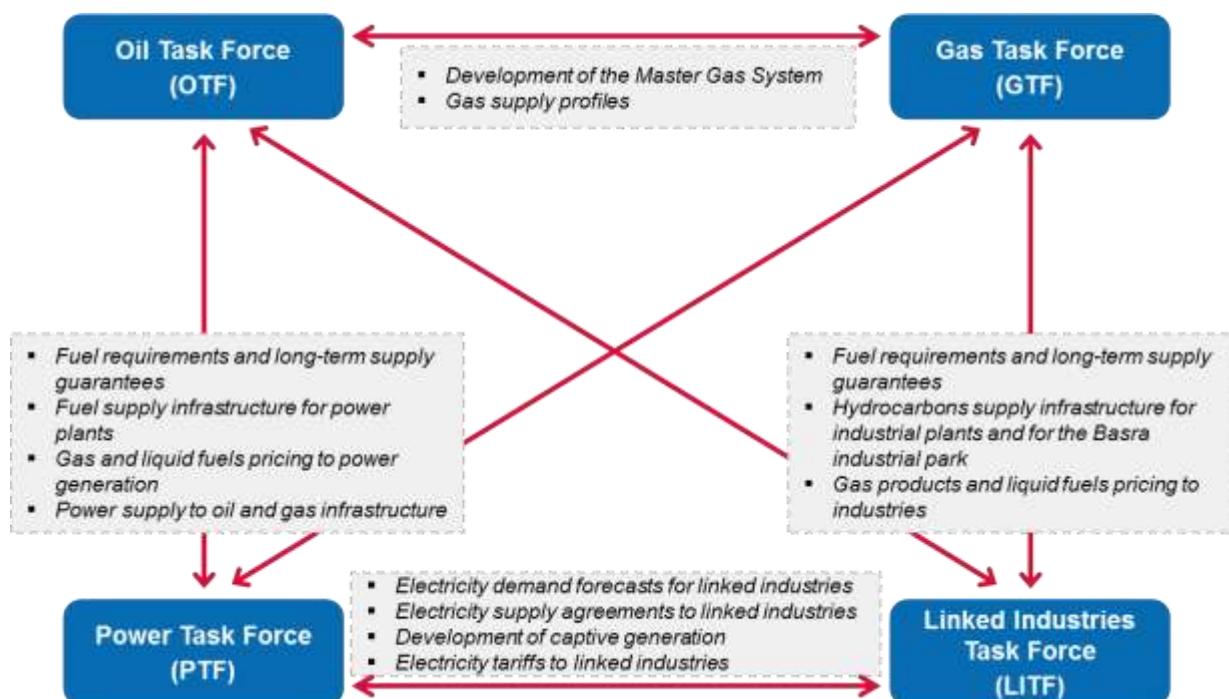
The task forces and committees established under INES would meet with the Steering Committee once a month to provide progress reports, identify and address risks and obstacles encountered, resolve issues of coordination between ministries, and secure agreement on any changes in initiatives or schedules.

In order to support the Steering Committee and to facilitate the day-to-day coordination of work among the INES tasks forces and committees, a full-time Program Management Office (PMO) will be needed. The PMO would be chaired by a senior representative from the office of the Deputy Prime Minister or the Energy Committee or the PMAC and would comprise representatives from the relevant Ministries. It would develop milestones and targets in sufficient detail to permit close tracking of implementation activities. It would prepare detailed progress reports for the Steering Committee, analyze risks, and monitor follow-up actions. The PMO also would support the task forces in coordinating among themselves and in securing necessary resource commitments.



One of the chief objectives of the proposed INES governance structure will be to encourage and facilitate coordination among task forces. Each task force will have a distinct agenda of responsibilities and targets. However, these agendas are interdependent. They can be achieved only if associated agendas under the responsibility of other task forces also are achieved, and if the timing and scope of inter-related tasks are aligned.

**Exhibit 7 - 16: Coordination Requirements among Ministerial Task Forces**



Finally, the INES governance entities will be responsible for making timely and coordinated adjustments to the strategy. As the future of Iraq's oil production becomes clearer in 2015, and as new needs arise, the infrastructure plans described in this document will evolve. INES is intended to provide a durable framework that accommodates such evolution but ensures that the various components of the energy sector remain aligned. A major task of the INES Steering Committee will be to review and update the INES on a regular basis, and to require Ministerial plans to adapt accordingly.

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**Appendix**

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***Appendix A – Infrastructure baseline***

***Appendix B – Regional and International Market Trends***

***Appendix C – Legal and Institutional Baseline and Benchmarks***

***Appendix D – Socio-Economic and Environment Baseline***

***Appendix E – Strategy Framework***

***Appendix F – Strategy Formulation and Detailing***

***Appendix G – Data Sources, Assumptions, and Additional Analyses***